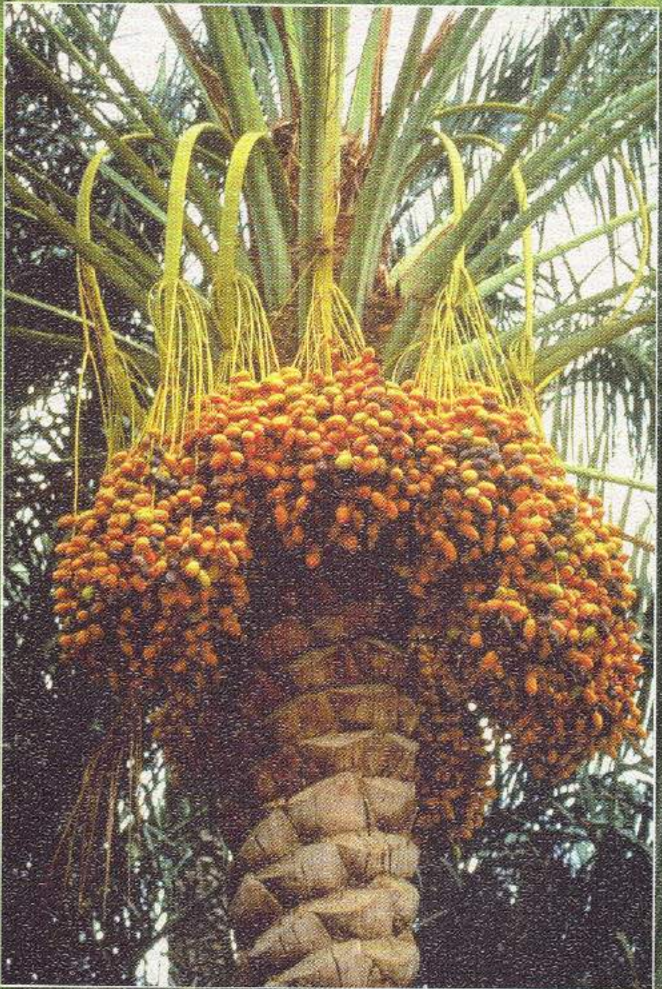
THE FIRST INTERNATIONAL CONFERENCE ON DATE PALMS

Proceedings



AL-AIN HILTON HOTEL
AL-AIN, United Arab Emirates
March 8 - 10, 1998

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Dedication

We are greatly honored to dedicate these proceedings, as humble effort, to :

HIS HIGHNESS, SHEIKH
ZAYED BIN SULTAN AL NAHAYAN,
PRESIDENT OF THE
UNITED ARAB EMIRATES

It is an expression of gratitude to His Highness for his generous support to scientific research and an appreciation for his encouragement to the workers in agriculture and his special care for the date palm tree.

His Highness Sheikh Zayed Bin Sultan Al Nahayan
President of The United Arab Emirates

His Highness Sheikh Nahayan Mabarak Al-Nahayan

Minister of Higher Education and Scientific Research,

Chancellor of The U.A.E. University

FOREWARD:

Date palms have been associated with people's life for many years, especially in the United Arab Emirates. It is believed that this tree is blessed since it is mentioned in many verses in the Holy Qura'an and in many of the sayings of the Profit. The date palm tree has been a source of nutrition and a shelter against harsh conditions. No wonder, date palms have been of great importance in the Arab world.

Since one of the main goals of United Arab Emirates University is to meet the needs of the society, the UAE University in cooperation with Department of Agriculture and Livestock, Al - Ain sponsored this First International Conference on Date Palms. The Faculty of Agricultural Sciences, Dept. of Plant Production organized this Conference during the period of March 8 – 10, 1998.

Date palm growers, producers, and extension specialists face many problems that could be solved through scientific research. This conference created the opportunity for linking research with community needs. In many cases, cultural practices that could improve the yield and quality of dates are neglected. The high tolerance of the tree to environmental stresses and its ability to yield even under sub optimal conditions may be behind such negligence.

Research discussions and constructive dialogues of this conference show the potential of date palm tree to have much higher yield and quality. The conference also directed growers towards the use of modern technology to accurately identify cultivars, improve cultural practices, and genetic improvement reduce the loss of dates before and after harvest, and utilize dates by-products.

His Highness, Sheikh Zayed Bin Sultan Al Nahayan, the President of the UAE, has been emphasizing the importance of agriculture in building the nation's civilization and the necessity of planting date palm trees in different farms. Thus, the great expansion in agricultural investments and the tremendous increase in date production in UAE reflect the wise perspective of the president. The appropriate environment provided by that conference created opportunities for fruitful discussions and interactions that help in solving the growers' problems.

Such commitment to the role of the University in serving the community has been instructed and followed up by His Highness Sheikh Nahayan Mabarak Al-Nahayan, Minister of Higher Education and Scientific Research Chancellor of the University.

We appreciate the joint sponsorship of the Department of Agriculture and Livestock, Al-Ain for their participation in organizing this conference.

We are pleased to present in these proceedings the referred research papers that resulted from the First International Conference on Date Palm held at Al-Ain during the period of March 8 – 10, 1998.

We would also like to express our sincere thanks and appreciation to His Highness Sheikh Nahayan Mabarak Al-Nahyan for his valuable assistance and utmost efforts and constructive direction to ensure the success of this international conference and his continuous support for high standards in scientific research.

Thanks are also due to the organizing and scientific committees and the editorial board. The efforts made by the prominent scientists who kindly referred the research papers are highly appreciated.

It is our hope that these proceedings which gathered the scientific efforts of some of the best date palm scientists in the world would be helpful for date palm producers, extensionists, and researchers.

Prof. Mahmoud A. Alafifi,
Dean, Faculty of Agricultural Sciences.

DATE PALM GERMPLASM: OVERVIEW AND UTILIZATION IN THE USA

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ABSTRACT

The date palm is one of the oldest domesticated crops. Utilization in the Middle East resulted in many local varieties that represent genetic diversity. Conservation of this genetic diversity is imperative. Date palm germplasm and its evaluation made possible the development of the date industry in the USA. Workers in the USA also developed local seedling varieties, identified superior local males, and conducted a breeding program to produce back-crossed males and intervarietal hybrids. Other *Phoenix* spp are briefly discussed.

Additional Index Words Phoenix dactylifera, breeding, metaxenia, hybrids, genetic diversity

INTRODUCTION

Plant germplasm is living tissue from which new plants can be grown. It contains the unique genetic information that gives plants their individual characteristics and links generations of living plants to one another. The genetic diversity of plants, developed by evolution, hybridization, natural selection, and manipulation by humans, provides the basis for the food production that supports the world's population. This diversity is threatened by habitat loss, development, the shift to cultivation of a small number of advanced lines, and other factors. Wilkes (1988) recognized this problem and pointed out that plant germplasm is in reality biological information passed down through generations in an unbroken chain. Once this chain is broken that unique germplasm is lost forever. This has lead to the necessity of protecting and preserving plant genetic diversity for current and future use.

Preservation of the genetic diversity represented in all the plant ecosystems throughout the world has become a major issue of international concern. The loss of increasingly large numbers of plant species through habitat destruction threatens the availability of a diverse plant germplasm base which will be needed to feed future generations (Holden and Williams, 1984; Wilkes, 1988; Brown *et al*, 1989; Holden *et al*, 1993; National Research Council, 1993; Chrispeels and Sadava, 1994). Similar losses have occurred in existing plant collections through inadequate maintenance.

Ideally, genetic resources should be conserved *in situ*. However, the factors mentioned above, especially habitat loss, make maintenance of genetic resources *in situ* somewhat precarious. Consequently, *ex situ* conservation is often necessary to salvage genetic resources. Genetic materials may be lost through disease, weather, etc, and so *ex situ* collections should be maintained in many cases even when there is not an immediate threat of habitat loss. *Ex situ* collections are also more accessible for researchers and necessary for characterization and evaluation. Maintenance of germplasm in a disease-free state is also desirable, and this is often possible only in *ex situ* collections.

Agricultural utilization of many crops involves a narrow range of genetic material, both in the US and abroad, making these crops vulnerable to genetic erosion. Genetic diversity in the centers of origin is threatened or severely threatened by habitat loss caused by deforestation, population pressure, fire, hydroelectric development, clearance for agriculture or other development, tourism, etc (WWF and IUCN, 1994-1995). These factors may be especially important in countries such as India and China, which have rapidly expanding populations coupled with rapid economic/industrial development. This situation makes *ex situ* conservation of genetic resources imperative in some cases.

This statement is not meant to diminish the importance of *in situ* conservation and habitat preservation, but to put into perspective the very real potential for loss of genetic resources conserved *in situ*. *Ex situ* collections are also important as they make germplasm more readily available for distribution to users; make possible the collection of characterization and evaluation data; and help reduce possible errors in documentation.

Assessment of the genetic vulnerability of any crop requires knowledge of the extent and distribution of genetic diversity. This is acquired by systematic sampling and mapping of the flora of the geographical areas in which the species in question are found, as well as an assessment of *ex situ* collections. Unfortunately, information on natural and semi-natural germplasm is often limited on the international level. This is due to the remoteness of some of the material, a lack of resources devoted to assessing these areas, and political considerations. In some cases, information may be available at the local or national level, but not to the international genetic resource conservation community.

The information that is available is often simply a catalog of plants present in an area, with little more than names and phenotypic descriptions. Often even information on the frequency of occurrence is lacking. More detailed characterization and evaluation data is needed to adequately assess the actual amount of genetic diversity present. This data should include both descriptive data and molecular level genetic analysis of germplasm existing both *in situ* and *ex situ*.

THE GENUS *PHOENIX*

The genus *Phoenix*, which includes the date palm (*Phoenix dactylifera*), is the sole member of the tribe *Phoeniceae* of the Monocotyledonous family *Palmae* (Moore, 1963; Bailey Hortatorium, 1976). *Phoenix* spp are either single trunked or clumping. Trunks range in size from nearly trunkless to over 30 m. *Phoenix* spp may be distinguished from other palms having feather-type leaves by the modification of the basal leaflets into spines, the presence of a terminal leaflet, and a central fold or ridge on the leaflets, which cause the leaflets to remain erect at all times. *Phoenix* spp are dioecious, with the inflorescences arising among the leaves. The small, pale yellowish flowers are borne singly, with the sepals being united into a cupule. There are 3 petals. Female flowers have 3 carpels, only one of which matures; male flowers generally have 6 stamens. The fruits of *Phoenix* spp are drupes of variable size, depending on the species, with a single grooved seed.

The taxonomy of *Phoenix* is not well established and lacks an authoritative treatment. There is disagreement between various taxonomic treatments and some confusion about species names and validity. *Phoenix* spp hybridize readily, which can lead to confusion, especially when several species are present, as may occur in *ex situ* collections. There is some suggestion that all species should be treated as a single species (Wrigley, 1995). The following discussion should be taken as an approximation based upon what is undoubtedly incomplete information.

Although 19 species have been named, most taxonomies list about 12 species as valid (not necessarily the same 12) (Table 1). It is apparent that *P acaulis*, P *canariensis*, *P dactylifera*, *P paludosa*, *P reclinata*, *P rupicola*, and *P sylvestris* are widely accepted as good species. However, there is some confusion over the other spp. Miller *et al* (1930), Chevalier (1952), Moore (1963), Munier (1973), and Bailey Hortatorium (1976) have similar schemes, with a few exceptions. Chevalier (1952) and Munier (1973) accept *P atalantica* as a valid species, although it is probably a hybrid of *P dactylifera* that does not deserve species status. Chevalier (1952), Moore (1963), and Munier (1973) use the species *P farinifera,* while Miller *et al* (1930) and Bailey Horatorium (1976) prefer *P zeylanica.* There is some confusion over *P farinifera*, *P pusilla*, and *P zeylanica*. Moore (1963) and Bailey Hortatorium (1976) use *P Loueirii* for the *P Hanceana* and *P humilis* of other workers. Most of the other specific epithets shown in Table 1 are more obscure and lack any botanical standing. In addition to these, Moore (1963) and Bailey Hortatorium (1976) list a number of specific epithets with no standing (*P Andersonii*, *P cycadifolia*, *P formosana*, *P glauca*, *P hybrida*, *P leonensis*, *P natalensis*, *P porphyrococca*, and *P tomentosa*. These treatments of *Phoenix* taxonomy do not deal with the recently described *P theophrasti* (Greuter, 1967). A usable treatment of *Phoenix* is shown in Table 2.

Phoenix is widespread in the tropical and subtropical areas of southern Asia and Africa (Figure 1). It does not occur in the New World, except when cultivated. Uses of *Phoenix* spp include food for man and animals, fiber, wood, fuel, and as handsome ornamental plants. *Phoenix dactylifera*, the date palm, is the 'type species' for this genus and will be discussed below. The following brief descriptions of other *Phoenix* spp should be considered approximate for some of the less well characterized species, or species of questionable validity.

Phoenix canariensis, the Canary (Island) date palm, is native to the Canary Islands, and is adapted to more moderate climatic conditions and cooler temperatures than some of the other *Phoenix* spp. It has a stout single trunk and can reach heights of 20 m. It is widely planted as an ornamental in the US and the Mediterranean area.

Phoenix sylvestris, the Indian Wild date palm, is widespread in India. It may also reach 20 m in height, but its single trunk is not as stout as that of *P canariensis*. Its fruits are eaten and also used to make sugar and other products, and its leaves are used in basketry.

P rupicola, the Cliff date palm, has a thin trunk to 7 m in height. It is native to northern India. It considered one of the most attractive for cultivation. *P farinifera,* from southern India and Sri Lanka, also has a single trunk, but is shorter in stature. It has edible fruit and the trunk has a floury pith which is also said to be edible. *P pusilla* (*P zeylanica*), is also from southern India and Sri Lanka, and is about the same size and general appearance as *P rupicola*.

P reclinata, the Senegal date palm, is a somewhat variable species from the tropical parts of Africa. It has thin, clustering trunks, and may reach a height of 10 m. It is widely planted as an ornamental. *P paludosa*, the Mangrove date palm, is similar in appearance to *P reclinata*, and is native to swampy areas in southeast Asia. It is also grown as an ornamental, and the two species are often confused in cultivation. *P abyssinica* is a poorly understood species from Ethiopia that is said to closely resemble *P reclinata*.

P acaulis, *P Loueirii*, and *P Roebelenii* are short statured palms, usually less than 2 m in height. *P acaulis*, which is from northern India and Burma, is clumping, whereas the latter two species apparently have solitary trunked and clustering trunked forms. *P Roebelenii*, the Pygmy date palm, is from southeast Asia and is often grown as an elegant ornamental. *P Loueirii*, from northern India and southern China, is a poorly understood species that is often confused with *P Roebelenii*, which it greatly resembles. Older references to *P Hanceana* and *P humilis* probably refer to *P Loueirii*.

A recently described species, *P theophrasti*, is not well characterized and not well established as a valid species. It appears to be native to the eastern Mediterranean area (Cyprus, Greece, Turkey). It is similar in appearance to *P dactylifera*, although apparently somewhat smaller, and may simply be a population of distinct *P dactylifera* native or naturalized in the region.

The status of genetic vulnerability is not well established for most of these species. This is reflected in the confused state of *Phoenix* taxonomy. Although many of the species are cultivated as ornamentals, there are probably few 'pure' *Phoenix* in ornamental plantings due to the readiness of *Phoenix* to hybridize. In addition, selection of plants for ornamental uses would exert selection pressure towards characteristics considered aesthetically pleasing.

There is apparently little information available about the status of these species in the wild. Their areas of origin are in many cases threatened with habitat loss due to some of the factors mentioned above. It is quite probable that there is at least some threat of genetic erosion to some of the species. The status of these species needs more attention devoted towards it. In addition to surveys of the areas of origin, the taxonomy of *Phoenix* needs to be better understood before some of these judgements can be made. There is also a lack of characterization and evaluation data for these species.

THE DATE PALM (*PHOENIX DACTYLIFERA*)

The Date Palm proper (*Phoenix dactylifera*) is the tallest of *Phoenix* spp, reaching heights of more than 30 m. It has clustering trunks smaller in diameter than *P canariensis*, but larger than other *Phoenix* spp. Under cultivation, it usually appears as a single trunked tree, as the offshoots are removed for propagative purposes. The fruit is the largest of any *Phoenix* sp, reaching up to 100 mm X 40 mm in size. The fruits are very tasty and nutritious, and are the reason that the date palm is widely cultivated in areas with suitable climates.

Date palms evolved in a unique manner (Wrigley, 1995). They have characteristics that adapt them to varied conditions, but differ from many other plants which are found in these conditions. The date palm grows well in sand, but it is not arenaceous. It has air spaces in its roots and may grow well where soil water is close to the surface, but it is not aquatic. It grows well in saline conditions, but it is not a true halophyte and does better in higher quality soil and water. Its leaves are adapted to hot, dry conditions, but it is not a xerophyte and requires abundant water.

The date palm is adapted to areas with long, very hot summers with little rain and low humidity, but with abundant underground water. This is expressed by the saying that the date palm 'must have its feet in running water and its head in the fire of the sky'. These conditions are found in oases and river valleys in the arid sub-tropical deserts of the Middle East.

Although there is some question as to where the date palm originated, it most probably arose in the area of northeastern Africa (the Nile delta), northern Arabia, Iraq, and western Iran (Figure 2). This is the area known as the 'Fertile Crescent' (ancient Mesopotamia), where agriculture in the Old World is thought to have arisen. Indeed, the date palm has been cultivated in this area from ancient times, possibly being one of the first crops domesticated.

The date palm has been cultured since antiquity, but its wild progenitors (of which no examples may remain) were undoubtedly used by man long before actual cultivation began. A date palm oasis must have been a welcome sight to those crossing the desert. Here were water, shade, and fresh and dried fruits high in carbohydrates. The dried fruits were easily stored and transported after leaving the oasis. The date palm also supplied building material, fiber, fuel, animal feed, honey (syrup), and wine.

Exploitation of the date palm by man probably began as simple gathering of the fruits and other usable parts of the tree. At this point, there must have been considerable genetic diversity in date palms. Later, trees were probably planted along the network of irrigation canals in ancient Mesopotamia. Selection of trees with superior characteristics probably also originated in ancient times, along with clonal propagation by offshoot planting. Later innovations would include hand pollination, manuring, shading, etc. Spread of date palm germplasm was probably originally as seed, which is much easier to transport than offshoots. After seedling populations were established in other areas, selections could be made and perpetuated by vegetative propagation. This gave rise to the many local varieties that are found in the Middle East. Propagation by offshoots was probably dependent upon the domestication of the camel, due to the weight of the offshoots and the consequent difficulties in transporting them for long distances.

The ancient time of the 'domestication' of the date palm is well documented (Popenoe, 1913; Oudejans, 1969; Munier, 1973; Dowson, 1982; Sauer, 1993; Krueger, 1995; Wrigley, 1995). The earliest records of date palm cultivation date from about 7000 BP in Mesopotamia, but it is generally believed that date culture began thousands of years earlier. Date seeds at least 5000 years old have been found in the storage godowns at Mohenjo Daro, the ancient city along the Indus river in the Sind, and the date palm was used in the construction of the Temple of the Moon God in Ur (Iraq) some 4000 – 5000 years ago. The date palm is shown in the bas-reliefs at Nineveh (Assyrian Empire). By several millennia BP, date palm culture had spread to Palestine, Arabia, Egypt, North Africa, and western India (Figure 3). The date had great spiritual and cultural significance to peoples of the region. The date palm and date culture are depicted on ancient Assyrian and Babylonian tablets, including the famous Code of Hammurabi, which contained laws pertaining to date culture and sales. The date palm is also found in old Egyptian, Syrian, Libyan, and Palestinian writings.

It is in Arab culture that the date palm achieves its greatest esteem. To them, the date palm is a sacred institution that they have been identified since the dawn of history and which was consecrated by Muhammad in both his public and his private life. There are many references to the date palm in pre-

Islamic chronicles, but it becomes more prominent from the time of the Prophet. Muhammad lived in a town at the center of date culture. Dates were the prophet's favorite food, and during his times of poverty he had little to eat but dates and water for months at a time. There are 26 references to dates in the Koran, 16 mentioning them as evidence of God's bounty. According to Muslim tradition, a date palm was said to be the Tree of Knowledge in the Garden of Eden and to have sheltered Mary when she was pregnant. There are also references to the date palm in other Islamic writings, including references to its medicinal uses.

The date palm is also mentioned a number of times in Jewish and Christian writings. In the book of Psalms it is said that 'the righteous shall flourish like a palm tree' and in the Song of Songs a beautiful woman is likened to a palm tree. The prophetess Deborah sat beneath a palm, and date palms adorned Solomon's temple. In fact, the columnar architecture so common in the Mediterranean area is thought to have been inspired by the use of date palms as building material. Palm leaves were used in temple services during the Feast of Booths and carried in victory parades. Jesus was hailed with palm branches when he entered Jerusalem just before the crucifixion.

This long history of exploitation and selection means that possibly there are no examples of 'wild' *Phoenix dactylifera*. There may be a few apparently wild groves still growing around oases, springs, or seepage areas, but most of the trees that currently exist are the end results of an unknown number of acts of selection. This includes trees which have are not currently cultivated, and may appear to be growing wild in oases, abandoned gardens, etc. Because of the length of time of domestication, there has undoubtedly been some time of selection pressure put upon the ancestors of these plants at some time in the past. However, probably evolutionary change due to human selection has been relatively low, so there is a certain amount of genetic diversity present in date palms. This is reflected in the many local varieties, which have been selected for their adaptations to local conditions. Characteristics such as offshoot production, tolerance to humidity, and fruit characteristics have been documented.

This state of affairs makes genetic vulnerability of date palms a less-than-clear-cut matter. Genetic diversity in the region in general is threatened by such factors as population pressure, overgrazing erosion, dam construction, logging, tourism, and other development pressures (WWF & IUCN, 1994-1995). Since no truly 'wild' date palm germplasm apparently exists, it can not be lost due to habitat destruction, etc. However, the genetic diversity that does exist in the cultivated date palm can be lost due to these factors if they result in the loss of local varieties having specific genetic constitutions. Continued selection pressures by man; shifts to fewer, more modern varieties; etc can also reduce genetic diversity in date palms.

This suggests that the genetic diversity of date palms should be monitored and *ex situ* collections maintained. Bettencourt *et al* (1992) list only about 10 collections world-wide, the largest of which are found in Algeria, India, Iraq, Nigeria, and the United States. Except possibly for the Nigerian collections, most accessions appear to be elite cultivars or breeding lines, so the genetic diversity is probably rather low. Collections of date palm germplasm are fewer and smaller than for most other crops, due to the relatively limited geographic area in which cultivation is possible and the relatively narrow base of genetic diversity present. In addition to preserving germplasm, *ex situ* collections also increase the efficiency of its utilization. These *ex situ* collections allow a careful preservation of a specific genotype; reduce the chances of disease problems; allow documentation of characterization and evaluation data; and permit easier experimentation to be carried out.

DATE PALM GERMPLASM IN THE US

The date palm first probably spread out of its 'natural' home in the Middle East via the Moorish conquest of Spain in 711. Date palms became established in Spain, although climatic conditions are not optimal for fruit development. After the Spanish expelled the Moors in 1492, they began their own colonization – that of the New World. Among the many agricultural commodities that the Spanish introduced to the Americas were date palms. The dates brought to what is now the US by the Spanish were brought as seeds, and were planted in relatively cool, coastal areas unsuited for good date production. A few trees survived into the present century, but they were notable more for their striking appearance than their fruit production.

After the conquest of what is now the western portion of the United States by the US, interest in date growing increased. However, at that time little was known about the climatic requirements of dates and so most plantings of seedlings were in unsuitable locations such as Florida (Nixon, 1971). A planting of seedling dates was made in 1877 by JR Wolfskill at Winters, California and at Yuma, Arizona, during the Civil War. The trees in

Winters are still standing, although production is not of commercial quality nor yield.

As experimental plantings of dates increased, it became apparent that the arid southwest deserts of California and Arizona had the greatest chance of being suitable for commercial date production. It was also apparent that if a viable commercial industry was to be established, superior true-to-type varieties were needed. A few types had been introduced as offshoots in the early to mid-1800's (Swingle, 1904). However, these apparently did not become successfully established. The first importation of offshoots from which there was appreciable survival was in 1890 by the Pomology Division of the US Department of Agriculture (Nixon, 1971) under the direction of HE Van Deman. These proved to be offshoots derived from inferior seedlings and did not provide the quality necessary to establish an industry in the US.

In 1900, the first successful importation of superior true-to-type varieties was made under the direction of WT Swingle, US Department of Agriculture (Swingle, 1947). These varieties were imported from Algeria and were primarily 'Deglet Noor' and 'Rhars'. These were planted near Tempe, Arizona.

Several other successful importations of offshoots were made by the USDA during the next several years. DG Fairchild imported varieties including 'Barhee', 'Sayer', 'Khadrawy', 'Zahidi', 'Maktoom', and others from Iraq, Baluchistan, and Egypt in 1901 – 1902 (Fairchild, 1903), TH Kearney imported 'Menakher' and other varieties from Tunisia and Algeria in 1905 (Kearney, 1906), WT Swingle brought back the 'Medjool' from Morocco when consulting there in 1927 (Swingle, 1945), and RW Nixon imported 'Amir Hajj', 'Bedrayah', and 'Baghdad Khadrawy' from Iraq in 1929 (Nixon, 1950). Most of these varieties were planted and evaluated in the US Date Garden near Indio, California.

When the promise of date culture in the US became apparent, a number of importation were also made by commercial growers. Early importations by BG Johnson (1903 – 1915) and HF Cole (1911 – 1913) were primarily of 'Deglet Noor' from Algeria (Nixon, 1947, 1950, 1971). P Popenoe imported such important varieties as 'Halawy', 'Khadrawy', 'Kustawy', and 'Zahidi' from Iraq in 1913, as well as many 'Deglet Noor' from Algeria (Popenoe, 1913). From 1920 – 1922, SC Mason of the USDA, funded by date growers, obtained 'Saidy' and 'Hayany' offshoots from Egypt (Mason, 1915, 1923, 1927).

With the importation of offshoots, the use of seedling dates by growers decreased. However, there were a few varieties successfully developed from seedlings by growers. Most notable of these growers were F Heiny and EK Davall (Nixon, 1955, 1971).

The imported varieties were to form the basis of the US date industry. However, while it was becoming apparent that the southwestern deserts were the natural home of the date industry in the US, much work still remained to be done to make date growing a viable enterprise in the US. The vast majority of the work needed to establish this industry was performed at the US Date Garden (later the US Date and Citrus Station) near Indio, California.

After returning from Algeria in 1900, Swingle (1904) determined that the Salton Basin of the Colorado Desert in California was better suited than any other area in the US for profitable production of quality dates. The Coachella Valley, in the northern part of the Salton Basin, was particularly promising. In 1904, the USDA established an experimental date garden east of Mecca in the Coachella Valley. In 1907, the newly formed Salton Sea threatened to inundate Mecca, and the headquarters for date experimentation was moved to a new location west of Indio. Offshoots of the date varieties imported were planted at Mecca and Indio for evaluation and selection. The determination of the most suitable varieties for cultivation in the US, as well as the development of cultural practices, pest management strategies, etc at the Date Station made the development of the US date industry possible.

The Coachella Valley became the center of the US date industry, as it has the climate most suited for date production. This is 'low desert' country – at or below sea level and fairly far south (although it is the northernmost area of date production in the world). This area has long, hot, dry summers suitable for date production, with mild winters.

Other desert areas have proven to be less suitable. The Imperial Valley, immediately south of the Coachella Valley, is generally suitable for date production. However, it is more prone to summer moisture from the Gulf of California, has generally heavier soils, and is farther from the main packing houses. Consequently, although dates can be successfully grown in the Imperial Valley, it has never developed a large amount of acreage. The Salt River Valley of Arizona has about 3 times as much summer rainfall as the Coachella Valley, and fruit damage can be frequent. The area around Yuma, Arizona, and across the California state border is suitable for date production and boasts a small industry centered around the more profitable 'Medjool'.

This variety was not released until 1944, and the industry revolving around this variety consequently developed later than the bulk of the industry.

Other areas once considered promising for date culture proved to be unsuitable for commercial production. Northern deserts did not develop enough heat units to mature fruits, and winters are often cold enough to be damaging to date palms. The Rio Grande Valley of Texas was once considered promising, but humidity is a problem and heat units are marginal. The same is true of Florida. The Central Valley of California is probably dry enough, but again heat units are insufficient.

The US date industry has been mature since about the 1950's. There are currently approximately 2500 ha in production, yielding about 20,000 metric tons annually, for farm gate receipts of about US$ 20 million. The bulk of the acreage is in the Coachella Valley and has stayed stable for about 40 years. Approximately 75 % of the acreage is planted to 'Deglet Noor'. 'Medjool' is the next most popular variety, accounting for about 15 % of the acreage. The remaining acreage is made up of various minor varieties. Most newer plantings or replantings are of 'Medjools' which are more profitable than other types but costly and more difficult to produce.

DATE PALM GERMPLASM ACTIVITIES IN THE US (RETROSPECTIVE)

There were three main areas of germplasm-related activities which occurred in the US: varietal selection, metaxenia studies, and a breeding program.

Varietal Evaluation

The most important date palm germplasm-related activities that occurred in the US were varietal evaluations of the offshoots imported early in the 20th century. The identification of suitable varieties for the Coachella Valley and other areas lead directly to the development of the US date industry as it exists today. The earliest evaluation of date palm varieties was done by B Drummond and SC Mason at the Date Station (Nixon, 1971). Much of the later work was performed by Mr Roy W Nixon, who was instrumental in the development of many of the cultural practices used by the US date industry as well as the varietal work.

The forms used for characterizing fruit and vegetative characters of date palms are shown in figures 3 and 4, respectively. These forms were also used in evaluations of results from the breeding program (see below). In addition to the straight-forward characteristics shown, the varieties were evaluated for such characteristics as yield, flavor, tolerance to humidity, and other characteristics which affect performance and profitability. The results of these investigations are summarized in Nixon (1950).

Metaxenia

Swingle (1926) coined the term 'metaxenia' to describe the direct effects of pollen from different male trees on the somatic tissue of the date fruit. Nixon (1928, 1934) showed that pollination of 'Deglet Noor' with pollen from a male seedling of the 'Fard' variety produced larger dates which matured about two weeks earlier than pollination with pollen from the variety 'Mosque'. Pollen from *P reclinata*, *P canariensis*, *P Roebelenii*, and *P rupicola* produced smaller, later fruit than pollen from *P dactylifera*, whereas pollen from *P sylvestris* produced slightly larger fruit than mixed *P dactylifera* pollen (although not as large as some date palm male selections) (Nixon, 1928, 1935; Crawford, 1935). Pollen from some male selections produced larger fruit in conjunction with increased size due to thinning. However, the increased size of the fruit produced from pollen from male selections did not lead to an increase in checking as did the increased size due to thinning (Nixon, 1956

These observations lent support to the common belief that some males are better than others for pollinating certain varieties. This in turn suggests the identification and selection of superior males and the development of clones thereof to produce a desirable type of pollen in quantity. Nixon and Carpenter (1978) suggest that growers observe male palms for their performance in regard to the following points:

- Time of blooming: The prospective male should flower at the same time as its prospective female partner. This means additionally that the males should receive the same cultural care that the females do.

- Number and size of flower clusters and quantity of pollen: Fewer males will be required if they have more and larger inflorescences with abundant pollen. Flowers that tend to adhere to the strands without shedding easily are preferred.

- Compatibility: In some varieties, fruit set is better with pollen from certain males as compared to others.

- Metaxenic effects: The metaxenic effects are most pronounced in areas where ripening may be slowed by cool weather, or where heat units are marginal.

These considerations lead to the identification of several seedling male palms of local origin with valuable characteristics. These were acquired before 1954, and are currently included in the Date Palm Germplasm Repository holdings.

- 'Barhee A19' originated at the Date Station as a seedling of 'Barhee'. It produces many inflorescences and flowers late in the season (a month or more after the 'Crane' and 'Boyer no 11' selections). The fruit produced by pollination from 'Barhee A19' is large but late ripening. This pollen is suitable for use on 'Deglet Noor'.

- 'Boyer No 11' was from the Boyer date garden which adjoined the Date Station. It is an unusually heavy producer of pollen (1 L per year from 25 – 35 inflorescences). It was the earliest male at the Date Station to flower.

- 'Crane' was a 'Deglet Noor' seedling from the Crane ranch. It is early, and produces about 1 L of pollen from 20 – 25 inflorescences.

- 'Fard No 4' produces early but small-sized fruit. It flowers midseason but produces only average amounts of pollen.

- 'Jarvis No 1' was obtained from the Brown date garden. It flowers early and produces numerous inflorescences that yield large amounts of pollen. It is a good pollinator for 'Deglet Noor'.

Date Palm Breeding Program

The overall objective of date breeding is to achieve the highest fruit quality and yield (and profitability) consistent with local requirements (Carpenter and Ream, 1976). The latter might include:

- Tolerance or resistance to cold, extreme heat, high humidity, rain damage, insect attacks, diseases, saline soil or water, poor drainage, and other soil-related problems.

- Adaptation to mechanical harvesting, processing, and pest control.

- Modification of growth habit to reduce the rate of vertical growth, reduce the number and size of spines, increase the length and flexibility of fruit stalks, improve distribution and numbers of fruits per bunch to increase size and reduce thinning operations.

- Modification of fruit quality, seed size, uniformity and time of ripening, and reduction of skin separation in soft varieties.

- Development of male palms with metaxenic characters that could be used to manipulate fruit production.

- Development of inbred lines to produce seed with sufficiently uniform characters to permit propagation of palms from seed.

Some other factors which should be considered (Barrett, 1973) are:

- Identification or discovery of hermaphroditic flowers or monoecious lines.

- Identification, discovery, or production of precocious lines.

The most serious drawback in date breeding is time. The average time from seed to flowering is about 6 years (Nixon and Furr, 1965). An additional drawback is the time required to produce enough offshoots for trials (5 years minimum, or more if a large number are needed which would entail several generations of offshoot production). Finally, date palms do not reach full production until they are 10 – 15 years of age. All these factors make date palm breeding a long-term project. This is especially true when back-crosses are made.

Initial attempts at breeding date palms in the US were made by the University of Arizona in 1912. These attempts were made to study the inheritance of fruit characteristics by inbreeding of 'Deglet Noor'. Some observations of the inheritance of fruit color were made but none of the progeny produced fruit as good as that of 'Deglet Noor' and the project was discontinued after 3 generations (Nixon and Furr, 1965).

In 1948, JR Furr and RW Nixon of the US Date and Citrus Station began a comprehensive date improvement program. Other participants over the years included CL Ream, H Barrett and JB Carpenter. The overall aims of the program (Nixon and Furr, 1965; Barrett, 1973; Carpenter and Ream, 1976; Carpenter, 1977) were:

- Production by back-crossing of male palms that approach the female parent in genetic composition.
- Production of new and superior females by use of advanced back-cross males in intervarietal hybridization.
- Selection of superior male and female seedlings with the potential for commercial development.

The initial phase of this breeding program lasted from 1948 – 1970 and was concerned primarily with production of back-crossed males. Towards the end of this period, intervarietal hybrids began to be made. The intervarietal crossing was intensified in the early to mid-1970's. However, it was during this period that US governmental policy with respect to the Date and Citrus Station changed. Support levels were cut, and the breeding program terminated. The Station was closed in 1981 and the breeding lines were incorporated into the National Date Palm Germplasm Repository (See below).

Back-crossed Male Date Palms

The impetus for the back-crossing program was to develop male lines that might be useful for producing hybrids. Because date palms are dioecious, intervarietal hybridization, a common breeding procedure for combining desirable characteristics, is not possible. It is necessary to obtain males that are as closely related genetically a female variety as possible before such crosses can be made. Seedling populations of some varieties tend to resemble the female parent in vegetative and fruit characteristics. This has been useful in selecting for further back-crossed (BC) males with growth characters resembling those of the female parent. Back-crossing is continued for 3 or more generations, until males strongly resembling the female are produced. A male after 3 back-crosses (BC3) should resemble the female parent in 93 % of his genetic makeup. Continuing on to BC5 should produce males that are over 98 % 'pure'.

Once this point is reached, the males produced can be expected to transmit mainly the characteristics of their recurrent parent to any intervarietal hybrids produced. However, it is not certain whether or not fruit characteristics – a uniquely female trait --are transmitted by male palms. Studies of female progeny in BC populations may suggest which fruit characters are being transmitted and the degree of character homozygosity.

Male progeny of back-crossing could be evaluated using exhaustive measurements of leaf characteristics and other vegetative qualities as shown by the evaluation form (Figure 4) in order to establish a very precise degree of resemblance to the female parent. However, this was generally not done due to the extreme amount of time and effort involved. However, increased numbers of individuals in each successive BC generation show the characteristics of the female parent. Using advanced BC males, it should be possible to study the inheritance of characters in progeny derived from parents with distinctive attributes.

The varieties used in making the back-crosses were the same as would be used as female parents in later intervarietal crosses. These varieties were selected on the basis of possessing one or more outstanding characters (as expressed in Coachella Valley conditions) that might be desirable in a new variety. Primary considerations were fruit characteristics, such as large size, attractive color and appearance, good texture and flavor, good shipping and storing quality, time of ripening, high yield, and rain tolerance (Nixon and Furr, 1965). The varieties utilized and some of their desirable qualities are shown in Table 3.

Males resulting from the BC project were selected on the basis of good flower characters and resemblance of leaf characters to the female parent in the hope that there was sine linkage with fruit characters. Any male considered desirable for intervarietal crosses was also a candidate for saving. By 1965, 38 BC lines had been established. Some varieties had advanced to the 3rd BC generation (BC3), and many of them strongly resembled the female parents based upon vegetative characteristics (Nixon and Furr, 1965). Female offspring often resembled the female parent as well. This tendency was more pronounced in some varieties than in others, and suggested that in some varieties it would be feasible to establish commercial plantings from seed produced by controlled pollinations (Nixon and Furr, 1965). However, this was never attempted, and the longer period to establish a plantation from seed as compared to offshoots would be a major drawback to this method.

By 1976, the number of lines had been reduced to 22 lines representing 14 varieties, as a result of genetic weaknesses in some lines and changes in breeding objectives (Carpenter and Ream, 1976). Some lines had advanced as far as the BC5 level. The more recently developed BC males had not been used in any intervarietal hybrids at the time the program was discontinued (Carpenter, 1977a). There are currently 27 lines of BC males representing 11 varieties in the Date Palm Germplasm Repository (Table 4). These represent the lines considered most valuable at the time that the Date Station was closed.

Intervarietal Hybrid Female Date Palms

The males produced above were to be screened for desirable male characteristics (metaxenia), but the ultimate objective was to utilize them in making intervarietal crosses to develop female varieties with the following characteristics (Carpenter and Ream, 1976):

- Quality and yield equal to, or superior to, those of 'Deglet Noor'.
- Freedom from black nose, a serious physiological disorder of ripening 'Deglet Noor' fruit.
- Adaptation to mechanical harvesting and processing.
- A fruit stalk at least equal in length and flexibility to that of 'Deglet Noor' to facilitate handling of fruit bunches.
- A moderate rate of vertical growth.

Although production of BC males commenced in 1948, it was not until 1961 that males considered appropriate for intervarietal crosses were available. This was due to the length of time needed to evaluate the males produced and in some cases to make additional BC's. The first intervarietal crosses were made in 1961, and at the time of the first report on the breeding program, little information was available on the progeny (Nixon and Furr, 1965). However, many advanced BC males flowered in 1970 and 1971, and 62 intervarietal crosses were made between 11 female and 13 BC male parents. From 1971 to 1974, about 3,000 hybrid seedlings, of which 1,200 were females, were planted and evaluation of fruit characteristics of the females began in the following years (Carpenter and Ream, 1976). At the time of the report cited, nearly 70 % of the seedlings had flowered, considered a good percentage for trees less than 4 years old from seed. Limited data suggested that 'Empress', 'Khadrawy', and 'Thoory' females and 'Khadrawy BC3', 'Tadala BC1', and 'Thoory BC3' males induced early flowering in a high proportion of the crosses in which they are used (Carpenter and Ream, 1976).

Limited observations of the characteristics of the crosses were summarized by Carpenter (1977a). Most of the crosses yielded inferior female seedlings. Rain and high humidity during the harvests of 1976 and 1977 cause moderate-to-severe damage to fruit of many of the seedlings even though the bunches were completely covered. Many progeny were discarded after this initial evaluation. The characters considered most deficient in the discarded progeny were fruit size, tolerance to high humidity and/or rain during the khalal stage, texture, flavor, appearance, and storage characteristics.

The crosses made in 1971 yielded 9 seedlings considered worth saving. These included dry, semi-dry, and soft-fruited selections. Some of the soft or dry selections had the potential to compete with commercial varieties. However, no semi-dry selection was found that appeared to equal 'Deglet Noor' in quality, although some may have lent themselves to mechanical harvesting and processing.

Barrett (1971) and Carpenter (1977a) have discussed some observations made on the seedlings produced. Although seedling populations of individual crosses were too small for rigorous genetic studies, some observations may have some value.

- The large fruit size of 'Medjool' appeared in many of the progeny produced by 'Medjool BC' pollen. Similarly, the attractive appearance of 'Abada' appeared in many of its progeny.

- Fruit quality was in most cases inferior to the female parent, and in all semi-dry progeny, inferior to 'Deglet Noor'.

- Moisture tolerance was in most cases similar to that of the mother variety, and there were few progeny with improved moisture tolerance that did not possess some undesirable traits.

- The desirable fruitstalk characteristics of 'Deglet Noor' were often transmitted to its offspring.

- Some deleterious characters observed included low pollen production by males, increased shattering, albino leaf (low chlorophyll content), depression in vigor, and sometimes a decrease in offshoot production (apparently not linked to vigor).

• 'Khadrawy' has useful characteristics including small stature and small spines. However, use of 'Khadrawy BC' males produced progeny with small, extremely soft fruit with excessive skin separation.

The date palm breeding project was terminated in 1978, as US governmental policy toward the Date and Citrus Station changed. The 9 selections considered most valuable were incorporated into the Date Palm Germplasm Repository. They are shown in Table 5, along with some of their characteristics. They may be considered for commercial planting or as breeding lines, but more extensive evaluation is necessary before they can be properly and efficiently utilized.

THE NATIONAL DATE PALM GERMPLASM REPOSITORY

What might be termed the 'National Date Palm Germplasm Repository' is currently a part of the USDA-ARS National Clonal Germplasm Repository for Citrus and Dates (NCGRCD). The roots of the date palm collection lie in the offshoots imported from the Middle East in the early part of this century and maintained and evaluated at the Date and Citrus Station. This collection of Old World (Nixon, 1950) and local (Nixon, 1955) date varieties grew to large proportions over the years. In 1971, the decision was made to retain only those female varieties that had commercial uses or had some valuable characteristics for breeding new varieties. As US governmental support for the Date and Citrus Station decreased, the date breeding program was terminated, and the most valuable materials incorporated into the National Date Palm Germplasm Repository in 1977 (Carpenter, 1977b). The Date and Citrus Station was completely closed in 1981, and the date palm collection was repropagated as offshoots to the USDA-ARS Irrigated Desert Research Station in Brawley, California, about 100 km south of Indio in Imperial County.

The NCGRCD was established by the USDA Agricultural Research Service in 1987 as a part of the US National Plant Germplasm System (Shands, 1995). The mission of the NCGRCD is to acquire, preserve, distribute, and evaluate germplasm of *Citrus* and related genera, date palms, and related *Phoenix* spp. The date palm germplasm collection was incorporated into the NCGRCD in 1989.

US governmental support for the Brawley station began to decrease in the early 1990's. The threat of closure prompted the repropagation of the collection to the University of California Coachella Valley Agricultural

Research Station (CVARS) in Thermal, California. CVARS is attached to the University of California, Riverside (UCR). The main NCGRCD facilities are located on the UCR campus, located approximately 125 km from Thermal. Thermal is only a few km from Mecca, the original site of the US Date Garden, and is a more suitable area for date culture (Krueger, 1995).

The collection currently consists of 26 female varieties (Table 6), 27 BC male lines (Table 4), 9 intervarietal hybrids (Table 5), and 5 superior males (Table 7), for a total of 67 accessions. These accessions are free of pathogens due to a California state quarantine of the date production area, and are available for distributions to qualified researchers world-wide as offshoots, seed, and pollen.

Although date palms make up a minor part of NCGRCD responsibilities, there are some date palm germplasm-related activities taking place. These include continuation of the BC program to produce BC5 males. With the development of molecular-based techniques, it may be possible to more precisely screen BC progeny for genetic similarity to the female parent. A marker for the sex of the plant may be possible, as has been reported for some other crops. Some characterization and evaluation observations are also being made. Some of the male characteristics reported earlier need to be reconfirmed. The hybrids also need further evaluation. These activities are currently being carried out at a low level due to funding constraints. Other areas also need attention, but must await increased resources.

ACKNOWLEDGEMENTS

I thank Drs Mahmoud Al-Afifi and Ahmed Al-Badawy for inviting me to this conference, and for their help and generosity in making arrangements.

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Table 1. Species of *Phoenix* recognized by several investigators.

Species	Martius[1]	Beccari[2]	Miller *et al*[3]	Chevalier[4]	Mowry[5]	Moore[6]	Munier[7 8]	Bailey H[9]
Abyssinica Drude						+		+
acaulis Roxb	+	+	+	+	+	+	+	+
Atalantica A Chev				+			+	
Canariensis Hort ex Chab		+	+	+	+	+	+	+
Dactylifera L	+	+	+	+	+	+	+	+
Farinifera Roxb	+	+		+		+	+	
Hanceana Naudin				+			+	
humilis Royle		+	+	+	+		+	
Loureirii Kunth	+				+	+		+
Ouseleyana Griff	+							
Paludosa Roxb	+	+	+	+	+	+	+	+
pumila Hort			+					
pusilla Gaertn	+	+	+		+	+		+
Reclinata Jacq	+	+	+	+	+	+	+	+
Roebelinii O'Brien			+	+		+	+	+
rupicola T Anderson		+	+	+	+	+	+	+
Spinosa FC Schum	+							
Sylvestris (L) Roxb	+	+	+	+	+	+	+	+
zeylanica Trimen			+		+			+

[1] Martius, CFP, De. 1836 –1850. Phoeniceae. Pp 257-276, 320-321 in: Historia naturalis palmarum: expositio systematica, vol 3. F Fleischer, Leipzig.

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Table 2. The genus *Phoenix*: a summary.

Species	Common name	Origin	Notes	Synonyms
P abyssinica	--	Ethiopia	poorly known sp	--
P acaulis	--	Assam, Burma	fruit edible	--
P canariensis	Canary (Island) date palm	Canary Islands	widely cultivated as ornamental, fruit edible	*P Jubae, P tenuis*
P dactylifera	Date palm	NE Africa, Middle East	widely cultivated in suitable climates for fruit	
P farinifera	--	India	poorly known sp, fruit edible	
P Loureirii	--	India, China		*P formosana, P Hanceana, P humilis, P Ousleyana*
P paludosa	--	SE Asia		
P pusilla	--	S India, Ceylon		*P zeylanica*
P reclinata	Senegal date palm	tropical Africa	widely cultivated as ornamental, fruit edible	P *madagascariensis, P pumila, P senegalensis, P spinosa, P zanzibarensis*
P Roebelenii	Pygmy date palm	Laos	widely cultivated as ornamental	
P rupicola	Cliff date palm	N India		
P sylvestris	Indian date palm	India	utilized in India (sugar, fruit)	

Table 3. Desirable characteristics of date varieties used in intervarietal hybridization (Barrett, 1973).

Variety	Desirable Characters
Abada	attractiveness, glossy black fruit with frost-like bloom, midseason maturity
Amir Hajj	high quality fruit, little spoilage of fruit in wet weathr
Barhee	high quality, heavy yield, late maturity, low tannin in khalal stage
Badrayah	large fruit, firm texture, midseason maturity
Dayri	high quality, distinctive rich flavor, moisture tolerance, good size, semidry texture
Deglet Beida	light-colored fruit, smooth skin, very firm texture, early maturity
Deglet Noor	superior quality, distinctive rich flavor, semidry texture, early maturity
Empress	high quality, attractiveness, good size, distinctive rich flavor
Halawy	high quality, distinctive rich flavor, moisture tolerance, early maturity
Horra	Good size, very firm texture, long fruitstalks, midseason maturity
Khadrawy	High quality, dwarf stature, moisture tolerance, precocious flowering, sparse spines, early maturity
Kush Zebda	Superior fruit quality, distinctive rich flavor, long fruitstalks
Medjool	Large fruit, moisture tolerance, early maturity, good quality
Tadala	Large fruit, moderate moisture tolerance, attractiveness, early maturity
Thoory	Light-colored fruit, moderately large fruit, very firm, moisture tolerance, late maturity

TABLE 4. BC Male Date Palms, USDA-ARS-NCGRCD.

Accession No	PI	Name
66-11-50	555405	Amir Hajj BC2
66-11-53	555406	Amir Hajj BC2
60-270-9	555412	Barhee BC3
70-41-53	555415	Barhee BC4
70-31-50	555419	Barhee BC4
60-271-2	555413	Dayri BC2
60-271-7	555414	Dayri BC2
70-41-53	555416	Dayri BC3
70-39-53	555417	Dayri BC3
64-354-22	555402	Deglet Noor BC4
69-150-52	555432	Deglet Noor BC5
69-150-50	555433	Deglet Noor BC5
64-351-1	555403	Halawy BC3
64-351-18	555404	Halawy BC3
69-152-50	555434	Halawy BC4
63-394-25	555444	Khadrawy BC3
69-154-28	555435	Khadrawy BC4
61-411-2	555423	Khalasa BC2
69-155-51	555436	Khalasa BC2
69-157-51	555439	Medjool BC3
69-156-52	555438	Medjool BC4
69-158-51	555440	Tazizoot BC3
62-431-3	555445	Thoory BC3
70-43-50	555418	Thoory BC4
66-14-52	555408	Zahidi BC2
66-14-50	555407	Zahidi BC2
66-15-51	555409	Zahidi BC2

Table 5. Intervarietal Hybrid Female Date Palm Selections, USDA-ARS-NCGRCD.

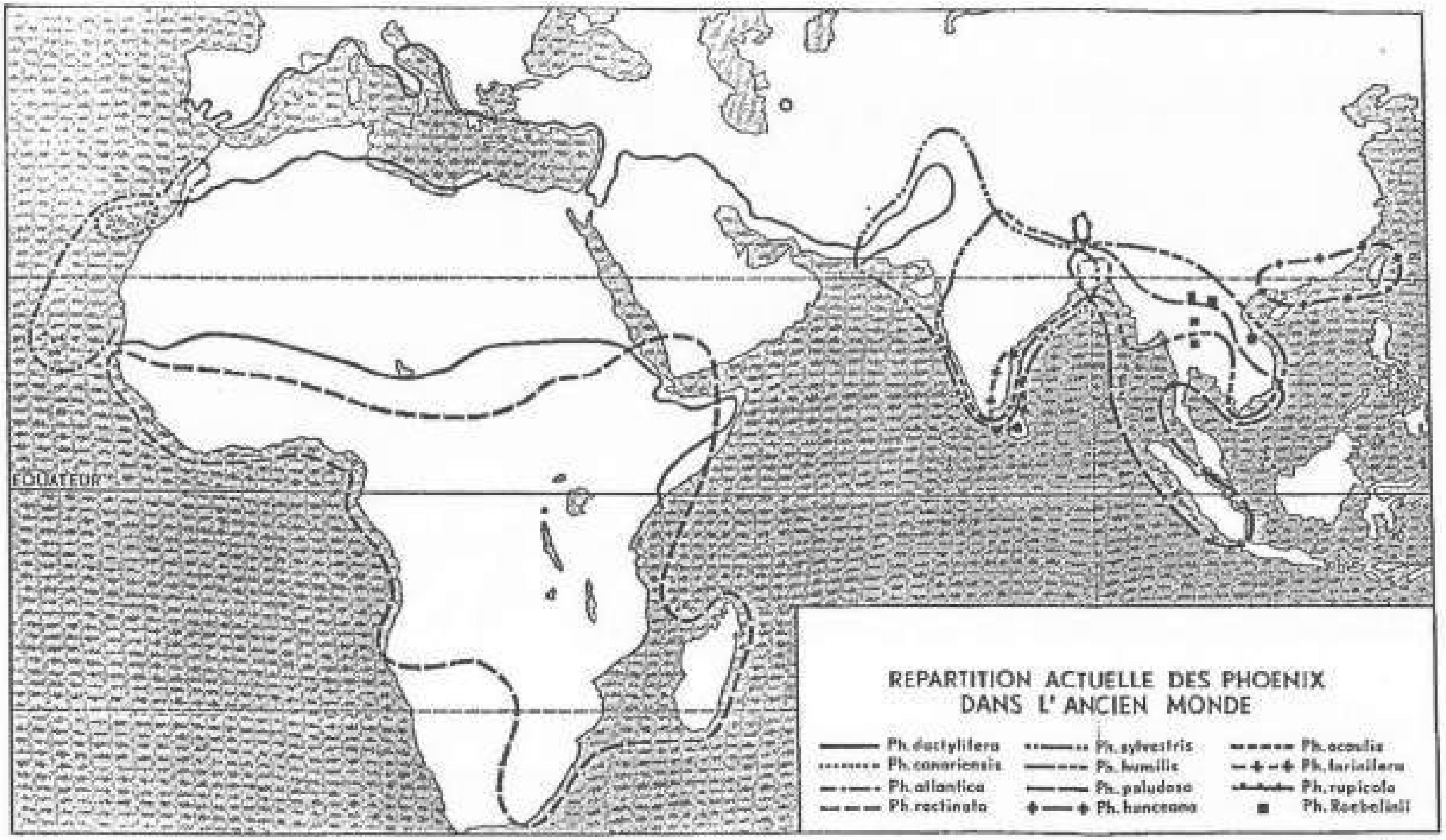
Accession No	PI	Parentage	Size (mm)	Type	Color (Rutab)	Comments
64-343-51	555401	Abada X (Medjool BC2)	45X25	soft	black	good black date
69-155-14	555437	Khalasa X (Khalasa BC2)	35X24	soft	brown	small, good quality
71-8-1	555428	Thoory X (Deglet Noor BC4)	44X27	semi-dry	buff	good, mild flavor
71-11-21	555431	Thoory X (Khadrawy BC3)	45X27	semi-dry	amber-brown	bright color, large fruit, early, susceptible to moisture
71-12-33	555429	Thoory X (Halawy BC3)	54X25	semi-dry	brown	good quality, but coarse
71-14-1	555446	Thoory X (Dayri X Deglet Noor BC3)	48X24	semi-dry	brown	good flavor and texture
71-25-15	555426	Medjool X (Dayri X Deglet Noor BC3)	43X28	soft to semi-dry	black	flavor good, keeps well
71-25-36	555427	Medjool X (Dayri X Deglet Noor BC3)	68X42	soft to semi-dry	brown	large, mild,fair quality
71-38-10	555425	Horra X (Dayri BC2)	42X36	semi-dry to dry	buff-brown	low tannin, breeding potential

Table 6. Female Date Palm Varieties, USDA-ARS-NCGR.

Accession No	PI	Variety	Origin
78-12	080781	Amir Hajj	Mandali, Iraq
78-14	008739	Ashrashi	Baghdad, Iraq
78-18	080789	Badrayah	Iraq
78-15	008746	Barhee	Basra, Iraq
78-19	036818	Bentamoda	Dongola Province, Sudan
78-20	008567	Dayri	Basra, Iraq
78-16	010834	Deglet Beida	Oasis Ourland, Algeria
78-22	004611	Deglet Noor	Touggourt, Algeria
78-23	008750	Halawy	Basra, Iraq
--	006438	Hayany	Alexandria, Egypt
78-26	008760	Hilali	Masqat, Arabia (Oman)
78-17	015026	Horra	Nefzaoua, Tunisia
78-21	008751	Khadrawy	Basra, Iraq
78-27	008753	Khalasa	Oman
78-28	011801	Khir	Arabia
--	--	Khisab	Basra, Iraq
78-43	074204	Medjool	Bou Denib, Morocco
--	037060	Saidy	Abshawai, Egypt
78-31	008748	Sayer	Iraq
79-16	010891	Thoory	Biskra, Algeria
79-17	008743	Zahidi	Iraq
78-13	555400	Abbada	Brawley, California, USA
78-24	555442	Haziz	Indio, California, USA
90-1	--	Sphinx	Phoenix, Arizona, USA
--	--	TR	Cathedral City, California, USA

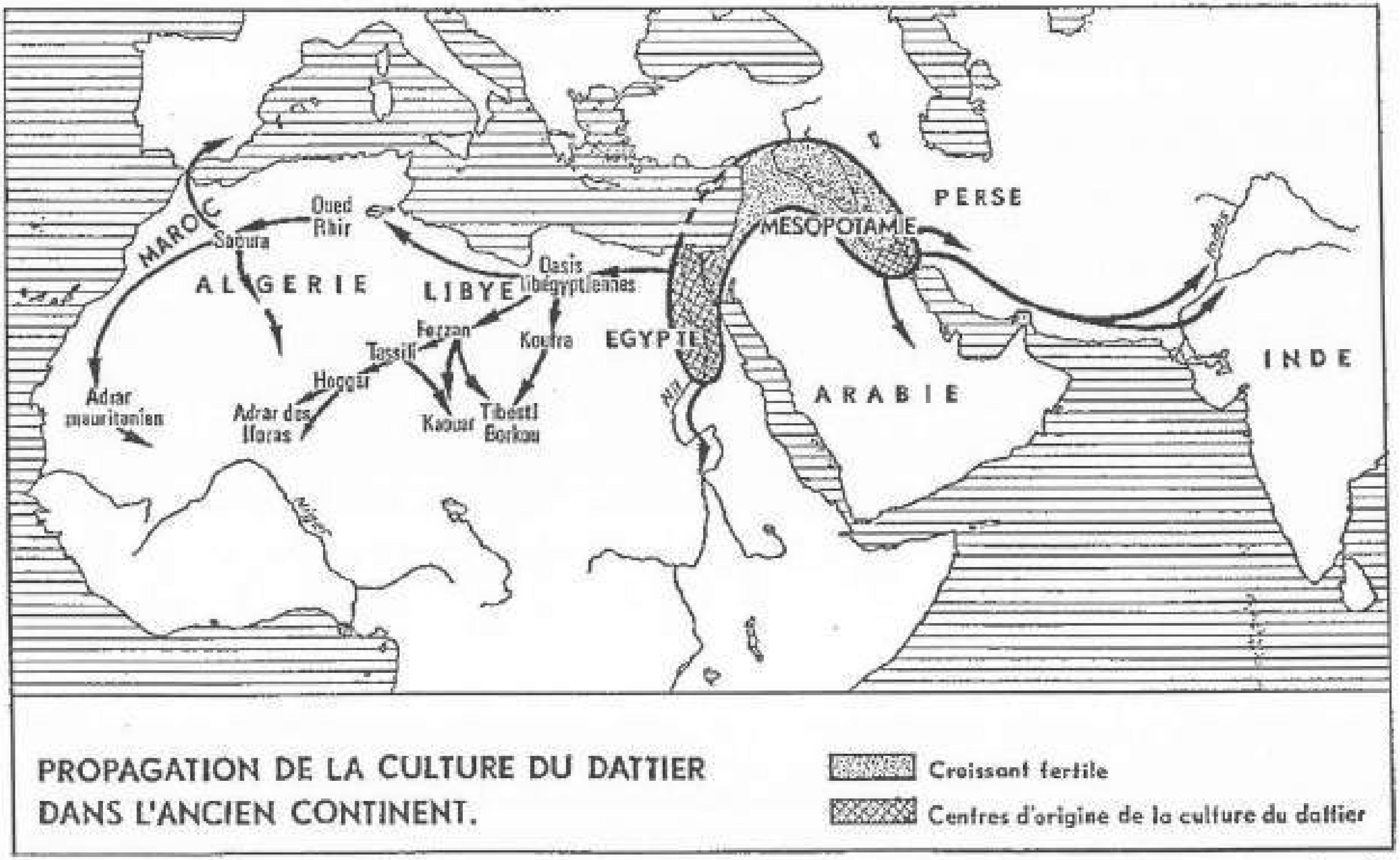
TABLE 7. Superior Male Date Palms of Local Origin, USDA-ARS-NCGRCD..

Accession Number	PI	Name	Notes
78-7	555410	Barhee A-19	late; produces large fruit
78-8	555420	Boyer No 11	early; prolific
78-9	555421	Crane	early; prolific
78-10	555411	Fard No 4	produces early, small fruit
78-11	555443	Jarvis No 1	early; prolific



croquis n°2

Figure 1. Distribution of *Phoenix* spp throughout the world (Munier, 1973).



croquis n:23

Figure 2. Spread of the date palm throughout the Old World (Munier. 1973).

FRUIT: soft, s-d, dry; season ____________________

color, khalal ____________________

____

" rutab ____________________

" tamar ____________________

____

shape ____________________

calyx ____________________

size ____________________

skin ____________________

flesh ____________________

rag ____________________

flavor ____________________

SEED: color ____________________

shape ____________________

size ____________________ g.p. ____________________

furrow ____________________

OTHER CHARACTERS ____________________

____

Figure 3. Fruit evaluation form used at US Date and Citrus Station.

VARIETY ______________________________

LOCATION ______________________________

DISTINGUISHING CHARACTERS ______________________________

____

____

TRUNK: Slender, medium, heavy; height ______________________________

OFFSHOOTS: few, medium, many; low, medium, high

LEAVES: Color--light, medium, deep; glaucous

Curvature--slt., med., pron.; even, out., tip

Base--narrow, med., wide; scurf--slt., med., heavy;

color ______________________________

Blade: length ______________________________; short, medium, long

Spine area: length __________; % blade length ______________________________

Spines: number ______________________________; few, medium, numerous;

single __________ paired __________ 3's __________

length sgl. __________ a __________ r __________

slender, med., broad; flexible, med., stiff

neck--lacking, length __________; def., indef.

rachis angle--sgl. __________ a __________ r __________

a-r divergence ______________________________

Pinnae: drooping--no, slt., med., pron.

longest ______________________________

widest ______________________________

terminal ______________________________

v-angle, narrowest __________ apex __________

d-angle, base __________ apex __________

rachis angle, a __________ i __________ r __________

divergence, apex ______________________________

B.S.I. ______________________________

grouping ______________________________

classes ______________________________

STALK: short, med., long; slender, med., heavy

Color ______________________________; scurf--slt., med., heavy

Figure 4. Tree evaluation form used at US Date and Citrus Station.

STUDIES ON POLLINATION OF DATE PALMS

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ABSTRACT

This study was carried out on "Seewy" date palm grown at El-Fayoum Governorate, Egypt to determine the proper time of pollinating female spathe from its cracking time which give appropriate fruit set, yield and good fruit properties. Female spathe was pollinated at different times, i.e., just after cracking, 2, 4, 6 and 8 days from cracking. The obtained results revealed that earlier pollination either just after spathe cracking or after two days from cracking time increased fruit set % with low quality of fruits. On the other hand, delaying pollination to 4 days from spathe cracking gave lower fruit set % and lesser bunch weight, but it was the most beneficial treatment which gave a high quality of fruits. Such effect is similar to the effect of fruit thinning and was accompanied by improving fruit quality. Consequently, such treatment could be considered as a recommended treatment under the conditions of this study.

"Additional Index Wrods": Date palms, Pollination, Fruit set, Yield, Fruit quality.

INTRODUCTION

The date palm tree is one of the oldest cultivated fruits in the world. Arab Nation is leading in date production because of the suitability of its climate for palm growth and fruitfulness. In Egypt, date palm is one of the most important fruits and widely distributed in different districts. There are three main types of dates based on fruit moisture content, i.e., soft, semi-dry and dry cultivars. El-Fayoum Governorate is considered one of the main districts of semi-dry date production in Egypt, especially "Seewy" cultivar. Therefore, it is required to ensure good fruit production through understanding some horticultural practices that affect tree growth and productivity. Pollination is one of the major practices in this concern (Nixon, 1951; Brown et al., 1969; Ream & Furr, 1970; Shaheen, 1986; Gasim, 1993 and Kotb, 1993). Pollination is an expensive practice due to the pattern of flowering of palm trees and climbing several times to the crown (Al-Baker, 1972; Hussein et al., 1979 and Hussein, 1982). Observations indicated to the need of "Seewy" palms grown at El-Fayoum Governorate to intensive pollination for several times to cover the long flowering season and to ensure good yield.

The determination of length of time during which the female flower of date palm remain receptive to fertilization is very important. In this concern, Leading (1928), Albert (1930), Reuveni (1970) and Shaheen (1986) showed that pistils do not remain receptive long and the period of receptivity differs among the cultivars. Shaheen (1986) cleared that the pollination of the female spathe just after cracking gave higher fruit set percentage. Leading (1928), Albert (1930), Al-Delaimy & Ali (1969) and El-Kassas & Mahmoud (1986) found that with most cultivars of dates, maximum set of fruit was obtained from pollinations within three or four days after spathe creaking, but fair sets may be obtained in some cases up to eight or ten days.

The main goal of this study is to determine the proper time of pollination after female spathe cracking which results in appropriate fruit set and yield and improved fruit quality.

MATERIALS AND METHODS

This study was conducted during two successive seasons of 1995 and 1996 on "Seewy" date palm (*Phoenix dactylifera*, L.) of about 30 years old grown in a loamy sand soil at El-Bassionia orchard, El-Fayoum Governorate, Egypt. In both seasons, five uniform vigorous palms were selected according to bearing the same number of female spathes. The selected palm trees were subjected to the same cultural practices. The leaf bunch ratio was maintained at 7 : 1. Ten female spathes of nearly equal size were selected on each selected palm tree in both seasons, while the other spathes were removed. Pollination was done by using pollen grains from the same male palm tree in the two seasons.

The 10 female spathes on each palm were labelled and subjected to the following pollination treatments during both seasons: pollination just after spathe cracking, two, four, six and eight days from cracking. Subsequently, each treatment was replicated five times, using two female spathes per every replicate tree in a complete randomized design. All spathes were bagged, each in a large paper bag just after cracking and it remained covered after pollination for approximately two weeks to prevent contamination from air or other surrounding pollinating treatments.

Five female strands were randomly selected from each bunch. On these strands, number of setting fruits was counted after 21 days from pollination, then fruit set percentage was calculated for each treatment. All bunches were harvested at full colour stage during the second week of October in both seasons. The average bunch weight (in kg.) was determined for each treatment. Samples of 30 date fruits were taken at random from each bunch for the determination of physical and chemical fruit properties, i.e., fruit weight, seed weight, flesh weight, flesh %, seed %, flesh / seed ratio, fruit dimensions, total soluble solids % (using a hand refractometer), total sugars % (estimated by the method of Schaffar and Hartman, 1921) and total titratable acidity % (A.O.A.C., 1965). The obtained data were statistically analyzed according to Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

Fruit Set %

From data in Tables (1 & 2) it can be shown that the percentage of fruit set varied according to pollination time of female spathe. The results showed that percentage of fruit set was decreased with delaying pollination after spathe cracking in both seasons. Statistical analysis revealed that delaying pollination to four, six or eight days after spathe cracking significantly reduced the percentage of fruit set as compared with earlier pollination whether just after spathe cracking or after two days from cracking in both seasons. The increase in the percentage of fruit set occurred by earlier pollination may be due to that the pollen grain tube can easily germinate and elongate to penetrate the stigma and style of the female flower resulting in better fertilization and fruit set (Brown et al., 1969). However, Leading (1928), Albert (1930), Al-Delaimy & Ali (1969), Ream & Furr (1970), Reuveni (1970), Marie (1971), Rahim (1975), El-Kassas & Mahmoud (1986) and Shaheen (1986) found that delaying pollination after female spathes cracking of date palm reduced the percentage of fruit set. They also reported that maximum set of fruit with most date cultivars was obtained from pollination within three or four days after female spathe opening.

Yield Per Bunch

As shown in Tables (1 & 2), the average bunch weight in both seasons, was not significantly affected if the female spathe was pollinated just after cracking comparing with those pollinated after two days from cracking. Delaying pollination to four, six or eight days from spathe cracking resulted in a significant reduction in the average bunch weight as compared with pollination just after cracking in the two seasons. These reductions were estimated in 1995 season to be 21.3%, 25.9% and 27.9%, respectively in comparison to bunch weight obtained from pollination just after cracking. In 1996 season, the percentage of reduction was 21.2%, 32.7% and 34.7% when pollination was delayed to four, six and eight days from spathe cracking, respectively comparing with bunch weight resulted from pollination just after cracking. Such results may be attributed to poor fruit setting as a result of delaying pollination. These findings agree with those reported by Leading (1928) and El-Kassas & Mahmoud (1986), who found that if pollination was delayed to more than a week from its cracking, the yield would be greatly reduced. In this concern, Leading (1928), Albert (1930), Brown & Bahgat (1938), Reuveni (1970) and Moustafa et al. (1986) reported that the length of time during which the female flowers of date palm remained receptive varied according to cultivar, temperature and humidity during flowering period.

It is worthy to mention that the significant reduction in bunch weight due to pollination after 4 days from spathe cracking may be responsible of improving the fruit quality. This finding is strongly supported by El-Kassas and Mahmoud (1986) on Zagloul dates.

Physical and Chemical Fruit Properties

Tables 1 and 2 exhibited the effect of different pollination times following female spathe cracking of "Seewy" date palm on fruit characteristics in 1995 and 1996 seasons.

The fresh weight per fruit was significantly increased when pollination was delayed to 4, 6, or 8 days from spathe cracking in the two seasons. Meanwhile, delaying pollination by 4 days from spathe cracking resulted in the greatest fruit weight in both seasons. Such results might be due to the effect of delaying pollination on lowering fruit set percentage and fruit number per bunch as well as the reduction in fruits compactness which prevents their accumulation within bunch. Consequently, such fruits take the opportunity of natural growth (Nixon, 1951).

The average seed weight was not significantly affected by any of the experimental treatments in both seasons. All treatments were similar in effecting seed weight.

Data proved that delaying pollination up to 4 days from spathe cracking significantly increased the average flesh weight, flesh weight % and flesh / seed ratio than pollination just after cracking. This is clearly shown in both seasons of study. Meanwhile, pollination after four days from female spathe cracking resulted the highest flesh weight (18.56 & 18.50 gm.), flesh weight % (89.79 & 89.81%) and flesh / seed ratio (8.80 & 8.81) in the first and second season, respectively. These increases which occurred by pollination after four days from spathe cracking might be due to consistent increase in fruit weight.

In both seasons, fruit length and diameter increased by delaying time of pollination up to 4 days after spathe cracking, where such treatment gained the greatest dimensions of fruit in the two seasons.

Table (1) : Effect of different pollination times from female spathe cracking on fruit set, yield and fruit quality of "Seewy" date cultivar in 1995 season.

Pollination time after female spathe cracking	Fruit set %	Bunch wt. (kg.)	Fruit wt. (gm.)	Seed wt. (gm.)	Flesh wt. (gm.)	Flesh wt. %	Seed wt. %	Flesh/ seed ratio	Fruit dimensions length (cm.)	Fruit dimensions Diam. (cm.)	TSS %	Total sugars %	Total acidity %
Just after cracking	86.92	15.25	15.12	2.10	13.02	86.11	13.89	6.20	4.10	2.40	36.30	31.50	0.30
2 days after cracking	85.10	15.00	16.60	2.11	14.49	87.29	12.71	6.87	4.51	2.42	36.20	31.50	0.31
4 days after cracking	72.40	12.00	20.67	2.11	18.56	89.79	10.21	8.80	5.00	2.63	39.40	32.60	0.23
6 days after cracking	71.60	11.30	19.24	2.15	17.09	88.83	11.17	7.95	4.85	2.58	39.50	32.75	0.23
8 days after cracking	63.50	11.00	18.45	2.16	16.29	88.29	11.71	7.54	4.77	2.49	37.20	32.00	0.26
L.S.D. at 5 %	1.96	0.33	0.56	N.S.	0.56	0.33	0.32	0.27	0.16	0.08	1.62	0.58	0.02

Table (2) : Effect of different pollination times from female spathe cracking on fruit set, yield and fruit quality of "Seewy" date cultivar in 1996 season.

Pollination time after female spathe cracking	Fruit set %	Bunch wt. (kg.)	Fruit wt. (gm.)	Seed wt. (gm.)	Flesh wt. (gm.)	Flesh wt. %	Seed wt. %	Flesh/ seed ratio	Fruit dimensions		TSS %	Total sugars %	Total acidity %
									length (cm.)	Diam. (cm.)			
Just after cracking	80.64	14.85	15.28	2.11	13.17	86.19	13.81	6.24	4.20	2.47	37.10	32.00	0.25
2 days after cracking	78.80	14.55	17.12	2.12	15.00	87.62	12.38	7.08	4.66	2.55	37.40	32.20	0.26
4 days after cracking	68.60	11.70	20.60	2.10	18.50	89.81	10.19	8.81	5.20	2.69	40.80	34.20	0.20
6 days after cracking	66.80	10.00	20.00	2.13	17.87	89.35	10.65	8.39	5.10	2.64	40.60	34.75	0.20
8 days after cracking	60.45	9.70	19.10	2.14	16.96	88.80	11.20	7.93	4.82	2.60	38.60	32.80	0.23
L.S.D. at 5 %	2.17	0.60	0.43	N.S.	0.43	0.25	0.26	0.21	0.34	0.14	1.37	0.64	0.02

The present data clearly indicated that delaying pollination to 4 or 6 days from the time of spathe cracking significantly increased the TSS% and total sugars % than pollination just after cracking. This is true in both seasons of study. However, the difference between the two treatments was negligible.

As shown in the attached tables, it is obvious that pollinating the female spathe, 4 or 6 days after its cracking significantly decreased the acidity than pollination just after cracking in both seasons. However, pollination by 2 days from the time of cracking did not significantly affect the titratable acidity content in the fruits as compared with pollination just after cracking in the two studied seasons.

In general, these findings concerning the response of "Seewy" fruit physical and chemical properties to pollination at different times from female spathe cracking go in line with those found by Nixon (1951), Reuveni (1970), Al-Baker (1972), Hussein (1982), El-Kassas & Mahmoud (1986) and Moustafa et al. (1986) on several date cultivars.

From the foregoing results, it is noticed that earlier pollination of "Seewy" date palm under El-Fayoum Governorate conditions either just after female spathe cracking or after two days from cracking time gave higher fruit set percentage with low quality of fruits due to the great number of fruits per bunch. On the other hand, pollination after 4 days from the time of spathe cracking caused lower fruit set and less bunch yield, but it gained better fruit properties due to the lesser number of fruits per bunch. Such effect is similar to the effect of fruit thinning and was accompanied by improving fruit quality.

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Evaluation of the Pollination method and Pollen Concentration on Chemical Characteristics of Date Fruit from Fard Cultivar

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ABSTRACT

Date palms of the Fard cultivar were pollinated for three successive years using hand pollination (HP), hand duster (HD) and motorized duster (MD). One part of pollen was mixed with 5, 7 and 9 parts of wheat flour and applied by the hand and motorized dusters; whereas 3 inverted male strands per female spadix were applied by hand. Sugars, pectin and titrable acidity percentages were determined on a dry weight basis. Fruit set, volume, weight and total yield were also assessed. No significant differences were observed in the fruit set volume, weight and yield with respect to method of pollination. Similar results were obtained for moisture, total and reducing sugars. The hand duster produced the highest fruit set (24.8 fruits/strand) and the motorized duster the lowest (20.6 fruits/strand). The hand duster produced the lowest pectin (2.06%) in Bisir (khalal), the lowest sucrose content in Tamr (2.7%) and the highest acidity in Rutab (1.08%). The lowest reduction rates in pectin (14.5%) and in acidity (17.5%) from Bisir to Rutab were found in fruits from the hand duster, an indication of the late ripening. However, the disappearance of this difference in later stages makes fruits of the three methods ripen simultaneously. Consequently the hand duster is favored because it is more convenient and efficient. No significant effect was found of the pollen concentration on most of the physical and chemical parameters. The hand pollinated fruits contained higher pectin during Bisir, lower acidity in Rutab and higher sucrose in Tamr than 1:9 pollen ratio. Reducing the pollen ratio from 1:5 to 1:7 to 1:9 did not affect pectin and acidity during Bisir and Rutab. But in Tamr the lowest pollen concentration produced the least acidity. Reduction rates of pectin and acidity from Bisir to Rutab was an indication that the latter occurred at a faster rate. Sucrose was greater in hand pollinated fruit than in any of the 3 pollen concentrations. None of the detected differences gives any of the pollen ratios superiority over the others. Interaction between pollination method and pollen ratio showed significant differences in physical and chemical charateristics of the fruits between methods, but not between pollen ratios. Pectin was lower in fruits produced from the hand duster at a ratio of 1:7 and 1:9, and motorized duster at 1:9 than from hand pollination. The higher the pollen concentration applied by the hand or with a motorized duster, the faster the reduction rate of pectin. It was -25.9, + 0.06, - 13.6% and -36.6, -19.2 and -31.3%, between Bisir and Rutab of hand and motorized dusters at 1:5, 1:7 and 1:9 pollen ratios, respectively. It was concluded that since the tested treatments did not seriously affect any of the physical and chemical characteristics of the Fard dates, mechanical pollination was recommended to overcome the problems associated with hand pollination. The hand duster, with a 1:9 pollen ratio was favoured over the motorized duster and hand pollination.

INTRODUCTION

The dioecious nature of the date palm necessitates the transfer of pollen from the staminate palm to the pistillate in order to obtain an economically feasible yield. The date palm is naturally wind pollinated, but this method and pollination by insects have proven inefficient and economically unfeasible (Clor et al.1974; Al-Bakr, 1972). The traditional method of hand pollination which involves climbing the palm, has become impractical under the changing socio-economic structure in areas where date palms are intensively grown. It requires experienced pollinators, has a high labor cost and is time consuming (Shabana et al., 1985 Hamood et al., 1986; Ibrahim 1988 and Al-Juburi, 1995). Under these circumstances, mechanical pollination has been recommended. The majority of researchers in this field were interested in the physical characteristics of the fruits in one or two seasons. Information about chemical characteristics of date fruit as affected by of the method of pollination and pollen concentration is scarce. The present research was intended to study the effect of pollen concentration and method of pollination on fruit set, size, weight, yield and its content of sucrose, reducing sugars, pectin and acidity of the date fruit.

MATERIALS AND METHODS

The Fard cultivar grown at Nizwa area was selected for this experiment which continued for three successive seasons starting in 1991. Randomly selected palms were at approximately equal height in a factorial experiment with 4 replications. The Khori cultivar was used as the source of pollen.

Three methods of pollination were assessed by hand, with a motorized pollen duster and with a hand pollen duster. With hand pollination, the pollinator climbs the palm and places 3 dry inverted male strands into the female spadix and then ties the distal end of the spadix. He does this operation whenever a spadix opens. A hand pollen duster involves the use of a locally made device consisting of a small piston pump, connected to a reservoir, and mounted on aluminium pipes. Air pressure is exerted inside the piston pump by pulling a string down and the pollen is pushed out by releasing the string. Motorized pollen duster consists of a small air compressor operated by a two stroke gasoline engine, a 10L pressurized air storage tank, a sprayer gun and a set of light weight plastic pipes. A hand pistol is used to release pressure and push the pollen through the pipes.

Pollen for the hand and motorized dusters was mixed with wheat flour (grade 1) at 1 part pollen to 5,7 and 9 parts flour. Mechanical pollination was carried out from the ground 3-4 times for each palm. This was found necessary because of variations in size, time and rate of opening of the spadixes.

Fruit samples were collected randomly, by removal of 6 strands at the Hababook stage and 4 strands for the Kimri, Bisir (khalal), Rutab and Tamr stages. These stages of fruit development are classified on the basis of morphological differences. For example, Hababok stage, the fruits are small, conical-shaped and light green in color with green strips. Kimri stage they are larger than Hababok, ovate and dark green in color. With the Bisir stage they have reached a maximum size, and are red and yellow. Rutab stage shows a browning of the top _ of fruit (distal end). The other two thirds portion are red and yellow. Finally at the Tamr stage, all fruit turn dark brown in color.

All collected fruits were immediately placed in plastic bags and kept on ice. In the laboratory samples were kept in a freezer (-18 pending physical and chemical analysis. The percentages of moisture, total sugars, reducing sugars and sucrose were analysed according to AOAC (1984). Pectin was measured according to Less (1975) and titrable acidity (citric acid) followed AOAC (1966). Results were then computed on a dry weight basis. The volume of fruits was measured by water displacement (ml).

Statistical analysis was carried out using SAS package. The analysis of variance (ANOVA) was employed and the LSD values were calculated for the averages of three years results.

RESULTS AND DISCUSSION

Effect of pollination method:

The results of the three year averages showed no significant differences in fruit set, size, weight and yield when hand pollination, hand duster or motorized duster were used. These results are in agreement with Al-Juburi (1995). Similar results were obtained in the case of moisture, total sugar and reducing sugar percentages during any of the five developmental stages of the fruit (data not presented). On the other hand, while the hand duster produced a larger number of fruits during Tamr than the motorized duster, it was not significantly different from hand pollination (Table 1). This is in agreement with the findings of Brown et.al. (1969); Hamood et al. (1986); Shabana (1988) and Al-Juburi (1995). Furthermore, the motorized duster produced the lowest number of fruits in spite of the fact that it is known to deliver the largest amount of pollen. We can speculate that this was more likely an effect of wind blowing the pollen off-target and a stronger pressure exerted to push pollen through the pipes (Shabana et al. 1985).

The lowest pectin concentration (2.06%) during the Bisir stage was produced by fruits from the hand duster method. However, pectin in fruits produced by hand pollination was at par with that in fruit of the motorized duster. In contrast acidity percentages did not show any significant effect of the pollination method during Bisir (Table 1). In Rutab, however, the hand duster fruits contained a higher acidity percentage than hand pollination fruits and they were at par with those of the motorized duster fruits. It has been reported that reductions in pectin and acidity percentages indicate the onset of the ripening process (Ahmed and Ahmed 1995; ElMardi et al. 1995; Rouhani and Bassiri, 1976; Abdullatif 1988). Consequently the rates at which pectin and acidity were reduced (Table 1) in the developing date fruit from Bisir to Rutab can be considered as rates of ripening (Hasegawa et al. 1969; Al-Jasim and Delaimy 1972 and Rygg 1946). Calculated reductions in Pectin while the date fruit was developing from Bisir to Rutab were in the following order: hand pollination (34.4%) > motorized duster (29.57%) > hand duster (14.5%). On the other hand reductions in acidity during the same period were as follows: hand pollination (66.3%) > motorized duster (33.3%) > hand duster (17.5%). These results indicate that fruits produced by the motorized duster and hand pollination were ripening at faster rates than those of the hand duster because they showed higher reductions in pectin and acidity. Furthermore, hand pollinated fruits produced a higher reduction in acidity than those produced by the motorized duster. These results indicate that hand pollinated fruits ripen at a faster rate than the motorized duster's which in turn ripened faster than the hand duster's fruits. They also indicate that the larger number of fruits produced by the hand duster ripened later than the smaller number of fruits produced by the motorized duster. Such an effect of fruit number on maturity is generally related to the increased competition among fruits for available food (Nixon, 1956; Nixon and Crawford, 1942, Nixon, 1940). Results in Table 1 also show that Tamr produced by hand pollination contained a higher sucrose percentage than that produced by the hand and motorized dusters. Such a pattern in sucrose concentration may indicate that hand pollinated fruits during "Tamr' were chemically less matured than those produced by the motorized and hand dusters (Al-Bakr, 1972; Cavell, 1947). This result contradicts with the above findings for pectin and acidity reductions which showed that hand pollinated fruits were ripening at a faster rate than fruits produced with the other two methods. Similar contradictory conclusions may be drawn if pectin and acidity were considered at separate individual stages. Therefore the rate of ripening as determined by the change in compound concentration from one stage of development, to the other provides a more reliable measure of ripening attributes.

Effect of pollen concentration

Pollen concentration produced similar patterns as in the method of pollination, on fruit size, weight, total yield and moisture, total sugars and reducing sugars contents. Slight differences were observed in pectin concentration during Bisir and Rutab (Table 2). Hand pollination produced fruits, with higher pectin than the lowest pollen concentration (1:9) during 'Bisir" and "Rutab', but it was at par with the two other concentrations viz: 1:7 and 1:5. In addition, no significant effect of pollen concentration was observed on pectin during 'Tamr' (data is not presented). These results indicate that low pollen concentration (1:9) can produce the same effect on the pectin content as high pollen concentration (1:5) does. Thus indicating no effect of the amount of pollen on the activation of pectinase enzymes and providing a clue for economizing on pollen application. On the other hand, the acidity percentage during Rutab was higher at 1:5 (1.03%) than for hand pollination (0.59%), while it was at par with the other two treatments.

Moreover during 'Tamr' no significant difference was observed in acidity between these treatments (Table 2). During 'Tamr' a 1:5 pollen ratio produced fruits with higher acidity (0.51%) than the 1:9 ratio which produced an acidity level of 0.43%. These results indicate that the pollen concentration influenced the titrable acidity of the fruits which in turn influenced the softening and browning of the dates (Al-Bakr, 1972). Results of pollen concentration on pectin and acidity indicate that the pollen concentration produced a more pronounced effect on acidity in the period between 'Bisir' and 'Rutab' than on pectin during the same period. Further more, in each of the pollen ratios, acidity reduction between 'Bisir' and 'Rutab' was lower than between 'Rutab' and 'Tamr'. This is explained by the reductions in pectin concentration and acidity level which point out that in the period between 'Bisir' and 'Rutab'; the latter was reduced at a faster rate (ranging from 23.13 to 53.07%) than the former (ranging from 11.8 to 31.5%) (Table 2). Such faster reduction in acidity is more likely a result of the increased activity of the polyphenol oxidases and the reductions in acidity between 'Bisir' and 'Rutab' and 'Rutab' and 'Tamr' respectively on the three isomeric monocaffeoylshikimic acids. Such a situation has been reported to occur during the softening process of the date fruit (Al-Jarah, 1982; Abdullatif, 1988). Thus it can be seen that the effect of these enzymes continues during the 'Tamr' stage and influences the dark pigmentation of the fruits.

The sucrose percentage was significantly higher in the Tamr produced by hand pollination than by the other pollen concentrations. It can also be seen that the highest sucrose concentration in the Tamr produced by hand pollination was associated with the highest reductions in acidity between Bisir and Rutab stages, but the lowest reductions between Rutab and Tamr, (Table 2). This indicates that conversion of organic acids to sucrose between the Rutab and Tamr stages was enhanced in fruits from the hand pollinated palms as reflected by the highest sucrose content. The high acidity during Rutab of the three pollen dilution treatments was associated with lower reductions in acidity indicating the interference of acidity with ripening (Rygg 1948). The reason for the effect of pollen when directly released from the anther on acidity and sucrose could not be explained with the present set of experiments. However, it is more likely a result of enzymetic activity which is temperature dependent.

Effect of the interaction between the method of pollination and pollen concent

No significant effect was found by the interaction between any of the mechanized methods and pollen concentration on the tested parameters during any of the developmental stages. Slight differences were observed on pectin during Bisir and sucrose during Tamr (Table 3). Hand pollination produced significantly higher pectin in the Bisir than the hand duster using 1:7 and 1:9 pollen ratio. It could also be seen in Table 3 that there was no significant effect of pollen concentration when the hand duster was used. The higher the pollen concentration used by the motorized duster, the higher the pectin concentration in the Bisir. These variations did not appear in the Kimri and Rutab stages. Results in Table 3 also show that the rate at which the date fruit was softening between the Bisir and Rutab stages (as indicated by the reduction in pectin) was greater at the highest pollen concentration when any of the mechanized methods was used (hand duster = 25.9%; motorized duster = 36.6%) as compared to 13% and 31% respectively. It was also greater in fruits produced from hand pollination (34.7%) than in fruits produced by 1:7, and 1:9 pollen ratios. This reduction in pectin of fruits at 1:5 pollen was the lowest in the hand duster fruit between Kimri and Bisir, whereas in the motorized duster fruits, the pectin concentration was increased by 25.8%. Such variations are more likely a result of competition among the fruits for the available food and ventilation as influenced by the changes in size and number of fruits, (Al-Bakr, 1972, Al-uaburi, 1993). It may also involve an alternating phenomenon in such a way that a compound at high concentration this season will be at very low concentration in the next season (El-Mardi et. al. 1995).

Sucrose during Tamr stage was significantly higher in hand pollinated fruits (5.13%) than in any of those pollinated mechanically except in fruits produced by the motorized duster with a 1: 7 pollen ratio (3.74%)..

CONCLUSIONS

Results of the three years provided no evidence of drastic changes in the physical and chemical charateristics of the fruit as a function of the pollination method. The main differences in the effect of these methods were on ripening attributes, specifically a reduction in pectin concentration and acidity which occured between the Bisir and Rutab stages. Hand pollinated dates matured at a faster rate than those produced by hand and motorized dusters. However, this effect was found to occur for a short period and before the fruits reached the fully ripened stage of Tamr. Therefore, we cannot consider hand pollination to be superior over the mechanized methods.

The pollen: flour ratios (i.e. pollen concentration) study produced similar patterns as the pollination methods experiments. The lower pollen ratio 1:9 was found superior to the 1:5 ratio as it provides for pollen conservation.

No significant differences in the physical and chemical charateristics of the date fruit were produced by hand pollination compared with the hand and motorized dusters at any of the three pollen concentrations. The significant differences in pectin during Bisir and sucrose during Tamr were found insufficient to judge any of the treatments superior over the others. For convenience, efficiency and pollen saving, a hand duster with a 1:9 pollen ratio is recommended to pollinate the Fard cultivar.

ACKNOWLEDGEMENT

The authors are gratefully indebted to Sultan Qaboos University and the Ministry of Agriculture and Fisheries Wealth for their continued support of the project.

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Table 1. Effect of pollination methods on number of fruit and changes in pectin, acidity and sucrose content of the Fard date during fruit developmental stages.

Methods of Pollination	No.of fruits per strand		Pectin (%)				Reduction	Acidity (%)				Reduction	Sucrose (%)	
	Tamr		Bisir		Rutab			Bisir		Rutab			Tamr	
	Mean	SD	Mean	SD	Mean	SD	%	Mean	SD	Mean	SD	%	Mean	SD
Hand Pollination	23.60 ab	6.57	3.14 a	1.49	2.06 a	0.50	34.4	1.75 a	1.69	0.59 b	0.15	66.3	5.13 a	3.25
Hand duster	24.80 a	6.87	2.06 b	1.14	1.76 a	0.61	14.5	1.31 a	1.14	1.08 a	0.77	17.5	2.70 b	1.93
Motorized duster	20.58 b	5.89	2.68 a	1.20	1.89 a	0.71	29.5	1.44 a	1.11	0.96 ab	0.56	33.3	3.10 b	2.2
P	0.02		0.016							0.06			0.007	

Numbers followed by the same letter in the same column are not significantly different at the 0.05 level.

Table 2. Effect of pollen concentration on changes in pectin, acidity and sucrose content of the Fard dates during different developmental stages.

Pollen Concentration	PECTIN (%)				Reduction in Pectin	Acidity (%)						Reduction in Acidity		Sucrose (%)	
	Bisir (Khalal)		Rutab			Bisir (Khalal)		Rutab		Tamr		Bisir - Rutab	Rutab - Tamr	Tamr	
	Mean	SD	Mean	SD	%	Mean	SD	Mean	SD	Mean	SD	%		Mean	SD
Hand Pollination	3.14 a	1.49	2.06 a	0.50	34.40	1.75 a	1.69	0.59 b	0.15	0.50 ab	0.07	66.30	18.0	5.13 a	3.25
1 pollen : 5 flour	2.73 ab	1.50	1.87 ab	0.57	31.50	1.34 a	1.20	1.03 a	0.75	0.51 a	0.14	23.13	50.1	2.23 b	1.16
1 pollen : 7 flour	2.29 ab	1.13	2.02 a	0.72	11.80	1.30 a	0.99	1.02 a	0.61	0.46 ab	0.10	53.07	55.0	3.45 b	2.44
1 pollen : 9 flour	2.08 b	0.83	1.59 b	0.64	23.50	1.48 a	1.20	1.02 a	0.68	0.43 b	0.09	43.33	58.0	3.03 b	2.30

Numbers followed by the same letter in the same column are not significantly different at the .05 level

Table 3. Interaction effect of method of pollination and pollen concentrations on changes in pectin and sucrose content of Fard date during different development stages.

		PECTIN %						CHANGES IN PECTIN CONCENTRATION		SUCROSE (%)	
		Kimri		Bisir		Rutab		Kimri to Bisir	Bisir to Rutab	Tamr	
		Mean	SD	Mean	SD	Mean	SD	%	%	Mean	SD
Hand Pollination		2.65 a	1.50	3.14 a	1.49	2.06 a	0.50	+18.5	-34.7	5.13 a	3.25
Hand Duster	1 pollen : 5 flour	2.80 a	1.31	2.55 abc	1.49	1.89 a	0.64	-8.9	-25.9	2.04 b	0.79
	1 pollen : 7 flour	2.37 a	1.52	1.77 c	0.90	1.78 a	0.59	-25.3	+.06	3.15 b	2.54
	1 pollen : 9 flour	2.11 a	1.46	1.84 bc	0.83	1.59 a	0.62	-12.8	-13.6	2.91 b	2.02
Motorized Duster	1 pollen : 5 flour	2.32 a	1.61	2.92 a	1.56	1.85 a	0.51	+25.8	36.6	2.42 b	1.45
	1 pollen : 7 flour	2.99 a	1.04	2.81 ab	1.12	2.28 a	0.78	-6.0	-19.2	3.74 ab	2.41
	1 pollen : 9 flour	3.22 a	1.73	2.30 ab	0.81	1.58 a	0.69	-28.6	-31.3	3.15 b	2.64

Number followed by the same letter in the same column are not significantly different at the 0.05 level.

ACCELERATING AND INTENSIFYING COLOR FORMATION OF ZAGHLOUL DATE PALM FRUITS USING MODIFIED ETHEPHON FORMULATIONS

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ABSTRACT

Intensely colored Zaghloul dates are demanded in the market. Most fruits are consumed at the khalal stage. Growers are attempting to acceleratee and improve color intensity before the rain season and are after early marketing to obtain higher prices. The spray of ethephon alone did not achieve their goals consistently. In this study, modified ethephon formulations were used two weeks before harvest to enhance its effectiveness either by using some enhancers or film-forming materials. Ethephon at 1000 ppm in the presence of ethanol (2%, v/v) and glycerol (1.5%, v/v) resulted in significantly higher anthocyanin content in the fruit than the control or ethephon alone. The addition of urea at 100 mM to the previous formulation caused even higher anthocyanin content in the fruit in both seasons of study 1995, and 1996 seasons. The application of either ethanol, urea, or glycerol alone did not result in any significant increase in anthocyanin content when compared with the control. The use of the film-forming chemicals, namely NU-Film 17 or Dormant Spray along with ethephon resulted in a consistent trend of higher anthocyanin content when compared with ethephon alone or the control. This increase, however, was not statistically significant. Other parameters such as TSS, acidity, fruit size and weight, and seed weight were measured. The results proved that by modifying ethephon formulation, color development and intensity could be enhanced by preharvest application.

Additional Index Words: anthocyanin, Ethrel, surfactants, khalal, ethanol, glycerol, urea.

INTRODUCTION

Zaghloul dates are highly demanded in the market. This cultivar is mainly consumed at the khalal stage. There is a trend of higher export to the Arab market. The consumers look for fruits with greater color intensity and uniformity. Delaying harvest could result in more anthocyanin in the fruit. However, farmers are forced to harvest their dates before the rain season. Rain causes cracking, acceleration of the rutab stage, and increasing the susceptibility to infection by pathogens. Hence, it is really desired to accelerate color development and increase its intensity and uniformity.

An ethylene-releasing compound, namely ethephon, has been used to achieve these goals (Balaket, 1988; El-Hammady et al., 1992). The results of ethephon, however, were inconsistent and farmers complain about the lack of effectiveness (Farag et al., 1992). Ethephon applications had to be accompanied with severe pruning in order to be able to enhance ripening of Samany dates (Hussein et al., 1993). Thus, many researchers have been attempting to accelerate ripening of dates after harvest (Khalifa et al., 1975; Rouhani and Bassiri, 1977). It was found that due to the hydrophilic nature of ethephon, its diffusion across the cuticle is very slow (Farag, 1989) and its penetration across the cuticle could be enhanced by changing its formulation (Farag and Palta, 1992). It was also found that the use of a wetting agent along with the sprayed material would result in increasing the contact angle and the reduces the surface tension of the drops but may not increase the actual penetration across the fruit cuticle (Farag, 1989). Furthermore, early application of ethephon after fruit set resulted in a significant yield reduction (Maximos et al, 1980; Mougheith and Hassaballa, 1979).

The objectives of this study were to accelerate color formation of Zaghloul dates and increase its intensity by using a new formulation of ethephon. This formulation aims at enhancing the effectiveness of sprayed ethephon either through the actual penetration (Farag, 1989) or forming a film on the fruit surface.

Materials and Methods:

Zaghloul date palm trees growing at Edko, Beheira were used in this experiment. Trees were twenty years old, uniform, healthy, and growing in sand loamy soil. On each tree, bunches at the southern part of the tree were sprayed to the runoff using a hand sprayer on Sept. 15 and 16 in the two consequetive seasons 1995, 1996 respectively. The study included two separate experiments.

Experiment 1:

Treatments were: water, ethephon at 1000 ppm, ethanol (2%, v/v), urea (100 mM), glycerol (1.5%, v/v), the combination of ethephon at

1000 ppm plus ethanol and glycerol at the same mentioned concentrations, and finally the combination of ethephon plus ethanol and glycerol along with urea at the same above concentrations.

Experiment 2:

Film-forming materials along with ethephon were used. Treatments included: the surfactant tergitol at 0.2%, v/v, ethephon at 1000 ppm, NU-Film 17 plus tergitol, Dormant Spray at 0.2%, v/v; from Miller Chemical & Fertilizers Corporation.; ethephon plus NU-Film 17 and tergitol, ethephon plus Dormant Spray and tergitol. Concentrations when not mentioned were the same as above.

Fruits were harvested two weeks after spray by taking 15 strands randomly from each harvested bunch. Ten fruits were randomly sampled from the strands taken from each bunch. Thus, thirty fruits were used for the determination of various parameters. After harvest, fruit weight (gm), volume (cm^3) and seed weight (gm) were determined. Total soluble solids were measured by hand refractometer. Juice titratable acidity was detected by titration against 0.1 N NaOH. The determination of anthocyanin in fruits was done by the method of Fuleki and Francis (1968). Three replications were used with each treatment in a completely randomized design. One tree represented one replication. Analysis of variance and the least significant difference for the means were obtained by the Mstat statistical program.

Results and Discussion

Experiment 1:

The data indicated that the formulation of ethephon in the presence of ethanol and glycerol caused a significant increase in anthocyanin content of the fruit during 1995 season. Similar trend was obtained in 1996 season but the difference was not statistically significant. The addition of urea at very low concentration (100 mM) to the above formulation caused a significant increase in anthocyanin content of the fruit as campared with the control in both seasons. The difference between the formulation of ethephon with and without urea was not significant in terms of their effect on anthocyanin production (Table 1).

Furthermore, the single treatment with either ethephon, urea, ethanol, or glycerol did not result in a significant increase in anthocyanin content of the fruit in both seasons as compared with the control.

Titratable acidity of the fruit juice (Table 1) was not significantly affected by any of the treatments when compared with the control during both seasons.

With regard to total soluble solids of the juice, it was found that ethephon treated fruits had higher TSS in the fruit than the control during both seasons. The formulation containing ethephon plus ethanol and glycerol in addition to urea also resulted in a significant increase in TSS compared with the control. The same above formulation but in the absence of urea caused a higher TSS than the control especially in the second season. It could be noticed that the spray of urea alone had an appreciable increase in the TSS values. Ethanol spray, however, did not cause any significant change in TSS when compared with the control in both seasons (Table 1).

In terms of fruit size, ethephon alone or in formulations caused a reduction in this character at harvest compared with the control during 1996 season (Table 1). This reduction, however, was not significant during the first season except with ethephon formulation containing ethanol, glycerol, and urea. Moreover, the magnitude of this reduction was negligible when compared with the control.

Similar trend was found with fruit weight. Ethephon alone or in a formulation caused a slight reduction in fruit weight especially in the second season. Furthermore, ethanol or urea or glycerol alone caused a statistically significant reduction in fruit weight and size in both seasons compared with the control (Table 1).

Seed weight was not statistically different between ethephon formulations and the control during the first season. However, ethephon treatment in the presence of ethanol, glycerol, and urea caused a significant reduction in seed weight during the second season when compared with the control. Ethephon treatment was not consistent in its effect on seed weight in both seasons. However, this reduction was statistically significant during the first season (Table 1).

Experiment 2:

The data proved that the film-forming chemicals, namely NU-Film or Dormant Spray, did not enhance anthocyanin production either alone or when each of them was combined with ethephon as compared with the control (the surfactant). This trend of result was consistent during both seasons of study. Meanwhile, ethephon in the presence of tergitol did not result in significant increase in the amount of anthocyanin as compared.

Table 1. Some fruit characteristics of Zaghloul date palm fruits as influenced by various ethephon formulations during 1995 and 1996 seasons.

Treatments	Anthocyanin Content (mg/100 g)		Total Soluble Solids (%)		Acidity (%)		Fruit Size (cm^3)		Fruit Weight (g)		Seed Weight (g)	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
1	13.62	15.21	17.27	11.87	0.53	0.51	25.80	27.93	27.63	27.97	1.91	1.88
2	18.35	20.25	17.97	18.93	0.39	0.40	26.03	24.17	25.2	26.47	2.02	2.12
3	19.12	22.72	19.77	18.20	0.44	0.45	23.10	22.80	27.73	24.63	1.87	1.75
4	14.85	19.28	20.33	17.87	0.45	0.42	26.43	25.10	27.40	24.17	1.72	1.85
5	14.02	16.83	16.13	12.33	0.51	0.46	22.37	25.13	23.90	25.80	1.93	2.04
6	15.28	16.90	20.60	21.23	0.48	0.60	22.03	21.93	22.87	22.30	1.97	1.87
7	14.25	16.22	16.73	18.13	0.46	0.63	24.47	23.90	24.73	24.23	2.32	2.10
LSD at (0.05)	2.32	5.56	1.46	2.82	0.21	0.13	0.67	0.93	1.27	0.87	0.16	0.09

Numbers under treatments means: 1, control; 2, ethephon+ethanol+glycerol; 3, ethephon+ethanol+glycerol+urea; 4, ethephon; 5, ethanol; 6, urea; 7, glycerol.

with tergitol during both seasons. The spray of ethephon in the presence or absence of the surfactant did not make any difference with regard to the amount of anthocyanin in the fruit (Table 2).

With regard to the total soluble solids (Table 2), their values were similar for most treatments during both seasons. There was only a significant increase in TSS by ethephon plus Dormant Spray treatment during 1995 season only except the significant increases in TSS by ethephon plus dormant Spray treatment in 1995 and by ethephon alone in 1996. Generally, ethephon alone or in combination with either of the film forming materials gave higher TSS than the surfactant but the difference was not statistically significant.

Titratable acidity, on the other hand, did not significantly vary among the treatments in both seasons. Although there was a reduction in acidity values due to spraying either ethephon plus NU-Film or plus Dormant Spray when compared with the control but it was not appreciable difference (Table 2).

The spray of ethephon alone or in combination with NU-Film lead to a reduction in fruit size in both seasons when compared with the control. However, fruits sprayed with ethephon plus tergitol had greater fruit size than the control during both seasons. Dormant Spray treated fruits had similar values of fruit size to the control in 1996 season. However, NU-Film spray resulted in significantly lower fruit size than the control in both seasons. The trend of results for fruit weight was generally similar to that of fruit size during both seasons. There was only a reduction in fruit weight caused by ethephon in the presence of NU-Film during the second season when compared with the control. Ethephon plus Dormant Spray, on the other hand, resulted in greater fruit weight than the control during both seasons.

With regard to seed weight, values were similar for all treatments in both seasons (Table 2).

This study proved that ethephon at 1000 ppm in the presence of ethanol (2%, v/v) and glycerol (1.5%, v/v) enhances anthocyanin production in the fruit as compared with the control or ethephon alone. The addition of urea at 100 mM to the previous formulation caused even higher anthocyanin content in the fruit in both seasons of study. These results agree with Farag, 1992, Farag and palta, 1992. Earlier application of ethephon resulted in acceleration of anthocyanin formation but along with fruit thinning (El-Hamady et al., 1983; El-Hamady et al., 1992;

Abd-Alaal, et al., 1983). Ethephon could be more effective on date palm fruits with early applications after fruit set due to the reduced resistance of the fruit cuticle to ethephon diffusion.

The application of ethephon is known to increase total soluble solids contents (Khalifa et al., 1975; Rouhani and Bassiri, 1977). This conclusion agrees with our finding that ethephon alone or in formulation increased the total soluble solids as compared with the control.

Preharvest application of ethephon was found to enhance ripening and markedly increase the total soluble solids (Mougheith and Hassaballa, 1979). Ethephon application was also found to improve fruit quality (Maximos, 1980)

This study provided evidence that ethephon has the ability to increase and accelerate anthocyanin content of date palm fruits when applied in a modified formulation.

Table 2. Some fruit characteristics of Zaghloul date palm fruits as influenced by ethephon in the presence of film-forming compounds during 1995 and 1996 seasons.

Treatments	Anthocyanin Content (mg/100 g)		Total Soluble Solids (%)		Acidity (%)		Fruit Size (cm^3)		Fruit Weight (g)		Seed Weight (g)	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
1	15.20	16.86	17.53	16.73	0.57	0.58	25.80	24.67	24.53	25.93	1.86	1.78
2	14.02	15.40	17.80	21.47	0.57	0.48	19.27	21.00	18.10	21.27	2.90	2.09
3	16.46	15.80	17.33	19.73	0.42	0.53	19.50	16.67	14.87	16.43	1.87	1.80
4	17.37	16.92	15.40	18.73	0.50	0.47	23.43	24.17	22.18	17.49	2.08	2.06
5	17.70	18.90	18.83	17.93	0.50	0.52	17.20	19.73	26.37	20.97	2.10	1.98
6	15.62	17.62	20.60	18.53	0.44	0.55	26.40	24.80	27.03	27.40	2.00	2.13
7	14.26	16.30	15.93	17.73	0.58	0.49	27.57	27.30	27.33	27.03	1.91	1.80
LSD (at 0.05)	3.13	5.56	2.38	2.16	0.38	0.18	0.92	1.23	2.30	1.23	1.12	1.34

Numbers under treatments mean: 1, Control; 2, ethephon; 3, NU-Film; 4, Dormant Spray; 5, ethephon+NU-Film 6, ethephon+Dormant Spray; 7, ethephon+Tergitol.

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EFFECT OF NAPHTHALENEACETIC ACID ON FRUIT RIPENING AND QUALITY OF (Khenazi, cv.) DATE PALM.

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ABSTRACT

Preharvest application of Naphthaleneacetic acid (NAA) at 50 and 100 ppm concentrations to immature "Khenazi" cultivar date palm Fruits 12–13 weeks after pollination (late chemri stages) was investigated. The result showed that fruit size, quality and ripening were higher for treated fruits compared with the control. In general NAA increase fruit size and delay ripening 1 to 2 months, at 50 and 100 ppm NAA.

INTRODUCTION

Attempts result (4,5,9) in using growth regulators to improve size, ripening and qualities of date fruits were discouraging. Failure to achieve encouraging results stimulated investigation (2,6) to determine the most responsive physiological stage of fruit development responsive to application of growth regulators. A physiologically active stage known as the "Depressed period" during the early second sub-stage of chimri stage was found in "Zahdi" and "Sayer" date palm (3,7,8).

Chemri is immature green colored stage of dates, which may be differentiated in two sub-stages. The first sub-stage is characterized by rapid increase in fruit size and weights, while fruit weight rate decreased in the second sub-stage in comparison to the first sub stage.. Application of NAA at 40, 50, 60 100, 150-ppm concentrations during the depressed period caused an increase in fruit size and weight for treatments (100 and 150 ppm) fruit never rapined (3,7). The increase in fruit size after treatment with NAA at 40, 50, 60, 100 and 150 ppm during the depressed period was mainly caused by cell enlargement (1). These results indicated that the synthetic growth regulator NAA might be used for improvement of various important fruit characteristics (size, weight, ripening, etc.), when the fruits are treated the fruit at depressed period. The depress period is a function of genetics and environmental factors (9). Therefor, it is necessary to determine the depress period before treating date palm fruit with growth regulators.

This paper reports the effect of two concentrations of NAA on various fruit characteristics of "Khenazi" cultivar date palm under United Arab Emirates climatic conditions.

MATERIAL AND METHODS

During the growth seasons of 1995 and 1996 on eight years old "Khenazi" cultivar date palm trees were selected for the experiment at Homraniya agriculture experimental station, (Ras Al Khaimah, UAE).

Fruit bunches on the selected trees were treated with NAA during the depressed period of fruit development 12 – 13 weeks after pollination. All bunches under treatments had been pollinated from one male palm tree.

NAA at 50 or 100 ppm was sprayed on bunchs in early morning with 1 litter plastic hand sprayers. A drop or 2 of tween 20 was added to the NAA solutions as wetting agent. Control bunches were sprayed with distilled water and tween 20..

Fruit samples were collected in two cases The first sample was collected from bunches as complete strands, so fruits were in various ripening stages, while second sample were collected randomizely from bunches in tamr stage only.

Volume, weight, fruit and seed, pulp weight, pulp to seed weight ratio, length, width, length to width ratio of fruits and ripening percentage were measured. Samples were collected in both years 1995 and 1996. Treatments were arranged in a randomized block design with each treatment replicated five times. Averages of the two years data were analyzed.

RESULTS AND DISCUSSIONS:

The results in Table 1 of the first sample indicated significant increases in volume, weight, length, width and ratio of length to width of fruits in the treated experiment compared with the control. Pulp weight and ratio of pulp to seed weight in treated fruit for both concentrations (50 and 100 ppm) were highly significant. Seed weight of treated fruit was significantly higher than untreated fruit (Table 1). Fruit and pulp weight in NAA (100 ppm) treated fruits were significantly higher than that in 50 ppm.

In Table (1) percentage of fruit ripening in mid of September were 100% in untreated bunch, while percentage of fruit ripening in treated ones was 30.60 and 27.93% for 50 and 100 ppm NAA, respectively.

Table (2) shows second sample (tamr stage) which were collected from all treatments. Fruit volume and weight, weight of seed and pulp, and ratio of pulp to seed weigh were significantly higher for treated fruits. The increases were not so high as in the first sample.

Fruit dimensions, length and width, had been increased in treated fruit compared with control. Length to width ratio was not significantly increased in treated fruits (Table 2).

In general NAA delayed fruit ripening at least 1 to 2 months in 50 and 100 PPM of Khenazi date palm cultivar. Similar results recorded in pervious investigation (3,7). Disturbance in the hormonal balance of developing fruit may cause the delay.

However, a delay in fruit ripening as recorded in the present experiment has some advantageous, because fruits in the rutab stage can be harvested late in the season for local fresh consumption. Fruit size, quality and ripening of Khenazi date palm cultivar was improved by applying NAA at 50 and 100 ppm concentration.

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Table 1. Effect of NAA on fruit characteristics and ripening of "Khenazi" dates (Data are averages for 1995 and 1996 seasons).

NAA ppm	Fruit volume (cc)	Fruit weight (g)	Seed weight (g)	Pulp weight (g)	Pulp/seed weight ratio	Fruit length (cm)	Fruit width (cm)	Length/ Width Ratio	Ripening %
0	8.00	7.82	0.65	7.17	11.03	3.38	2.04	1.66	100.00
50	15.75	15.72	0.80	14.92	18.65	4.46	2.54	1.76	30-60
100	15.50	16.64	0.82	15.82	19.29	4.41	2.56	1.72	27.93
LSD 5%	1.63	1.81	0.14	1.02	2.53	0.12	0.08	0.43	

Table 2. Effect NAA on fruit characteristics of "Khenazi" dates (tamr stage) (Data are averages for 1995 – 1996 seasons).

NAA ppm	Fruit volume (cc)	Fruit weight (g)	Seed weight (g)	Pulp weight (g)	Pulp/seed weight ratio	Fruit length (cm)	Fruit width (cm)	Length/ Width Ratio
0.0	8.00	7.82	0.65	7.17	11.03	3.38	2.04	1.66
50.0	10.00	10.46	0.68	9.81	14.43	3.93	2.28	1.72
100.0	10.25	10.58	0.69	9.89	14.33	3.82	2.29	1.67
LSD 5%	1.05	0.98	0.02	1.03	1.98	0.03	0.02	0.25

INTERACTION EFFECTS OF THE SEQUENTIAL APPLICATIONS OF SOME GROWTH REGULATORS ON THE GROWTH OF DATE PALM TREES (*PHOENIX DACTYLIFERA* L.)

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ABSTRACT

Sequential application of growth regulators (paclobutrazol and uniconazole) have significant effect on the growth of date palm trees. Four application treatments of both paclobutrazal and uniconazole at 1000 mg/l at 30 days intervals produced long lasting effects on vegetative growth and enhanced the fruit cluster formation. The height and trunk of the tree and the length of leaves were significantly retarded by paclobutrazol and uniconazole. However, the number of offshoots and fruit clusters were significantly increased by both growth regulators whereas they had no significant effect on the leaf number and leaflets. There was no difference between the effects of paclobutrazol and uniconazole treatments.

Additional Index Words: Growth retardant, offshoot, stimulation

INTRODUCTION

During recent years considerable attention has been given to the possibility of controlling the growth and cropping of fruit trees by means of chemical regulators. Hormones have been implicated as inhibitory factors in apical dominance (Treharne et al 1985). However, a discrepancy exists as to the role of gibberellins in the apical control of lateral buds. Growth regulators explored the possibility of inducing parthenocarpy in fruit of date palm, hastening or retarding ripening, and stimulating flower initiation (El-Hodairi et al. 1992).

Growth retardant may be described as chemicals which primarily inhibit subapical cell division and elongation hence reducing the growth of the aerial parts. It has already been suggested that growth regulators are required to increase the yield and uniformity of the crops. However, research during the last 35 years has indicated that these chemicals can stimulate photosynthesis enzymes (Treharne et al. 1985), effect respiration and delay leaf senescence and can alter the partitioning of assimilates (El Hodairi, 1987).

Date palm (*Phoenix dactylifera* L) is a high energy food and regarded in Libya as a popular food commodity. It is known that Libya produce more than 120,000 metric tons per year. The production of offshoots is limited in date palm depending on tree ages vigour and cultivar Al-Jabbory, 1993. Date palm produces leaves in 3 to 5 stages (period) per year, depending on the environmental condition and the biological activity of the date. The number of leaves produced in each stage are 3 to 5 leaves which are growing closely at the beginning. Root system could be stimulated by NAA, El Hodairi et al., 1992; El Hodairi et al., 1993, and by drip irrigation(Al Ghamdi, 1988).

The fact that many physiological processes, such as shoot elongation, flower initiation and root development, depend on a balance between growth regulators, rather than on the absolute amount, suggests a wide scope for the use of synthetic growth retardant. Paclobutrazol (PP333) is a very potent plant regulator and effective on a very wide range of species where its principal mode of action is the inhibition of gibberellin biosynthesis. The other growth retardant has been developed in Japan is uniconazole (S.3307-D) which has similar mode of action as paclobutrazol.

Regulating date palm tree growth is a major problem confronting date palm growers. Hence the economic success of modern type of date palm orchard depends upon the ability of the grower to bring his trees into dwarfing growth. The object of the present study was to investigate the extent to which such factors as tree height, offshoot, flowering and fruiting of date palm could be controlled.

MATERIAL AND METHODS

This research was carried out at the Sebha Date Palm stripe (Latitude 27°North, altitude 14.3° East). In October 1993 sixty three year old Tafsirt date palm trees were chosen, which were as nearly identical as possible. The trees had been planted in rows, 8 meter apart. The soil type of the field was sandy soil, the trees were irrigated by net piping irrigation, which give 10,000 m^3 per hectar.

Sixty kg of manure fertilizer was applied to each tree in every winter and 800 g ammonium phosphate was given to each tree in spring each year, spraying was done in November each year with superacid 40 EC to protect the plants from insects. In early October, 1993 one of the following sequential treatments of 50 ml paclobutrazol and uniconazole were applied by pouring them to the apical bud of the experimental trees: water control; single application at 1000 mg/l; two applications at 1000 mg/l; three applications at 1000 mg/l; four applications at 1000 mg/l. The intervals between the sequential application were 30 days. Tween 20 at 0.1% v/v was included as a wetting agent in all treatments.

The experiment was designed as a complete randomized block with factorial arrangement 2x5x6, two growth regulators Paclobutrazol and uniconazole at five levels of sequential applications, with 6 replicates of each treatment, which were allocated at random in each of the 6 blocks. It was designed so that the significance of the treatment effects could be tested by analysis of variance. Where the results are shown, SE represent standard error. L.S.D. represent the least significant differences between treatments at 5%(*) or 1% (**) or 0.1% (***) level of probability (P), N.S. means Not Significant between treatments.

The tree height and trunk length and the number of leaves, were counted every month in the first year, then these parameters and the number of offshoots produced per tree were all recorded in December every year. The number of fruit clusters and the number of fruits and the weight of fruits were recorded in September. The inflorescences were hand pollinated in March every year.

RESULTS AND DISCUSSION

Growth regulators (Paclabutrazol and Uniconazole) significantly reduced tree height, leaf length throughout the period of four years (Table 1).meanwhile, effect of sequential application was clear as it reduced trunk length in 1997 and the effectiveness increased by increased the number of application, and four times applications of uniconazole at 1000 mg/l was more effective than paclobutrazol (Table 2). However, there was no significant effect on the number of leaves. These are in agreement with the results reported by El-Hodairi, et al., 1996 in that using one dose of these growth regulators.

A long-term shoot retarding effect was obtained with all paclobutrazol and uniconazole treatments. These growth retardant effects may be due to gibberellin biosynthesis inhibition properties (El Hodairi, et al., 1996). The production of offshoots could be increased as the results in table 1 indicated that growth retardants, paclobutrazol and uniconazol; increased the number of offshoot production in 1997 (Table 1). These effects of growth retardant may be due to the change in source - Sink relationship, hence, the axillary bud under the base of leaves could be stimulated (El Hodairi 1987).

The effects of sequential applications of growth retardant on flower induction were varied, but both paclobutrazol and uniconazole generally enhanced flowering (table 1 and table 2) as the number of fruit clusters were significantly increased especially by multiple dose of both growth retardant. The fruit weight per cluster and the total fruit weight per tree were highly significant increased by multiple application of both growth retardants. However, there was no difference between paclobutrazol and uniconazole on these parameters (Table 2). The positive effects of sequential application at 30 days intervals of these growth retardants on the fruit parameters could be due to an increase in crop demand it met by enhanced photosynthesis and prolonged leaf activity when the tree bearing fruit hence these growth retardants altering the movement of assimilates (El Hodairi, 1987).

In conclusion, four application treatment of both paclobutrazol and uniconazole at 1000 mg./l at 30 day intervals between applications had the most marked long-term dwarfing effect on Tafsirt date palm trees. Another beneficial result is the improvement of fruiting and offshoot production of treated trees.(Figures 1,2,3,4,5 and 6).

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Table 1. Effects of sequential applications of growth regulators (paclobutrazol and unicanazole) on some growth characters of date palm trees (means of 12 trees).

Sequential applications of growth regulators	Tree height increase (cm) 1994	tree height increase (cm) 1997	Leaf length (cm) 1997	Number of offshoot 1997	Number of fruit clusters per tree 1997
water control	135.83	285.0	273. 42	9.417	2.33
1000 x 1	132.50	218.75	268. 33	13.42	4.00
1000x2	132.08	220.83	255. 92	13.58	4.67
1000x3	117.50	216.25	243.16	12.67	4.08
1000x4	103.33	193.25	239.16	13.33	5.17
L.S.D.	26.86 P.at 0.01)	39.72 (p. at 0.01)	29.73 (P. at 0.01)	3.04 (P. at -0.01)	1.63 (P. at 0.05)

Table 2. Effects of sequential applications of paclobutrazol and uniconazole on some growth characters of date palm trees (mean of 6 trees)

Sequential applications (30 days intervals)	Number of fruit clusters per tree ((1995)	Number of shoots/tree (1995)	Length of tree trunk (cm) 1997	Number of fruit clusters 1997	Weight of fruit per cluster (kg) 1997	Total fruit weight/tree (kg) 1997
Paclobutrazol (mg/l)						
Water control	1.000	1.17	105.67	160.67	0.42	2.08
1000x1	5.00	6.67	70.00	174.00	1.40	6.87
1000x2	3.83	4.83	83.00	386.50	2.58	12.87
1000x3	1.50	3.50	85.50	442.50	2.31	8.11
1000x4	1.67	3.83	79.67	332.83	1.12	5.63
Uniconazole (mg/l)						
Water control	0.50	3.33	99.00	95.83	0.58	1.57
1000x1	1.67	3.17	87.17	406.00	1.92	6.93
1000x2	0.83	3.00	93.00	337.17	1.99	8.40
1000x3	3.83	4.00	78.33	385.33	1.78	8.14
1000x4	2.50	2.83	72.33	398.17	1.94	12.44
SE (df 45) for comparing any two values	0.82	0.69	4.79	44.57	0.24	1.43
Sig. Of effects of:						
Sequential applications	*	**	***	***	***	***
Paclobutrazol x Uniconazole	NS	NS	NS	NS	NS	NS
Paclox unico x seqentiual	**	**	*	**	**	**

PREPARATION AND EVALUATION OF EGYPTIAN DATE SYRUP

BY

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ABSTRACT

Date syrup (dibs) was prepared from Saidy date (Semi-dry) variety and three seedling date (Manthour; M_1, M_2 and M_3) fruits. Data revealed that the extraction rate of sugars was increased according to the water/flesh ratio increased. The produced date syrups were evaluated for their physico-chemical characteristics and compared with cane syrup (Molasses). The moisture, total sugars, crude protein, ash and TSS content of date syrup ranged as: 25.14-29.36%, 71.20-91.09%, 2.28-3.86%, 1.75-2.28% and 69.04-75.00%, respectively. Results of the organoleptic evaluation proved that syrup of dates are considered highly desirable than molasses. Date syrup had good storage ability.

Additional Index Words: Date molasses, syrup, dibs, seedling date (Manthour), composition, preparation, organoleptic evaluation.

1- INTRODUCTION

The importance of the date palm tree (*Phoenix dactylifera* L.) was appreciated by many nations over the centuries. This is due to the economical as well as the nutritional value of its fruit, hence it is one of the eldest cultivated tree crops (Fayadh and Al-Showiman, 1990). The date culture in Egypt extends from north, the relatively cool and humid coastal region of Alexandria to south, the hot and dry region of Aswan (about 1500 Km). This wide climatic range gives rise to an equally wide variation in the date (soft, semi-dry and dry) varieties. Although there are many varieties of dates in Egypt, only twenty are widely commercial distributed. Besides, there are a great number of seedling date palms (Manthour), as a result of sexual reproduction, some of them are highly desirable for fruit qualities (Ragab, 1953; Hussein *et al.*, 1979; Youssef and Ramadan, 1987; Moustafa *et al.*, 1989; Nour *et al.*, 1989 and Ramadan, 1995).

Egypt had 7.25 million date palm trees producing 677,934 tons with 93.55kg fruits per tree, in 1995. The average of date consumption per capita was 9.3 kg in 1993 (The Agric. Economy, Bull. 1995, Egypt).

Egypt lies in the first largest producer among Arab countries (680,000 tons) followed by Saudi Arabia (597,000 tons) and Iraq (550,000 tons), FAO (1996).

The surplus date fruits of inferior grades, which not accepted for the packaging industry are sold at low prices. These fruits differ in their composition but still it is considered as a good source of sugars, minerals and other substances (Ramadan, 1995). Industrially, it is utilized for produce several products such as syrup, jam, date-jelly, date-kutter, date-butter, liquid sugar, vinegar, ethyl alcohol, single cell protein, ... etc. (Al-Saady and Benjamin, 1983; Khatchadourian *et al.*, 1983; Mustafa *et al.*, 1983a; Yousif *et al.*, 1987; Yousif *et al.*, 1989).

Date juice extraction and date syrup were studied by Benjamin *et al.*, 1982; Hamad *et al.*, 1983; Mikki *et al.*, 1983; Mustafa *et al.*, 1983b and El-Shaarawy *et al.*, 1989. Date syrup (dibs) is probably the most common derived date product. It is produced as an incidental by-product when bagged humid dates are heaped for several months, some syrup oozes out by the force of their own weight. Also, it is produced in the home and village by extraction and boiling down of juice, and on a semi- and full industrial scale (FAO, 1993).

Since ancient times, in Egypt, date syrup locally known as "Date molasses" and produced as an accidental by-product in the storage of bagged, humid dates. This way give not more than 6% of the date weight and the syrup quality not be controled (FAO, 1993). Although, there were a continuous increase in sugar production from both cane and beet, unless this is not enough to meet the population increasing in Egypt. Therefore, it is essential to find an other new untraditional sources such as date syrup and find a way for utilization of seedling and low quality dates. Therefore, the aim of the present study is to preparate date syrup from a surplus of inferior grades of dates and to evaluate the yield.

2- MATERIALS AND METHODS

2.1- Date samples:

Saidy date variety and three of unclassified (Manthour or seedling) date fruits; M_1, M_2 and M_3, were used to preparate the date syrup in this investigation. The former, Saidy, one of the finest cultivars (semi-dry) in Egypt. It was obtained from Kharja Date Packing Factory during the sorting operations of the high quality fruits. The date fruits of M_1, M_2 and M_3 were collected from the local market at Kharja oasis, the New Valley Governorate. All date samples were obtained during the 1996 season, at over ripe stage.

Representative part of date bulk was used for some physical evaluation. Another part was pitted and the flesh was minced just before chemical analysis. The residue fruits were washed, pitted, the flesh was cut into small pieces, and kept refrigerated in sealed polyethylene bags.

2.2- Preparation of date syrup:

The weighed flesh of date samples were boiled in sufficient amount of water for 20 min. and blending. The slurry was filtered through a cloth with a hand press. The residue pulp was rewashed with hot water (80-85°C) for 10 min. and filtered again twice, to make up the water/pulp ratio as 2, 2.5 and 3.0/1. The collected raw date juice was then centrifuged at 7,000 rpm for 30 min. The clear extract was concentrated under vacuum using rotary evaporator apparatus at 70°C to obtain one fourth or third of the total extract volume. The produced date syrup was packed in sealed glass bottles and stored at room temperature (20-30°C). Date syrup was analyzed and evaluated compared with the sugar cane molasses from the local market.

2.3- Analytical Methods:

2.3.1- Physical and chemical evaluation:

Fruits of the studied date samples were evaluated for fruits number per kg; weights of fruit, flesh and pit; flesh/pit ratio; and fruit flesh percentage.

- Total soluble solids (TSS) and refractive index were determined by an "Abbe" refractometer at 20°C.

- The pH value was determined using a research pH-meter.

- The color of the diluted date syrup (20% TSS) was measured as optical density at 520 nm using a spectrophotometer.

- Moisture was determined by oven method according to Auda *et al.* (1976).

- Reducing and total sugars were determined according to Lane and Eynone method. Non-reducing sugars were calculated by difference. Sugars, crude protein and ash were determined as mentioned in AOAC (1990). Potassium and sodium were determined using Flame photometer 400. Calcium, magnesium and iron were determined using Atomic absorption Spectrophotometer 2380 as described in AOAC, 1990.

2.3.2- Organoleptic evaluation:

Organoleptic evaluation of date syrup samples were determined by a taste panel comprised of the 15 staff members at Assiut Univ., Assiut, Egypt. The panel scoring system applied was: color, 20 points; taste, 30 points; consistency, 20 points; and acceptability, 30 points. This system was applied for some date products by Sumainah and El-Nakhal (1984), Yousif *et al.* (1987) and Ramadan (1990 and 1995). Data were subjected to analysis of variance and least significant difference (LSD) at 5% probability according to Snedecor and Cochran (1980).

3- RESULTS AND DISCUSSION

3.1- Physical and chemical evaluation of dates:

From data presented in Table (1) it was observed that, the number of fruits/kg varied from 115-232 fruits for Saidy and M_3, respectively. Consequently, the mean weights of fruit and flesh of Saidy date were the highest (8.70 g and 7.30 g) followed by M_2 (8.00 g and 7.14 g). While, M_3 date had the lowest fruit and flesh weights. It could be noted from the same Table (1) that, M_2 date had the highest flesh/pit ratio and fruits flesh percentage. Whilst, M_3 date was the lowest level for the same previous parameters.

Table 1. Physical characteristics of date fruits.

Date samples	Fruits No./kg	Fruit weight g	Flesh weight g	Pit weight g	Flesh/pit ratio	Fruit flesh %
Saidy	115	8.70	7.30	1.40	5.22	83.91
M_1	178	5.62	4.63	0.99	4.68	82.38
M_2	125	8.00	7.14	0.86	8.40	89.25
M_3	232	4.31	3.43	0.88	3.90	79.58

Results showed that, M_2 was the best among the seedling dates and superior than Saidy variety in most physical properties. These results are in the line with that reported by Hussein and Hussein (1983), Nour *et al.*

(1989) and Ramadan (1990 and 1995). On the other hand, the studied dates were not merited with the Egyptian Standard Organization (1963) for the semi-dry dates (weight of 100 fruit not less than one kg).

The data of gross chemical composition (Table, 2) showed that, the studied date samples contained predominant amount of sugars and moderate levels of crude protein and ash. Saidy date variety recorded a higher amount of sugars and crude protein. The obtained data are in close agreement or even less than that reported by Salem and Hegazi (1971), Auda *et al.* (1976), Yousif *et al.* (1982), Khatab *et al.* (1983), Nour *et al.* (1989) and Ramadan (1990, 1995). Hussein *et al.* (1976) reported that, the dry and semi-dry dates had a moisture content less than 20% and 20-30%, respectively. However, it was clear from the data in Table (2) that, the moisture content of all studied dates were less than the recorded average of semi-dry varieties. This might be reasoned to a higher loss in moisture content after harvesting during storage and marketing, and made them to be included within the dry varieties characteristics.

Table 2. Chemical composition* of date fruits (on dry basis).

Date samples	Moisture %	Sugars %			Crude protein %	Ash %
		Reducing	Non-Red.	Total		
Saidy	11.20	80.52	3.28	83.80	3.81	1.95
M_1	9.32	71.90	1.69	73.59	2.39	1.93
M_2	7.58	73.64	0.79	74.43	3.20	1.62
M_3	12.56	70.28	0.59	70.87	2.70	1.98

*Average of three replicates.

3.2- Extraction of date juice:

The effect of water to date pulp (W/D) ratio in the sugar extraction rate (SER) of the extracted date juice was presented in Table (3). These data revealed that, there was a positive relationship between the extraction rate of sugar and W/D ratio. This positive relationship could be due to the

Table 3. Effect of water/date pulp ratio (W/D) on sugars extraction percentage.

W/P	2/1	2.5/1	3/1
Date pulp	Sugar extraction %		
Saidy	72.04	87.12	95.45
M_1	62.76	77.90	93.64
M_2	61.86	75.18	92.23
M_3	75.09	89.35	96.91

increased rate of molecular diffusion, reduced liquid viscosity and better liquid solid contact. Consequently, the increase in the extraction rate, the residual sugar in the draft date decrease. Moreover, it is evident from data in Table (3) that, SER was relatively affected by the moisture content of date pulp. Whereas, date fruits, M_3 (highest moisture content) recorded the highest SER at all W/D ratios (96.91% at 3/1, W/D ratio). Benjamin *et al.* (1982) reported that, the optimum conditions to maximize the extraction rate of 96% were temperature, 85°C; diffusion time, 50 min.; draft percent, 250% and slightly flaked. The best extraction method by autoclaving dates at 15 Lb/sq. i. for 10 min. with 2.5 times their weight water (El-Shaarawy *et al.*, 1989). Water to date ratio was evidently a very important parameter in solids extraction, for technical and economic reasons. A high ratio will assist rapid and thorough extraction. However, the low TSS of the extract is not easy to preserve on the industrial scale and will require very high energy to concentrate. A too low W/D ratio will leave much of the soluble solids unextracted, Table (3).

3.3- Evaluation of date syrup:

3.3.1- Physical properties:

Data concerning the physical characteristics of date syrup and cane molasses are presented in Table (4). The color of used dates was ranged from light and dark brown (Fig. 1). The total soluble solids (TSS) and

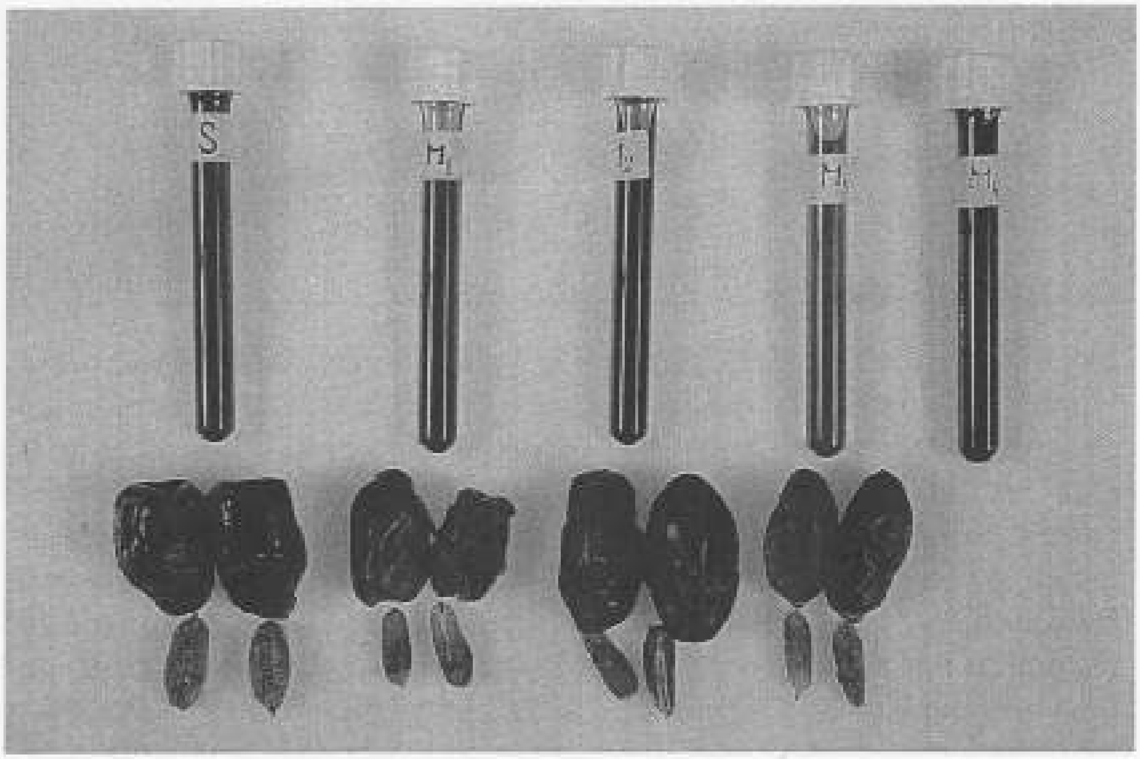

Figure 1. The morphological picture of the studied (Saidy, M_1, M_2, M_3) dates, syrups and cane molasses (M_4)

Table 4. Characteristics of date syrup compared with cane molasses.

Syrup	Syrup/ date pulp g/kg	TSS %	Refractive index at 20°C	PH	O.D. of 20% TSS at 520 nm
Saidy (S)	920.8	69.04	1.4630	3.4	0.45
M_1	904.4	70.05	1.4650	3.6	0.48
M_2	888.84	75.00	1.4775	3.7	0.55
M_3	878.10	72.02	1.4700	4.0	0.43
Molasses M_4	-	73.00	1.4725	3.5	0.58

refractive index of the date syrup were higher. This is principle due to the high level of sugars and relatively low moisture content. The pH value ranged from 3.4 to 4.0 for date syrups. The high level of acidity in syrups contributed to its stability against microorganisms. The results confirm those previously recorded by Mohamed and Ahmed (1981) for Libyan date syrup and Mikki *et al.* (1983).

The optical density of 20% TSS of date syrups and cane molasses were 0.43-0.55 and 0.58, respectively. The concentration (TSS), refractive index and pH value of cane molasses are in the line of those in date syrups (Table, 4). The above data showed that, the prepared date syrup had high acidity, TSS and total solids contents, therefore the expected storage ability will be high.

Moreover, it was concluded from the data in Table (4) that, one kilogram of each date pulp could be produce about 878 to 921 g syrup.

3.3.2- Chemical composition:

The chemical composition of the date syrup compared with the cane molasses were mentioned in Table (5). From such data, it was observed that, there was a narrow rage in the moisture content among date syrup and cane molasses. Data also shown that, the reducing sugars of date syrups were the main dominant and comprised about 96% or above of its total sugars content. This is due to the used date fruits. Whilst, the cane molasses contained a very low amount of reducing sugars (1.34%) and a very high level of non-reducing sugars. Crude protein and ash contents of the date syrups were in the same trend of their fruits. Molasses contained approximate amounts of crude protein and ash with date syrups. Date syrups and cane molasses were rich in sodium, potassium, calcium, magnesium and iron contents.

Table 5. Chemical composition* of date syrup compared with cane molasses (on dry basis).

Syrup	Moisture %	Sugars %			Crude Protein %	Ash %	Minerals mg / 100g				
		Reducing	Non-reducing	Total			Na	K	Ca	Mg	Fe
Saidy (S)	29.36	87.55	3.54	91.09	3.85	1.75	18.81	199.31	780.26	145.92	23.38
M_1	26.56	69.61	1.59	71.20	2.40	2.00	31.48	218.15	493.20	242.99	33.38
M_2	25.81	90.24	0.54	90.78	3.86	1.81	36.18	164.96	477.12	154.59	42.94
M_3	28.20	89.26	0.52	89.78	2.59	2.28	38.24	254.47	641.11	162.87	31.32
Molasses M_4	25.14	1.34	88.87	90.21	2.28	1.83	35.60	199.61	215.56	295.49	33.67

*Average of three replicates.

The present data are in the same line with that reported by Mikki *et al.* (1983) and Mustafa *et al.* (1983b) and higher than that published by Mohamed and Ahmed (1981) and Al-Saidy *et al.* (1982).

3.3.3- Organoleptic evaluation of syrups:

The prepared date syrups were palatability tested in terms of color, taste, consistency, and acceptability compared with cane molasses, and the results are listed in Table (7). It was evident from these data that, M_3 syrup recorded the highest average scores for color, acceptability, and total score; and equal in their taste score, with M_1 syrup. With regard to the same data, it was clear that, the cane molasses recorded the lowest scores of all sensory evaluation terms. There were no significant differences inbetween all studied date syrups in their color, taste, consistency and total score and among date syrups except between M_2 and M_3 syrup in their acceptability (Tables 6, 7). On the other hand, there were significant difference among all date syrups and cane molasses in their organoleptic test except between M_2 syrup and cane molasses in their acceptability. The results, stated that the prepared date syrups are highly desirable and more acceptable than cane molasses.

Table 6. Analysis of variance for organoleptic evaluation of date syrup compared with cane molasses.

S.O.V.	D.F.	Mean square				
		Color	Taste	Consistency	Accept - ability	Total score
Samples	4	28.713**	16.978**	8.487**	18.130**	251.672**
Rep.	14	9.766	16.989	5.006	13.470	126.163
Error	56	3.006	3.180	1.987	4.816	27.416

** High significance difference (above 0.05 level).

Table 7. The average of organoleptic evaluation of date syrup compared with cane molasses.

Syrup	Color 20	Taste 30	Consistency 20	Acceptability 30	Total score 100
Saidy (S)	16.67^a	25.07^a	16.87^a	25.10^{ab}	83.70^a
M_1	17.00^a	25.90^a	17.07^a	25.33^{ab}	85.30^a
M_2	15.93^a	25.20^a	17.20^a	23.83^{bc}	82.17^a
M_3	17.20^a	25.90^a	16.73^a	25.70^a	85.53^a
Molasses M_4	13.80^b	23.30^b	15.33^b	23.10^c	75.53^b
$LSD_{0.05}$	1.268	1.304	1.031	1.605	3.830

CONCLUSION

1 - To maximize the sugar extraction rate for 96% or more, the date pulp was boiled for 20 min. and mixed with warm water (80-85°C) by 1/3 ratio.

2 - The composition and sensory evaluation of date syrups confirmed that, it was rich in sugar, minerals, high acceptability and good expected storage ability.

3 - Dates of seedling and inferior grades can be successfully use for syrups preparation and as unconventional source of sugar.

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SUITABILITY OF NINE SAUDI DATE CULTIVARS FOR CANDY MAKING

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ABSTRACT

The optimum processing conditions as well as the suitability of nine Saudi date cultivars for candy making was studied. The storability of the prepared date candy was also covered. The obtained results showed that the ratio 60/40 date paste / nuts with chocolate coating achieved the best scores and was better than the other examined ratios. Regarding the effect of cultivar on the quality of the prepared date candy, it was shown that candy made from Ruzeiz and Sullag dates were evaluated as the best amongst the nine date cultivars used in this study. The storability study results revealed that storage duration for more than 8 weeks at room temprature (25 + 5° C) had a pronounced negative effect on most of the quality attributes of date candy. After 16 weeks storage time, the date candy was evaluated as poor and inferior to the imported Mars. However, these drawbacks in date candy might be attributed to storage at relatively high temperature and storage at low temperature (10-15°C) should be recommended.

INTRODUCTION

Candy or confectionery is considered a popular food item amongst the population of the Kingdom. There are different types of canddy available in the local market most of which are imported. The availability of dates in the Kingdom in substantial quantities and their high levels of sugars justify their use in processing plain or chocolate coated date candy which can be used as a partial replacer for similar importes candy products which accounted for about $ 60 million for the year 1996 (Statistical Yearbook, 1997).

Sawaya et al. (1983) studied the possibility of fortifying date bars with soy protein isolate (SPI) and dry skim milk (DSM) in an attempt to improve their nutritive value. Their results revealed that the addition of SPI and DSM could enhance the protein quality and quantity of date bars without any deleterious effect on their acceptability. The sensory

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evaluation results also indicated no difference in the control and fortified date bars which were stored for 6 months. Addition of 1.5% SPI and 10.5% DSM was found to be the optimal level of supplemntation in terms of nutritious benefit.

Yousif et al. (1987) studied the possibility of using date paste as a replacer for caramel or sugar paste in preparing candy bars. Processing conditions, nutritive value and organoleptic properties of the prepared date bars as well as their storability were evaluated. The results indicated that the prepared date bars either plain or chocolate coated had good acceptability, possessed a high nutritive value and could be stored for more than 5 months under refrigeration (5° C) without affecting their qualities.

Recently, utilisation of second quality dates by processing and storage of plain and chocolate coated date bars for up to 6 months at 25 C was investigated by Yousif (1995). The obtained results highlighted the possibility of storing chocolate coated date bars at 25° C up to 6 months without affecting their good quality attributes.

MATERIALS AND METHODS

Materials

Samples of nine date cultivars, at the tamar stage, representing the major date producing region in Saudi Arabia were used in this study. The Eastern region (Al-Ahsa and Al-Quatif) was represented by three date cultivars i.e Rezeiz, Khnazi and Bkerah. The Central region Ryiadh, Kharj and Al-Qassem) was represented also by three date cvs i.e. Khudri, Shagra and Sullga. The Southern and Al-Madena region was represented by another three date cvs: Sefri, Kusbah and Barni. The date fruits were cleaned, pitted, packed in 1 kg plastic bags and kept refrigerated prior to further treatment and analysis.

In date candy processing, date paste was used and mixed with desiccated coconut and roasted groundnut. Date paste was prepared from the obove nine date cultivars (Shagra, Kusbah, Sefri, Rzeiz, Khudrii, Bkerah, Khnazi, Barni and Sullag) as mentioned earlier by Yousif et al. (1996).

Date candy preparation:

Date candy was prepared using the following ingredients; date paste, 40 – 60%; roasted groundnut 20 – 30% and dessicated coconut 20 – 30%. The mixed candy paste was passed through a meat grinder to obtain a homogenized paste. The homogenized candy paste was formulated and shaped manually using a cookie decoratiog tool. Some of the prepared date candies were kept plain whereas the rest was coated with chocolate. Chocolate chips after being melted in a water bath was used for coating purposes. Plain and chocolate coated date candies were kept for 2 hours in a cold storage before being packed and stored for further studies.

Three variables were covered during the preparation of date candy i.e. the date paste / nuts ratio, the suitability of nine Saudi date cultivars for candy making and the storability of the prepared date candy.

The effect of date paste / nut ratio and chocolate coating on the quality and acceptability of the produced date candy:

In studying this variable, Rezeiz date were used in preparing the date paste needed. Three date paste / nuts ratios were used: 40/60, 50/50 and 60/40. The nuts were desiccated coconut and roasted groundnut and were used in equal portions for each recepi. A total of six date candy samples were prepared; three of them were plain whereas the other three were chocolate coated. The produced date candies were then tested sensorilly by performing ranking preference test as recommended by Larmond (1982). The six date candy samples after being coded were given to a panel of 16 semi – trained judges at the Date Palm Research Center with the ranking preference test. Sheet. The sheets were collected and scores were calculated and accordingly the best date paste ratio either with or without chocolate coating was determined.

Effect of date cultivar on the quality of the produced date candy:

The same date cultivars mentioned above were used in this study. Since the 60/40 date paste / nut ratio (chocolate coated0 was the candy prefered by the judges, this ration was used to study this variable. The coded chocolate coated date candy representing the date cultivars and were divided into 3 groups. Each group with a reference sample which was an imported candy bar (Mars) available in the local market was given to a panel of 16 followed. The test sheets were collected and the scores were calculated and tabulated. The candy of the two date cultivars attaining the best scores was selected and used for further studies.

Effect of storage on the properties of date candy:

According to the results of the date cultivar variable, two date candy samples prepared from Rezeiz and sullag date were evaluated and judged as the best. The two date cultivars were used in preparing large quantities of candy (5 kg for each).

The prepared candy was chocolate coated, cooled, packed and stored at room temperature (25 + 5°C). the chemical, physical, and sensory properties of date candy either at fresh stage or after being stored up to 4 months were determined.

Methods of analysis:

Moisture, ash, total soluble solids (Brix), pH, total acidity as tartaric acid, and protein were determined using the standard A.O.A.C. methods (AOAC, 1990). Minerals were analyzed using an Perkin Elmer atomic absorption spectrophotometer model 3030. Color was measured using an extraction procedure as described by Maier and Schiller (1960). The sugar monomers were determined by high pressure liquid chromatography (HPLC) as described by Yousif (1989). The ranking preference test as well as the multiple comparison difference test as recommended by Larmond (1982) were followed to dertmine the sensory properties of the prepared date candy. Ranking test was used where preference between samples was required, whereas multiple comparison test was used to evaluate the effect of the cultivar variable as well as the storability variable. Semi-trained panel from the Date palm Research Center were used as the candy evaluators.

Data were analyzed by analysis of variance using the SAS system of the University of Jordan Computer Center, where F values were significant, the Duncan multiple range test was used to show the significant differences between the means.

RESULTS AND DISCUSSION

Effect of date paste/nut ratio and chocolate coating:

Three ratios of date paste were used to cover this variable i.e. 40,50, and 60%. The other ingredients were desiccated coconut and roasted groundnut. The nuts were used in an equal proportions and constituted 60, 50, and 40% of the three recipes; respectively. As it is clear from Table 1, the date candy sample which was chocolate coated and contained 60/40 paste/nuts ratio gained the best scores and as a result was used in the further experiments regarding the date candy study.

Table 2 presented the results regarding the effect of date cultivars on the quality and acceptability of the prepared date candy. It is obvious from these results that the candy prepared from Rezeiz and sullag dates were evaluated as the best, and accordingly, they were used in the storability study.

The chemical, physical and sensory properties for both Rezeiz and Sullag candy either as fresh or after 8 or 16 weeks storage time were presented in Tables 3 and 4. Results in Table 3 show that Rzeiz date candy had a lower pH value than either Sullag date candy or the imported Mars. On the other hand, Rezeiz date candy had higher values of pigment concentration and protein compared with Sullag date candy. However, a close similarity could be observed between the two date candies with respect to their moisture, ash, sugar and fiber contents. As far as the imported Mars was concerned, results in Table 3 show that the total sugar content of the Mars was higher than that of the date candy. At the same time the sugar composition of the Mars was widely different from those of the date candy. While the date candy contained almost equal amounts of the three sugars i.e. fructose, glucose and sucrose, the Mars contained lower levels of fructose and sucrose and higher glucose level. This might be attributed to the high level of corn syrup used in manufacturing the imported candy. With regard to the acceptability of the two date candies, the sensory evaluation results showed that Rezeiz date candy was more acceptable than the Sullag candy. Storage time significantly affected the pH of the stored date candy as indicated by the results given in Table 4. A pronounced decrease could be noticed in the pH of the date candy.

Regarding the color (pigment concentration) of the date candy, it is evident from Table 4 that the color of Sullage candy was not affected by storage time, whereas Rezeiz candy was slightly affected. These variation in the color results might be attributed to the lack of homogenity of sampling since date candy was chocolate coated and any variation in the chocolate portion was expected to create such problems. It is clearly shown from the storability study results that storage duration had a pronounced effect on the sensory properties of the date candy. After 16 weeks storage time, date candy was not acceptable and gained a mean score which was equivalent to poor and slightly inferior to the reference. However, the drawback in the sensory properties of Rezeiz candy was moderate and lower than that of Sullag candy, since it was judged slightly inferior than the reference (the imported Mars).

It could be seen from Table 4 that the fructose and glucose content of the date candy tended to increase as a function of storage duration, whereas sucrose tended to decrease. These results of the sugar composition might be explained on the basis of sucrose inversion due to acid environment in the date candy and to the relatively high storage temperature.

CONCLUSION

It could be concluded from the results of this study that there is a good possibility for utilization of surplus dates in candy making. The produced date candies were evaluated as better than the imported Mars and were characteristics of high nutritive value. The storability study results revealed the possibility of storing date candy at 25 C up to 8 weeks without affecting their good quality attributes.

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ACKNOWLEDGMENTS

The financial support of King Abdulaziz City for Science and Tec (project No. At-10-31) is acknowledged.

Table 1. Sensory evaluation scores for six date candy samples either plain or chocolate coated prepared using different date paste ratios

Panelist			Date candy samples code			
	5	310	101	215	71	410
1	5	6	4	3	2	1
2	4	2	5	3	6	1
3	6	5	4	3	2	1
4	4	2	5	3	6	1
5	5	4	6	2	1	3
6	3	5	2	6	1	4
7	3	6	2	5	1	4
8	4	5	2	6	1	3
9	6	3	5	1	2	4
10	3	2	6	1	5	4
11	6	2	5	1	4	3
12	5	1	3	4	5	2
13	6	1	4	3	5	2
14	3	5	1	4	2	6
15	1	5	6	2	4	3
16	2	1	4	3	5	6
Total	66 a	55 b	64 a	50 c	53 b	48 c

- Plain date candy prepared using 40% date paste was coded 5; chocolate coated date candy prepared by using 40% date paste was coded 310; plain date candy prepared using 50% date paste was coded 101; chocolate coated candy prepared by using 50% date paste was coded 215; plain candy prepared using 50% date paste was coded 71 while the chocolate coated candy prepared using 60% date paste was coded 410.

** Totals having the same letters are not significantly different.

* Table 2. Sensory evaluation scores for date candy samples prepared using different date

Panelist	Date candy samples codes and cultivars								
No.	560 SH	417 KS	134 SR	310 RZ	440 KD	601 BK	74 KH	26 SG	123 BR
1	4	4	2	1	2	4	6	2	3
2	5	6	3	2	3	5	3	2	2
3	5	6	7	2	5	5	5	5	7
4	5	8	5	8	4	8	9	8	5
5	5	5	6	2	5	8	9	4	6
6	6	5	4	5	4	6	7	4	7
7	5	3	5	5	6	4	5	1	2
8	4	4	6	4	4	4	2	1	3
9	3	2	7	2	2	2	5	2	2
10	2	3	6	2	4	3	3	3	6
11	1	2	6	1	2	2	5	2	3
12	4	5	4	6	8	5	5	6	3
Total	49 e	53 d	61 b	40 f	49 e	56 c	64 a	40 f	48 3
Mean	4.08	4.42	5.08	3.33	4.08	4.67	5.33	3.33	4.00

- Cultivars:

SH – Shagra; KS – Kusbah; SR – Sefri; RZ – Rezeiz

KD – Khudri ; BK – Bkerah; KH – Khnazi; SG – Sullag

Totals having the same letters are not significantly different

Table.3. Chemical ,physical , and sensory evaluation of fresh date candy

Composition	Values means Rzeiz date candy	Sullag date candy	Imported Mars
Moisture %	12.34 a	12.28b	....
PH	5.96c	6.16b	6.26a
Ash %	1.89b	2.0a	....
Protein %	8.89a	7.94b	....
Color (mg pigment/g dry matter)	3.0a	2.6 b	....
Total sugar %	40.1b	37.6c	51.4a
Sucrose %	12.5a	11.4b	7.8c
Fructose %	13.2a	12.3b	5.7c
Glucose %	14.5b	13.9c	38.4a
Fiber %	5.25b	5.45a	....
Sensory evaluation (mean scores)	2.80	3.10a	....
K (mg/100g)	1042a	1043a	230a
Ca (mg/100g)	294b	258c	366a
Mg (mg/100g)	218a	182b	100c
Na (mg/100g)	208b	200b	280a

Means having the same letters in the same row are not significantly different

Table 4. Effect of storage on chemical, physical and sensory properties of date candy

		Storage period (wk)		
Composition	Date bars	0.0	8	16
Moisture %	Rezeiz date candy	12.3a	10.1c	10.3b
	Sullage date candy	12.3a	10.8c	11.2b
pH	Rezeiz date candy	5.96a	5.73a	5.4b
	Sullag date candy	6.16a	5.87b	5.60c
Color (mg pigment/g dry matter)	Rezeiz date candy	3.00c	3.50b	3.60a
	Sullag date candy	2.60a	2.40b	2.60a
Total sugar %	Rezeiz date candy	40.1c	41.5b	43.9a
	Sullag date candy	37.6c	40.6b	43.5a
Sucrose %	Rezeiz date candy	12.5a	11.2b	4.4c
	Sullag date candy	11.4b	11.7a	9.8c
Fructose %	Rezeiz date candy	13.2c	13.8b	17.9a
	Sullag date candy	12.3c	12.9b	16.5a
Glucose %	Rezeiz date candy	14.5c	16.5b	19.9a
	Sullag date candy	13.9c	16.0b	17.5a
Sensory evaluation (mean scores)	Rezeiz date candy	2.80b	2.70b	5.30a
	Sullag date candy	3.10C	3.40B	7.0a

Means having the same letters in the same row are not significantly different

الملخص

تناولت هذه الدراسة التعرف على الظروف المثلى لتصنيع حلويات اصابع التمور وكذلك على مدى ملائمة تسعة اصناف من التمور السعودية لصناعة الحلويات وصلاحية الحلويات المصنعة للخزن. أشارت النتائج إلى أن حلويات التمور المصنعة بإضافة عجينة التمور إلى المكسرات بالنسبة ٦٠ : ٤٠ (عجينة / مكسرات) مع التغطية بالشيكولاته قد حصلت على أعلى الدرجات. كما كانت تمور الرزيز والسلج الاكثر ملائمة من غيرها لصناعة حلويات أصابع التمور. دلت نتائج الدراسة الخزنية على أن الخزن على درجة حرارة الغرفة (٢٥ + ٥س) لمدة تزيد عن ٨ أسابيع قد أضر بأغلب صفات جودة تلك الحلويات.

أشارت نتائج تقييم اصابع التمور بعد خزنها لمدة ١٦ اسبوعا من قبل فريق المحكمين على أنها ذو جودة منخفضة ولاترقى الى جودة المارس المستورد. أن مثل هذه النتائج قد تعزى إلى التأثير السئ لدرجة حرارة الخزن المرتفعة نسبيا، وبناء على نتائج هذه الدراسة ينصح بخزن اصابع التمور على درجة حرارة منخفضة (١٠ – ١٥° م).

WATER SORPTION ISOTHERMS OF DATE PASTES AS INFLUENCED BY DATE CULTIVAR AND STORAGE TEMPERATURE

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The water sorption isotherms of pastes of three date Culltivars; Ruziz, Khudari, and Khlass were determined using the static method of saturated salt solutions at three storage temperatures; 5, 25, and 40 °C. Equilibrium moisture content decreased with increasing temperature at water activities below 0.4-0.5 range, indicating a type 1 behavior typical of high sugar foods. The experimental data were fitted well with GAB, Iglesias and Chirifie,and Halsey equations, suitable for high sugar foods. Thermodynamic considerations were discussed based on determined isosteric heat of sorption of pastes as a function of moisture content.

INTRODUCTION

The date fruit of date palm trees (Phoenix dactylifera L.) is the most widely grown fruit in Saudi Arabia. Annual production is estimated as over 600,000 tons of more than 400 different date cultivars, produced from over 13 million date palm trees spread throughout different regions of the country (Saudi House for Consultancy Services, 1997). Only 15% of the produced dates in the Kingdom is processed by the date industrial sector which is presently comprised of 22 date producing factories. Most of the date factories are traditional packing houses with production capacities ranging from 1,500 to 20,000 tons of dates per year. The major operations in those factories include fumigation, cold storage, manual grading, washing, mild air-drying, compressing, and packaging of compressed or whole non-compressed dates. This is in addition to whole dates packaged in flexible plastic packages under vacuum.

During the last decade, some of the factories diversified their date products and started to produce date paste, date syrup, date jam, date vinegar, and animal fodder based on low grade dates and date pits. Recently, many date factories produce increasing quantities of date pastes. Most of the date paste in the market is packaged in either solid or flexible plastic packages made from high or low polyethylene or polypropylene. The paste is produced from clean-pitted dates by mixing /mincing in large scale electrical mincers with simultaneous addition of predetermined amounts of water or steam. Presently the major users of date pastes are household consumers, bakery sector, and confectionery and biscuit factories.

It is generally accepted that water activity (a_w) is more closely related to physical, chemical, and biological properties of foods and other natural products than its total moisture content. Specific changes in color, aroma, flavor, texture, stability, and acceptability of raw and processed food have been associated with relatively narrow water activity ranges (Rockland, 1969). The sorption isotherms reveal information about sorption mechanism and interaction of food biopolymers with water. They are very useful in design and optimization of unit operations such as preservation, drying, mixing, storing, and packaging (Van den Berg, 1981).

Water sorption isotherms of high sugar fruits such as dried apricots, figs, raisins, and prunes have been determined by many investigators (Chirife and Iglesias, 1978; Bolin, 1980; Sarvacose et al., 1986; Abdelhag and Labuza, 1987; Maroulis et al., 1988; Ayranci et al., 1990; Tsami et al, 1990). However, studies on water sorption isotherms of dates products are very limited in the open literature (Hassan, 1991; Hamdi and Jendoubi, 1994).

The objectives of this study was to determine the water sorption isotherms of pastes of three date cultivars at three storage temperatures 5, 25, and 40 °C, determine isosteric heat of sorption of date paste as a function of moisture content, and fit to experimental sorption data three well known high sugar foods sorption isotherms equations.

MATERIALS AND METHODS

Materials

Pastes of three date cultivars, namely, Ruziz, Khudari, and Khlass were obtained from a local date factory. The pastes were wrapped with flexible low-density polyethylene film bags (primary package) and contained inside carton packages (secondary package), weighing 7kg net date paste per package. Initial moisture content of the pastes of the three date cultivars Ruziz, Khudari, and Khlass were 21%, 19%, and 22% (d.b.); respectively.

Methods

The static method, with standard saturated salt solutions to maintain constant vapor pressure was used to obtain equilibrium moisture contents at constant temperatures. Ten saturated salt solutions were prepared corresponding to a range of water activities from 0.113 to 0.985. The water activity of most salt solutions decreases with increasing temperature because of the increased solubility of salts and their negative heats of solutions (Chirife et al., 1983; Rizvi, 1995). The values of the binary saturated aqueous solutions at the three applied temperatures (5, 25, and 40 °C) are shown in Table 1 (Greenspan, 1977; Labuza et al., 1985). Glass desiccators containing the salt solutions and maintaining the ten different relative humidity (water activity) levels were kept in temperature controlled rooms at 5, 25, and 40 (±0.5 °C). Samples of date pastes (about 40 g each) were carefully weighed inside petri dishes using a standard analytical balance with 0.1 mg accuracy (Model 204, Mettler, Toledo, Switzerland) and placed over perforated plates above the saturated salt solutions in each dessicator. Triplicate samples of the paste of each date cultivar were placed inside each of the ten desiccators at each constant temperature room, totaling 270 samples. The relatively large sample quantity (about 40 g each) required longer periods to attain equilibrium, up to five months. The samples were weighed periodically until sample mass between two successive readings were less than 1%. The moisture content of the samples were determined by the vacuum oven (Model VT6025, Heraeus-Instruments Vacutherm, Germany) method (AOAC, 1980), and they were defined as the equilibrium moisture content (EMC).

Table 1. Water activity of saturated salt solutions at 5, 25, and 40 °C (adapted from Greenspan, 1977 and Labuza et al., 1985).

Salt	Water activity (a_w)		
	5 °C	25 °C	40 °C
Lithium chloride	0.113	0.113	0.113
Potassium acetate	0.291	0.225	0.206
Magnesium chloride	0.336	0.328	0.316
Potassium carbonate	0.431	0.432	0.433
Sodium nitrate*	0.644	0.584	0.533
Sodium bromide *	0.731	0.658	0.614
Sodium chloride	0.757	0.753	0.747
Potassium chloride	0.877	0.843	0.823
Barium chloride *	0.936	0.934	0.907
Potassium sulphate	0.985	0.973	0.964

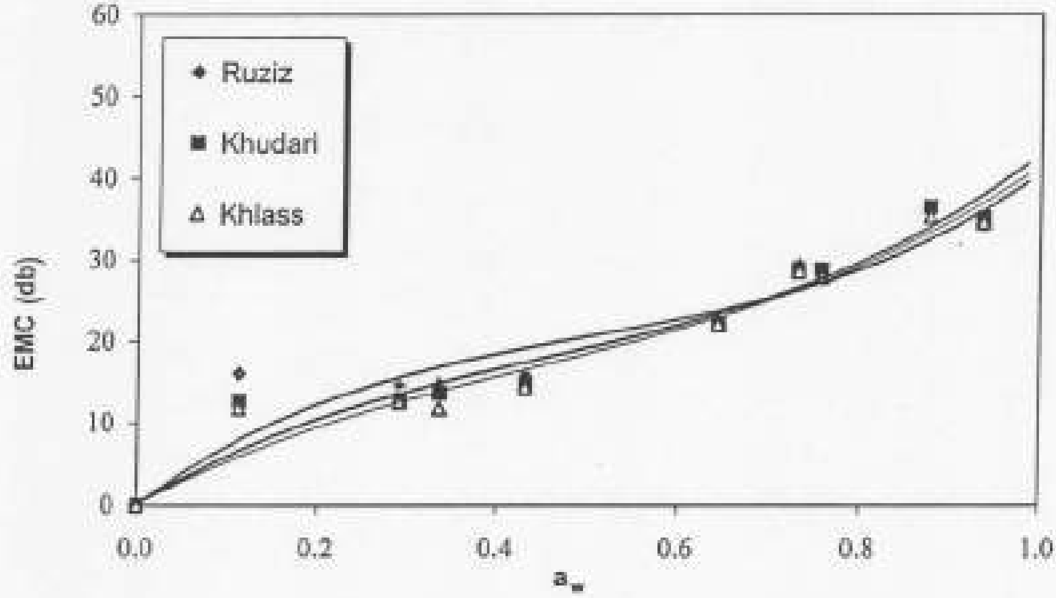
* Measured using Aqua-lab (Model CX-2T, readability 1 mg, Decagon Devices Inc., Washington).

RESULTS AND DISCUSSION

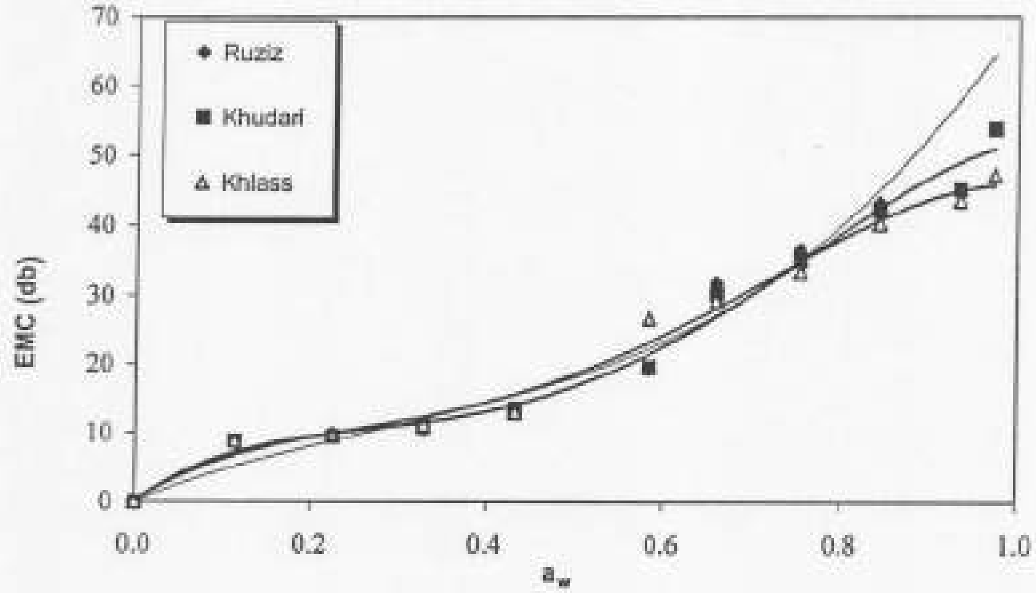
The sigmoid shapes of the sorption isotherm curves shown in Figs. (1-6) showed the characteristic of high sugar foods. At the first segment (with low relative humidity) of the S shaped sorption isotherm curves, dates pastes sorbed relatively lower amounts of moisture due the water sorption of biopolymers (high molecular weight components). However, larger amount of moisture was absorbed at higher relative humidities (above 0.4-0.5 range) due to the dominant water sorption of sugars.

The influence of Dates cultivars:

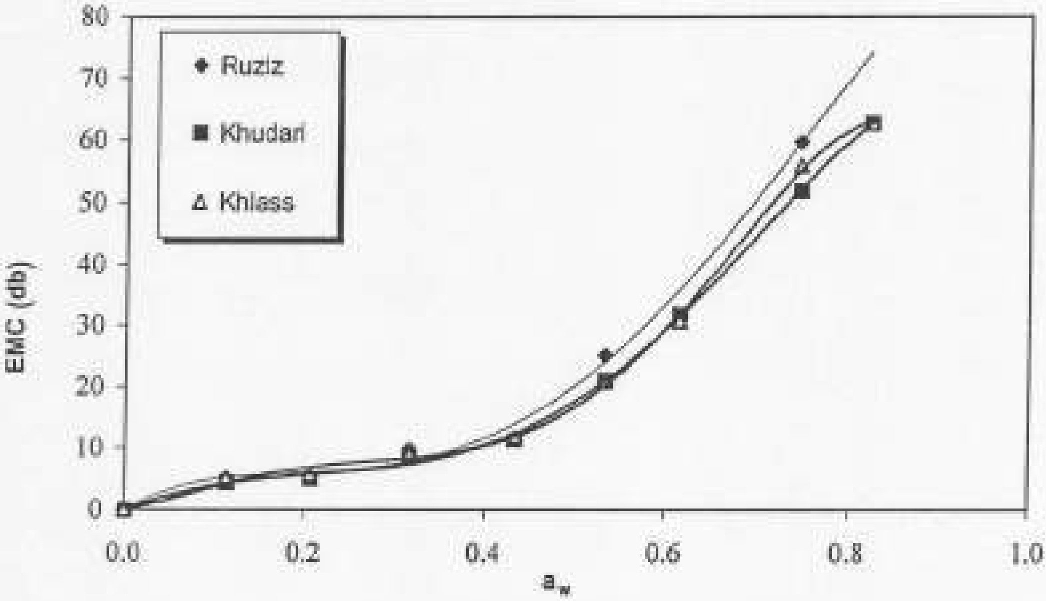
In general, the sorption isotherms curves of the three cultivars exhibit no significant differences (Figs 1-3). However, examining those curves more closely, it can be noted that a trend of lower activity of Ruziz cultivar was evident as compared to Khudari and Khlass cultivars. That could be attributed to the composition of dates cutlivar especially the sugar content.



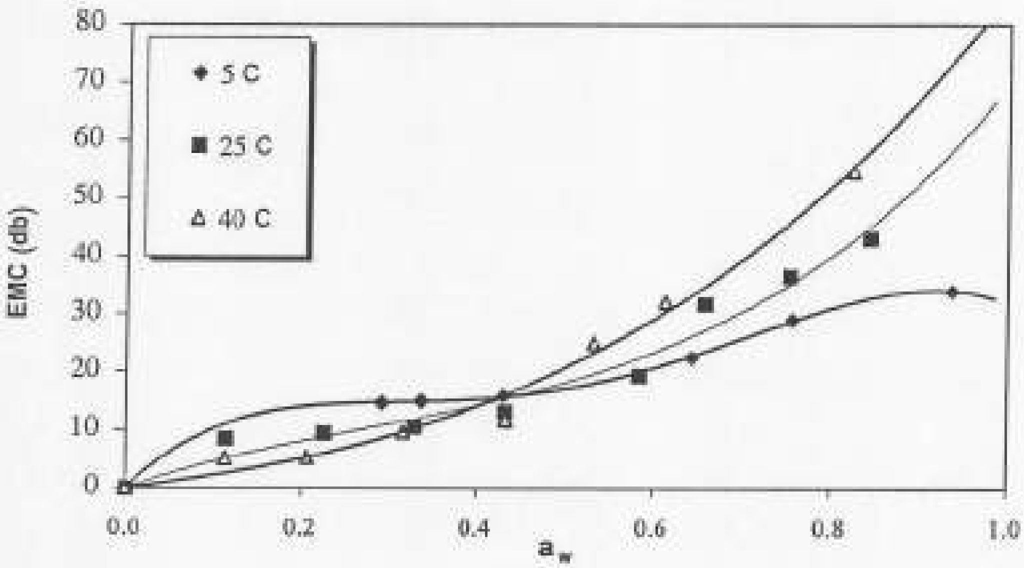
<u>Figure 1</u>. Sorption isotherms for different dated cultivars at5 C.



<u>Figure 2</u>. Sorption isotherms for different dates cultivars at 25 C.



<u>Figure 3.</u> Sorption isotherms for different cultivars at 40 C.



<u>Figure 4.</u> The effect of temperature on sorption isotherms of Ruziz cultivar.

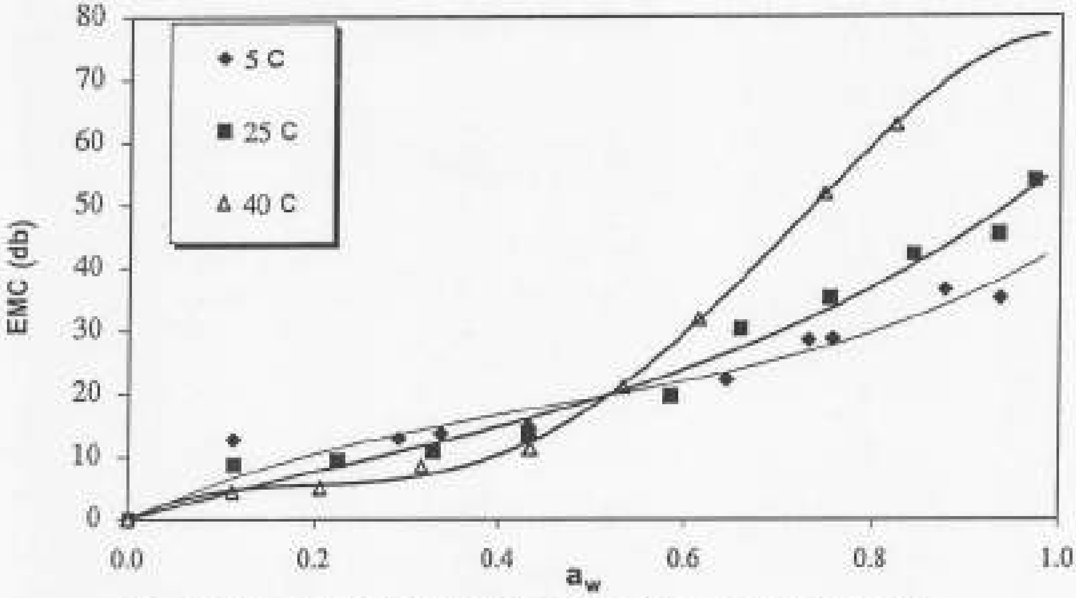


Figure 5. **The effect of temperature on sorption isotherms of Khudari cultvars.**

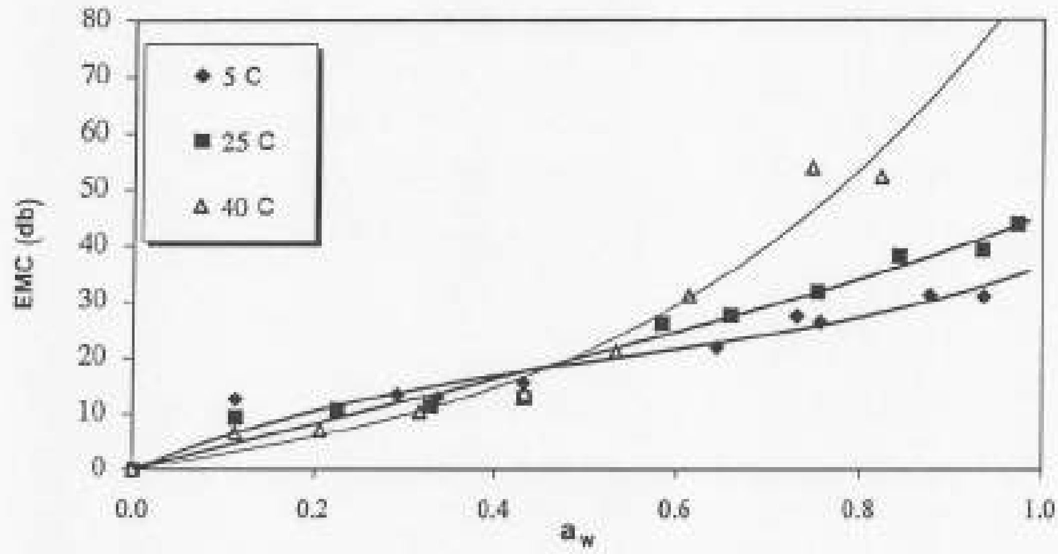


Figure 6. **The effect of temperature on sorption isotherms of Khlass cultivar.**

The effect of Temperature on sorption isotherms:

For most solutions and food products, it is widely accepted that the increase of temperature increases the water activity. This was the case for this study but up to water activity range of 0.4-0.5. At this range a crossings of sorption isotherms curves of the different temperatures were observed. Above this range, it was found that increase in temperature resulted in a decrease of water activity. The 'crossing' phenomenon of those curves was observed by several investigators (Saravacos et al., 1986; Tsami et l., 1990a;b; Hassan, 1990; Lieras and Iglesias, 1991; Ayranci et al., 1991; Manuel and Serreno, 1993) for high sugar foods. Saravacos et al. (1986) explained this trend, above the range of 0.4-0.5 of this study, by the dissolution of sugars (an endothermic process).

Fitting sorption data to isotherm models

A) GAB equation

The GAB (Guggenheim-Anderson-deBoer) equation is one of the most widely accepted models for sorption isotherms (Labuza et al., 1985; Sarvacos et al.,1986; Ayaranci et al.,1990; Tsami et al.,1990)and can be written as follows:

$$M = \frac{M_m CKa_w}{(1-ka_w)(1-ka_w+cka_w)} \quad (1)$$

M = equilibrium moisture content, g water/g dry matter.

M_m = monolayer moisture content, g water/g dry matter.

C = constant related to heat of sorption of monolayer.

K = constant related to total heat of sorption.

a_w = water activity

It provides not only the value of monolayer moisture content, but also other useful information related to heat of sorption of monolayer and multilayer (Ayranci et al., 1990). Statistical software (JMP for Macintoch, version 2.04) was used to fit experimental sorption data to the GAB model. A nonlinear regression fitting procedure using second derivative method was used.The software required the sorption data in addition to initial values of C,k,and M_m parameters. Those initial values were determined by solving equation (1) using three experimental values of m and a_w. Starting from these initial values, the software determined the best values of C,k, and M_m which satisfy the equation, by carrying out several iterations for values of these parameters. In addition it fits experimental sorption data to the model and illustrates the results graphically.

Results of nonlinear fitting of GAB model are shown in Table (2). The monolayer moisture content varied from a minimum of 0.063 (g water/g dry matter) for Khudari at 40 °C to a maximum of 0.173 (g water/g dry matter) for Ruziz at 5 °C.It decreased with increasing temperature, and at all three temperatures it was highest for the pastes of Ruziz cultivar, followed by Khlass and Khudari. The values of M_m, C, and k are comparable to those of other high sugar foods reported in the literature. The GAB model fitted curves (not shown) were very close to experimental data.

B) Iglesias and Chirife equation

Chirife and Iglesias (1978) proposed the following equation for high sugar foods,

$$\ln [M + M^2 + M_{0.5})^{1/2}] = b\, a_w + p \qquad (2)$$

Where M is the equilibrium moisture content (g water/ g dry matter),a_w is water activity, $M_{0.5}$ is the equilibrium moisture content at a_w=0.5, and b and p are constants. $M_{0.5}$ was directly determined from the experimental sorption isotherms. Results of linear regression of equation (2) using experimental sorption data are shown in Table (2). Values of the constant b consistently increased with increasing temperature, while values of p consistently decreased with increasing temperature. The regression coefficient (R^2) was high for all pastes of the three date cultivars at the three examined temperatures indicating a good fit of the experimental sorption data by the model. Iglesias and Chirife applied their model for sorption data of nine high sugar foods which were mostly fresh fruits with sugar present mainly in dissolved form (Chirife and Iglesias, 1978; Ayranci et al., 1990). The pastes are similar in sugar type since they are predominantly reduced sugars (glucose and fructose) naturally in dissolved state.

C) Halsey equation

Halsey equation is also one of the widely used equations in modeling experimental sorption data of high sugar foods. The equation can be written as follows,

$$\ln M = (1/r) \ln c - (1/r) \ln [\ln(1/ a_w)] \qquad (3)$$

where M is the equilibrium moisture content (g water/g dry matter), a_w is water activity, and r and c are constants. Values of the constants r and c were obtained by linear regression using experimental sorption data, and they are shown in Table (2). The values of the correlation coefficient (R^2) indicate a good fit of the equation by the experimental data. However, Chirife and Iglesias equation is slightly better (in terms of R^2) than Halsey equation in fitting experimental data. For dried apricot, fig, and raisin at 20 and 36 °C. Ayaranci et al. (1990) found Halsey equation to be slightly better than Chirife and Iglesias equation in fitting the experimental data.

Table 2. Estimated parameters for GAB, Iglesias & Cherifi, and Halsey equations for the pastes of the three dates cultivars at 5, 25, and 40 °C.

Model	Ruziz			Khudari			Khlass		
	5	25	40 °C	5	25	40 °C	5	25	40 °C
<u>A) G.A.B.</u>									
Mm	0.173	0.154	0.137	0.148	0.132	0.063	0.167	0.143	0.117
C	13.980	2.790	4.760	7.220	5.863	5.045	8.350	7.530	3.220
K	0.560	0.840	0.950	0.690	0.849	1.324	0.578	0.781	1.062
SSE[1]	0.007	0.006	0.035	0.005	0.005	0.001	0.004	0.005	0.002
MSE[2]	0.001	0.001	0.007	0.001	0.001	0.000	0.000	0.000	0.000
RMSE[3]	0.038	0.035	0.084	0.034	0.031	0.012	0.029	0.028	0.019
<u>B) Cherifi & Iglesias</u>									
b	1.143	2.351	3.449	1.456	2.201	3.747	1.543	2.129	3.614
p	3.139	2.453	1.857	2.923	2.515	1.761	2.832	2.572	1.865
R^2	0.870	0.976	0.960	0.946	0.966	0.983	0.944	0.959	0.979
<u>C) Halsey</u>									
R	15.073	5.885	4.007	12.083	7.891	3.864	14.853	9.175	3.918
C	14.895	2.205	1.941	7.163	3.351	1.850	10.889	4.129	1.721
R^2	0.871	0.963	0.899	0.942	0.931	0.924	0.924	0.898	0.948

1 SSE = Residual Sum of Squares error

2 MSE = Mean square error

3 RMSE = Estimate of standard deviation of residual error.

R^2 = Correlation cofficient.

Isosteric Heat of Sorption

The Clausius – Clapeyron equation is often used to predict water activity at any temperature if the isosteric heat and water activity values at one temperature are known. The equation for water vapor, in terms of isosteric heat (Qst) is (Rizvi, 1995):

$$d(\ln P) = -\frac{Q_{st}}{R} d\frac{1}{T} \tag{4}$$

Where P = pressure, Pa, Q_{st}= isosteric heat of sorption, Kj/mol, R= gas constant=8134.34 x 10^{-3}Kj/mol °K, and T= absolute temperature °K.

Subtracting the corresponding relation for vapors in equilibrium with pure water at the same temperature gives,

$$d(\ln p) - d(\ln Pw) = -\frac{Q_{st} - \Delta\overline{H}_{vap}}{R} d(\frac{1}{T}) \tag{5}$$

where Pw is partial pressure of pure water, Pa.

Since aw = p/pw, Equation (5) can be written as,

$$d\ (\ln aw) = -q_{st}/R\ d(1/T) \tag{6}$$

Where qst = net isosteric heat of sorption (also called excess heat of sorption) = Qst- Δ H_{vap}.

Integration of above equation yields,

$$Ln(aw) = -qst\ /RT + constant \tag{7}$$

Values of the net isosteric heat of sorption (qst) obtained from the slopes were plotted as a function of moisture content for the pastes of the three date cultivars as illustrated in Fig. 7. Net isosteric heat of sorption curves of the cultivars Khndari and Khlass were similar in shape, with values of qst consistently slightly higher for the Khudari cultivar. However, the curve for Ruziz cultivar was distinctly different in shape as compared to Khudari and Khlass, with much higher values of qst at lower moisture content below about 0.12 (kg water/ kg dry matter).

In the moisture content region of 0.15 to 0.3, the curve shows a platue with a minimum value of qst at moisture content of about 0.23, and then levels up at moisture content beyond 0.3. Within the moisture content range of 0.04 to 0.4 (kg water / kg dry matter) the ranges for values of qst were -6.75 to 18.43, -8.01 to 14.01, and -5.29 to 47.98

(Kj/mol) for pastes of the three date cultivars Khudari, Khlass, and Ruziz; respectively.

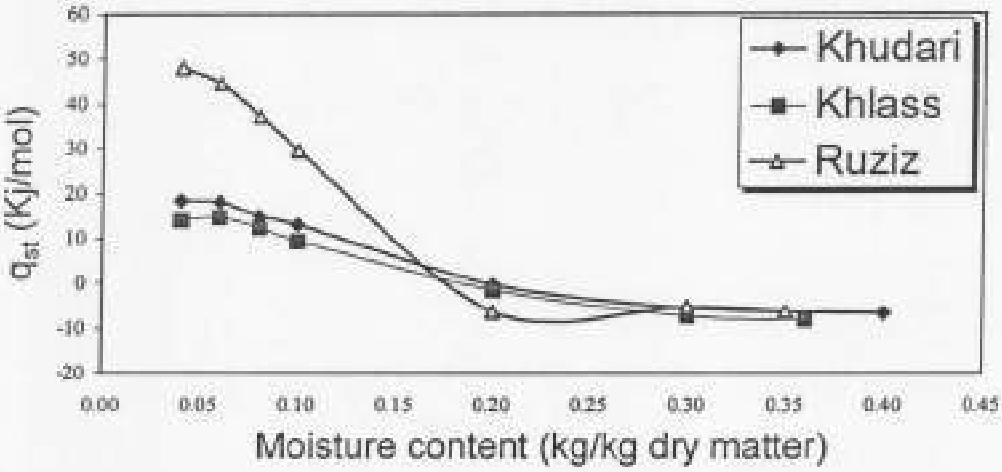


Figure 7. Net isosteric heat of sorption.

The high net is osteric heats of sorption of water at low moisture

contents (< 0.12) indicates a stronger water-date paste component interaction in the dried state. As moisture content increases, the available sites for sorption of water diminishes, resulting in lower values of qst. The negative values of qst at high moisture contents (>0.18) may be explained by the contribution of the endothermic dissolution of sugars in the sorbed water (Sarvacos et al., 1986). Since the sugar contents of the three date cltivars were reported as 76.2, 82.9, and 73.3 (g total sugar / 100 g dry matter); 76.2, 81.0, and 72.9 (g reducing sugar (glucose& fructose) / 100 g dry matter); and zero, 1.9, and 0.4 (g sucrose/ g dry matter), for the date cultivars Khudari, Khlass, and Ruziz; respectively, (Sawaya et al., 1986), the variation in behavior may be related to the total amount of sugar present, and the different proportions of each individual type of sugar.

CONCLUSION

1. Water sorption isotherms of pastes of three date cultivars, Ruziz, Khudari,and Khlass were highly dependent on temperature, while dependence on cultivar type was not as stronger.

2. The experimental data fitted well the three popular sorption models.

3. The dependence of q_{st} on M.C was similar to published behavior of high sugar foods.

ACKNOWLEDGMENT

We would like to thank SABEC for providing the financial support to carry out this work.

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IRRADIATION OF DATES: INSECT DISINFESTATION, MICROBIAL AND CHEMICAL ASSESSMENTS, AND USE OF THERMOLUMINESCENCE TECHNIQUE

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ABSTRACT

Irradiation of dates (Khalas variety) at 0.9 kGy was sufficient to eliminate single insect infestation (*Oryzaephilus surinamensis*) and mixed infestation (*O. surinamensis* and *Tribolium castaneum*), whereas 0.3 kGy was effective only in controlling single infestation. Sensory properties were not affected but irradiation contributed to some reduction in microbial counts immediately after irradiation and counts remained low till the end of 6 months' storage period. All sugars were significantly reduced immediately after irradiation but they increased gradually with increasing storage time. Thermoluminescence (TL) technique was useful in discriminating between irradiated and unirradiated dates during the entire storage period but was less sensitive as far as the dose estimation is concerned.

Additional Index Word : Khalas, sensory properties, sugars.

INTRODUCTION

The Kingdom of Saudi Arabia is one of the major dates producing countries in the world. The date palms (*Phoenix dactylifera* L.) are widely distributed in Saudi Arabia, and number of trees in the Kingdom is estimated to be over 13 million (Ministry of Agriculture, 1994). Although most of the dates produced in the Kingdom are used directly for human consumption with little or no further processing, the quantities of properly processed dates are growing rapidly due to governmental support and subsidies to date production and processing. The annual production of dates in Saudi Arabia was 563,000 tons in 1994 (Ministry of Agriculture, 1996).

Dry dates are attacked by moth and beetle (Hussain, 1974). Methylbromide, which is used in Saudi Arabia, is very effective for controlling stored products insects (Cherif et al., 1985). However, the use of such gas will be banned in the year 2001 due to its suspected carcinogenic effect (Council on Radiation Application, 1985). Therefore, irradiation is the possible alternative to control insects in dates.

Studies on use of irradiation to control insects in dates are enormous (Farkas et al., 1974; Zaklandnoi and Ratanova, 1978; El-Sayed and Baeshin, 1983; Grecz et al., 1986). However, only few studies were conducted on either the effect of irradiation on nutrients of dates (Farkas et al., 1974; Auda et al., 1977; Auda and Al-Wandawi, 1980; El-Sayed and Baeshin, 1983; Grecz et al., 1986; Siddique et al., 1986; Ewaidah, 1987) or the detection of irradiated dates (Khan and Delincée, 1995).

Khalas variety is dry fully-ripened dates known for its expensive value and commercial demand. It is usually subject to insect infestation during storage and this results in high economical loss if disinfestation treatment was not applied. In this study irradiation was mainly used for insect disinfestation and the efficiency of applied dose as well as their effects on sensory, microbial, and chemical properties were investigated. A method of detection of irradiated dates was also adopted.

MATERIALS AND METHODS

Preparation and Irradiation of Dates

The variety "Khalas" dates, marketed at Tamar or full-ripened stage with moisture content of 7.3% were purchased from a farm in Al-Hasa region in Eastern province of Saudi Arabia during the 1995 dates production season. Two hundred and twenty kg of dates were packed in carton boxes (18 x 16 x 11cm), 1.5 kg each. The boxes containing the dates were irradiated by Co^{60} source (International Nutronic) at 0.3 and 0.9 kGy for exposure times of 32.15 and 96.46 min, respectively. Irradiation facility at King Faisal Specialist Hospital and Research Center was used. The dose rate was 933 rads/min (0.56 kGy/h). The absorbed dose was monitored by ferric sulfate dosimeter (ANSI, 1972).

Insect Disinfestation

Oryzaephilus surinamensis and *Tribolium castaneum* were used. Treatments were classified according to the infestation to 3 groups. These groups were as follow: Dates without infestation (control) , dates infested by 20 *O. surinamensis* adults per replicate (Single infestation), and dates infested by 20 *O. surinamensis* and 20 *T. castaneum* adults per replicate (mixed infestation). Two doses (0.3 and 0.9 kGy) were applied 2 and 45 days after dates be infested. Dates irradiated 2 days after infestation contained adults and eggs, while dates irradiated after 45 days contained adults, eggs, larvae, and pupae. Boxes containing dates were kept under room condition before and after irradiation.

For infested treatments, observations and examinations were made after 1 and 6 months of post-irradiation treatments. Four replicates were selected each time from each treatment and were examined for the presence of alive insects. Five dates were selected randomly from each box, each was cut opened and numbers of frass were counted per date.

Microbial Examination

Dates were analyzed microbiologicaly for total bacterial counts and molds and yeasts according to the procedures recommended in the Compendium of Methods for the Microbiological Examination of Foods (APHA, 1992). Plate count agar (Oxoid, Basingstoxe Hampshire, England) was used for the total bacterial count. Inverted plates were incubated at $32^{\circ}C$ for 48 ± 3 h. Acidified potato dextrose agar (Oxoid) was used for the enumeration of molds and yeasts and plates were incubated at room temperature ($25^{\circ}C$) for 5 days.

Sensory Evaluation

Sensory evaluations were conducted on irradiated and control (unirradiated) samples. The quality attributes, including color, texture, taste and overall acceptability were evaluated by a trained panel, consisting of 10 judges from the staff of Food Science and Nutrition Dept., King Saud University. The evaluation was based on a nine-point hedonic scale with 9 representing like extremely and 1 representing dislike extremely (Larmond, 1980).

Sugars Determination

Analysis of reducing sugars was performed on Shimadzu HPLC (Shimadzu LC-10 AD, Shimadzu Corporation, Kyoto, Japan) according to AOAC method (1995). Sugars separation (fructose, sucrose and glucose) was performed on a 250 x 4.6 mm column packed with 5 µm Supelcosil LC-NH_2 (Supelco/INC., Bellefonte, PA) connected to the Refractive Index Detector (RID-6A, Shimadzu Kyoto, Japan). The mobile phase (20% water and 80% acetonitrile, HPLC grade) was introduced by a delivery pump model LC-10 AD (Shimadzu) at a flow rate of 2.5 ml/min. The system was attached to an injector (Model SIL-10A, Shimadzu) through which a 5 µL sample was injected. The running time was 15 min. The peak areas for the calibration curves and for the calculations of sugar amounts in the date samples were measured by an integrator model C-R7A (Shimadzu chromatopac data processor). Sugar standards (glucose, sucrose and fructose) were purchased from Sigma (Sigma Chemical Co., St. Louis, MO.). Sample preparation and chromatographic procedure were conducted as described in AOAC (1995).

Determination of Total Sugars was carried out according to the procedure of Lane-Eynon method in AOAC (1995).

Detection of Irradiated Dates

Minerals extraction and thermoluminescence (TL) measurements were conducted according to the procedure of Khan and Delincée (1995) to detect irradiated dates at applied doses. Thermoluminescence measurements were carried out using Harshaw 3500 TL reader (Harshaw Bicron, Solon, Ohio, USA) with preheat temperature 70 $^{\circ}$C, heating rate 6 $^{\circ}$C/S and final temperature 350 $^{\circ}$C. The heating chamber of TL reader was flushed with high purity nitrogen before depositing the mineral samples (0.5 - 2.0 mg) on a clean stainless steel disc (10 mm diameter, 0.5 mm thickness) for thermoluminescence determination.

Statistical Analysis

Data were analyzed using analysis of variance (Steel and Torrie, 1980) and SAS programs (SAS, 1985).

RESULTS AND DISCUSSION

Insect Disinfestation

Radiation at dose of 0.3 and 0.9 kGy two days after infestation led to a complete control without causing any damage to the irradiated dates in the single and mixed insect treatments (Table 1). However, insects were detected in all replicates in the infested non-irradiated treatment. The mean number of *O. surinamensis* adults in the infested non treated sample was 10366 and 9522 in single and mixed infestation, respectively.

Deferment of irradiation 45 days after infestation caused damages to dates. Eighty-100% of irradiated dates were found contaminated by frass (feces). Regardless of the dose, no alive insects were detected in the irradiated single infestation treatment. In mixed infestation, dose of 0.9 kGy was sufficient to cause 100% mortality. But, five adults of *O. surinamensis* were found alive in one replicate of mixed infestation treatment when dose of 0.3 kGy was applied. The dose of 0.3 kGy, which was used in this study, is laid within the range of sterility dose of this pest. Zaklodnoi and Ratanova (1987) reported that the sterility dose of this pest was 18 kard (0.18 kGy), whereas Auda (1980) found that dose of 0.7 kGy was sufficient for sterilization of *O. surinamensis*. Brower and Tilton (1970) found that 0.4 kGy is a sufficient dose to control this pest. Therefore, a few individuals might not be sterilized by dose of 0.3 kGy. Tilton and Brower (1987) stated that the use of sterilizing dose might mean that a small proportion of the insect population is not completely sterilized. Therefore, dose higher than 0.3 is recommended here to control this pest and other pests that could be found in stored dry dates.

The mean number of *O. surinamensis* adults six months after treatment in the infested nontreated sample was 10670 and 10430 in single and mixed infestation, respectively. Moreover, all dates were damaged and filled by frass. In mixed infestation, number of *T. castaneum* was not increased as much as *O. surinamensis*. This probably could indicate that *T. castaneum* is not a good competitor in dried date.

Microbial Examination

Although irradiation treatment of dates in this study was mainly for insect disinfestation, it also contributed to some reduction in microbial counts of the irradiated dates (Table 2). Total bacterial counts were reduced immediately after irradiation to a greater extent compared to the reduction in molds and yeasts since the later are generally less sensitive to irradiation (Jay, 1986). The microbial flora of both irradiated and unirradiated dates remained low till the end of storage period of 6 months with irradiated samples being lower in microbial counts. Dates (Khalas) are considered dry type date fruit (7.0% moisture content) and this low moisture content along with high sugar contents have made the conditions unfavorable for the growth of microorganisms.

Sensory Evaluation

Table 3 shows the sensory evaluation of irradiated and nonirradiated dates during storage for up to 6 months after irradiation. Irradiation (0.3 and 0.9 kGy) followed by 3 or 6 month post-irradiation storage at room temperature did not effect the sensory properties of Khalas dates. Literature on organoleptic changes induced by irradiation treatments of fully-ripened date like Khalas date was very rare. El-Sayed and Baeshin (1983) found no change in sensory quality of four irradiated varieties of dates at 0.2 kGy. In another work by Grecz et al. (1986), panelist could not discriminate between unirradiated dates and those irradiated at levels of 1.0 to 6.0 kGy. Khalas is a dry-type date fruit and its insensitivity towards irradiation is probably due to the low water activity and low protein content as compared with many other fruits and vegetable where threshold for undesirable organoleptic changes was found in the range of a few hundred krad (Dowson and Aten, 1962; Hasegawa et al., 1969).

Sugars Determination

The effect of irradiation and post-irradiation storage of dates on sugars is shown in Table 4. Fructose, glucose and total sugars were significantly ($p \leq 0.05$) reduced immediately after irradiation. Fructose and glucose of irradiated samples increased gradually with increasing storage time, whereas those of unirradiated samples showed inconsistent decrease or increase during the 6-month storage. However, maximum levels of both sugars were obtained at the end of storage and were significantly higher in unirradiated samples compared to the irradiated ones. Reduction in sugars immediately following irradiation could be due to the formation of some radiolytic products of carbohydrates.

Thomas (1986) reported that radiolytic products of carbohydrates could be formed when foods treated with ionizing energy, such products include glucuronic, gluconic, and saccharic acids, glyoxal, arabinose, erythrose, formaldehyde, and dihydroxyacetone. Oligosaccharides yield monosaccharides and products similar to those obtained from simple sugars. Polysaccharides (starch, cellulose) yield smaller units, such as glucose, maltose, and dextrins, and the radiolytic products of these substances. In this study, no sucrose was found in Khalas dates, and this is in agreement with Kanner et al. (1978) and Jaddou and Al-Hakim (1980). These authors found that fully matured dates contain no sucrose. Hasegawa and Smolensky (1970) indicated that the enzyme invertases are fully active in the fully matured stage (late stage of Rutab) and this would explain the reduction in sucrose content during the storage period of fully matured Zahdi dates.

Auda et al. (1977) studied the effect of irradiation (0.3 to 2.7 kGy) on the reducing sugars of completely ripened dates (Tamar) of several Iraqi varieties. The results showed no effect of gamma irradiation on reducing sugars and major carbohydrate components. El-Sayed and Baeshin (1983) studied the effect of irradiation on total carbohydrates, reducing and non-reducing sugars and free sugars of two varieties of dates (Tamar stage) produced in Saudi Arabia. Irradiation dose up to 25 Krad (0.25 kGy) had no effect on sugars even after storage up to 12-months at 20-35^{o} C.

Detection of Irradiated Dates

Thermoluminescence (TL) technique was used for detection of irradiated dates. The intensity of first glow curves (glow curve 1) showed difference between the unirradiated and irradiated dates (Figs. 1-3), and integration areas are used in discussion (Table 5). Therefore, discrimination between irradiated and unirradiated dates just on the basis of the first glow curve from separated minerals seems possible. These glow curves were normalized by re-irradiation at 0.5 kGy (second glow curve or glow curve 2 - figures are not shown) to improve the reliability of the results by eliminating the problem associated with the different amounts and composition of insoluble minerals from different lots of samples. It has been found that origin of this TL signals in food samples mainly lies in the insoluble minerals and dust particles adhere to food items and not in the organic matrix (Sanderson, 1990). By separating these minerals from the food samples and performing the thermoluminescence analysis on these minerals alone produce much better results. This will enable to distinguish between the irradiated and unirradiated food samples. TL intensities of whole samples mainly depends on the degree of mineral contamination. However, even isolated minerals (quartz, feldspar, etc.) emit intensities after irradiation which may differ by several orders of magnitude (Autio and Pinnoja, 1990). The ratio of the integration area of the first and second TL glow curves (intensity of glow curve) was much less than 0.001 for the unirradiated samples (0.00056) and greater than 0.1 (0.34 - 0.57) for the irradiated samples at zero time. The area of glow curves for the irradiated samples was 125 and 592 times higher (0.3 and 0.9 kGy, respectively) than the area of glow curve for unirradiated samples. The ratio of first and second glow curves intensity was also much less than 0.1 for the unirradiated samples (0.000562 - 0.0008067) and greater than 0.1 for the irradiated samples (0.153 - 0.522) after post-irradiation storage of 1, 3 and 6 months (Figs 4-7). The signal still persisted even after 6 months of post-irradiation storage and this made TL method reliable for the detection of irradiated dates.

Four types of dates have been studied by Khan and Delincée (1995) for the detection of irradiation treatment using thermoluminescence for the mineral contaminants adhering to the dates and ratio of the first glow curve as a whole to the second glow curve was more than 1.0 for all irradiated samples and much less than 0.1 for unirradiated samples which made detection of irradiated dates more reliable.

Thermoluminescence (TL) is an important routine method for the detection of irradiation treatment of food items (Delincée, 1993; Khan and Delincée, 1995).

ACKNOWLEDGMENTS

This research was funded by King Abdulaziz City for Science and Technology (Project No. AR-14-32).

We thank Dr. Sultan Al-Saidary, Executive Director of the Research Center, King Faisal Specialist Hospital for his assistance.

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Table (1) : Effect of Irradiation at 2 and 45 Days After Infestation of Dates (Khalas-variety) on *Oryzaephilus surinamensis* (single infestation) and *O. surinamensis* and *Tribolium castaneum* (mixed infestation).

Time of irradiation after infestation (days)	Time of Examination after irradiation (months)	Treatment (kGy)	Single infestation				Mixed infestation				
				Mean No. / date			Mean No. / rep.		Mean No. / date		
			Mean No. of OS/rep.	L	P	F	OS	Tr	L	P	F
		0.0	11	0.6	0.6	114.05	11.7	3.5	0.5	0.1	99.1
	1	0.3	0	0	0	0	0	0	0	0	0
2		0.9	0	0	0	0	0	0	0	0	0
		0.0	10366	3	2.3	4400	9522	58	2.3	1.75	2232
	6	0.3	0	0	0	0	0	0	0	0	0
		0.9	0	0	0	0	0	0	0	0	0
		0.0	430.5	0.45	0.4	314.75	763.5	14.7	1.6	0.4	555.1
	1	0.3	0	0	0	285.6	0	0	0	0	450.2
45		0.9	0	0	0	248.1	0	0	0	0	432.3
		0.0	10670	1	2.25	5091	10430	29	1.7	1.25	4722
	6	0.3	0	0	0	114	1.25	0	0	0	55
		0.9	0	0	0	40	0	0	0	0	17.65

OS = *Oryzaephilus surinamensis,* Tr = *Tribolium castaneum,* L = Larvae, P = Pupae, F = Frass

Table (2): Effect of Irradiation and Post-irradiation Storage at Room Temperature on Microbial Flora of Khalas Date.

Storage (months)	Microorganism (CFU/g)	Dose (kGy)		
		0.0	0.3	0.9
0	TC*	1.6×10^4	2.7×10^2	1.7×10^2
	Y+M**	3.3×10^2	1.1×10^2	5.0×10^2
3	TC	8.5×10^2	4.0×10^2	3.0×10^2
	Y+M	2.6×10^2	1.5×10^2	1.5×10^2
6	TC	1.1×10^3	3.3×10^2	2.1×10^2
	Y+M	4.5 x 10	1.4 x 10	1.5 x 10

*TC = Total Counts
**Y+M = Yeasts + Molds

Table (3) : Sensory Evaluation Scores for the Quality Attributes of Non-irridiated and Irradiated Dates (Khalas) Stored at Room Temperature.

Storage Time (Months)	Dose (kGy)	Score (mean±SD ; n = 10)			
		Color	Texture	Taste	Overall acceptability
0	0.0	7.4 ± 1.4 [a*]	6.4 ± 1.5 [a]	7.5 ± 1.0 [a]	7.4 ± 1.1 [a]
	0.3	6.8 ± 1.6 [a]	6.4 ± 1.8 [a]	7.3 ± 1.0 [a]	6.8 ± 1.4 [a]
	0.9	6.9 ± 1.6 [a]	6.7 ± 1.3 [a]	7.4 ± 1.0 [a]	7.2 ± 1.3 [a]
3	0.0	7.6 ± 1.3 [a]	6.8 ± 1.5 [a]	7.4 ± 1.1 [a]	7.5 ± 0.8 [a]
	0.3	6.6 ± 1.5 [a]	6.4 ± 1.8 [a]	7.0 ± 1.5 [a]	6.7 ± 1.3 [a]
	0.9	7.0 ± 1.4 [a]	6.5 ± 1.6 [a]	6.9 ± 0.9 [a]	7.1 ± 1.2 [a]
6	0.0	6.3 ± 0.6 [a]	6.3 ± 0.7 [a]	6.6 ± 1.2 [a]	6.6 ± 1.0 [a]
	0.3	6.4 ± 0.8 [a]	6.3 ± 0.7 [a]	6.5 ± 1.2 [a]	6.2 ± 0.9 [a]
	0.9	6.6 ± 1.0 [a]	6.5 ± 0.8 [a]	7.0 ± 0.9 [a]	6.8 ± 0.9 [a]

* Means in the same column for each individual storage time with unlike superscript differ significantly ($p \leq 0.05$).
Scoring scale: 1 = dislike extremely, 9 = like extremely.

Table (4): Effect of Irradiation and Post-irradiation Storage at Room Temperature on Sugars of Dates (Khalas)*.

Storage Time (months)	Dose (kGy)	Fructose	Glucose	Total Sugars
0	0.0	29.7 ± 0.1^{a}**	34.1 ± 0.6^{a}	71.9 ± 0.0^{a}
	0.3	29.2 ± 0.1^{b}	33.7 ± 0.1^{a}	66.4 ± 0.1^{c}
	0.9	27.1 ± 0.0^{c}	31.3 ± 0.3^{b}	68.4 ± 0.0^{b}
3	0.0	27.0 ± 0.4^{b}	30.6 ± 0.3^{b}	67.5 ± 0.0^{c}
	0.3	33.2 ± 0.5^{a}	38.6 ± 0.1^{a}	79.0 ± 1.3^{a}
	0.9	32.87 ± 0.3^{a}	39.98 ± 1.2^{a}	72.6 ± 0.0^{b}
6	0.0	35.0 ± 0.5^{a}	39.6 ± 0.2^{a}	76.2 ± 0.5^{a}
	0.3	34.0 ± 0.0^{b}	38.1 ± 0.4^{b}	76.1 ± 0.0^{a}
	0.9	33.7 ± 0.1^{b}	38.7 ± 0.0^{b}	73.7 ± 0.5^{b}

* % Dry weight basis

** Mean ± S.D. (n = 10). Means in column for each individual storage time with unlike superscript differ significantly ($p \leq 0.05$).

Table (5) : Integration Area (nc) of the First and Second TL Glow Curves for the Khalas Dates.

Storage Time (months)	Dose (kGy)	First Glow Curve (FGC)	Second Glow Curve (SGC)	$\frac{FGC}{SGC}$
0	0.0	0.1303	232.7	0.00056
	0.3	16.26	47.81	0.34
	0.9	77.15	136.9	0.57
3	0.0	0.2738	339.4	0.0008067
	0.3	30.22	154.7	0.1953
	0.9	44.94	166.1	0.2705
6	0.0	0.1287	229.0	0.000562
	0.3	98.57	644.6	0.153
	0.9	668.6	1282	0.522

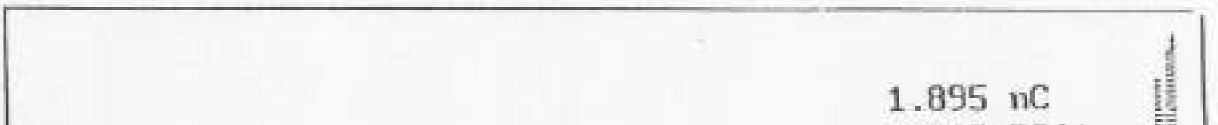


Fig. (1) TL Glow Curve I for the Minerals Isolated from Unirradiated Dates at Zero Time.

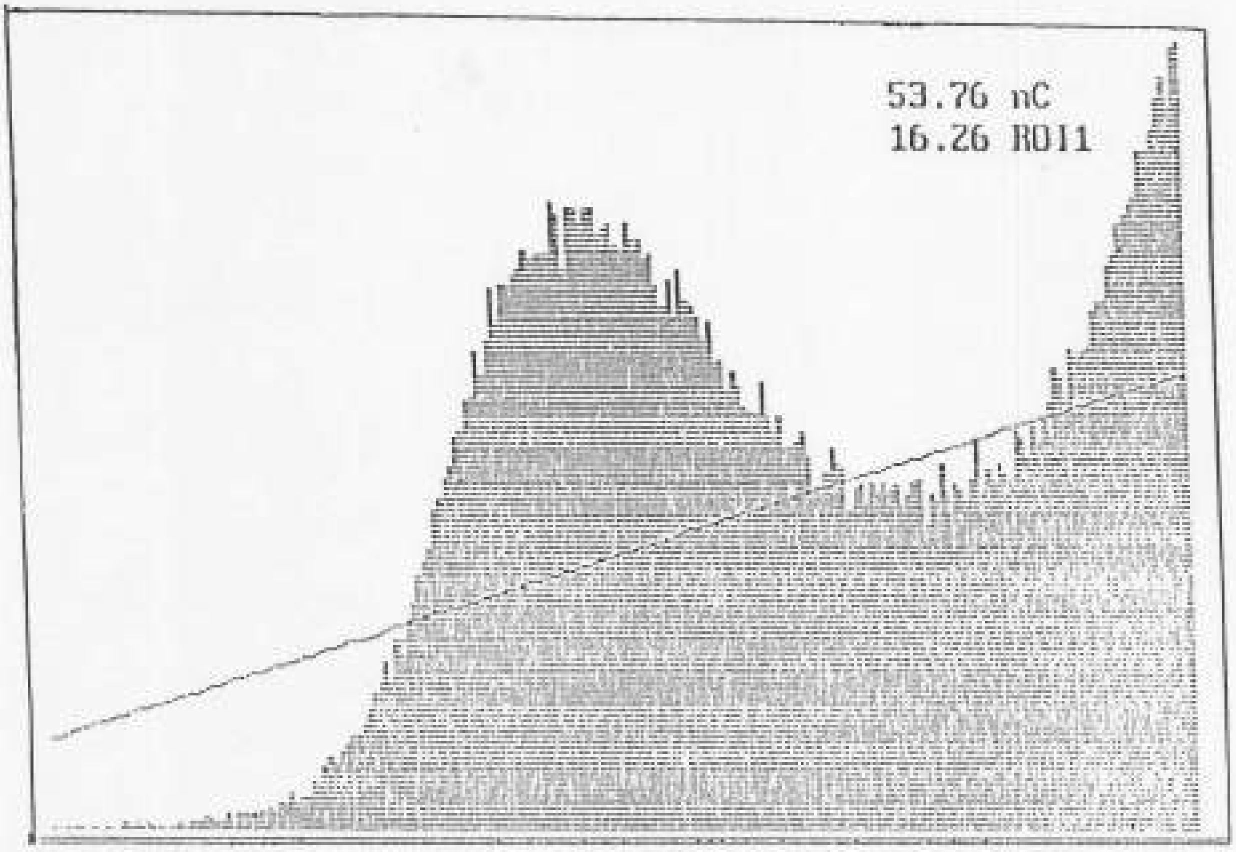
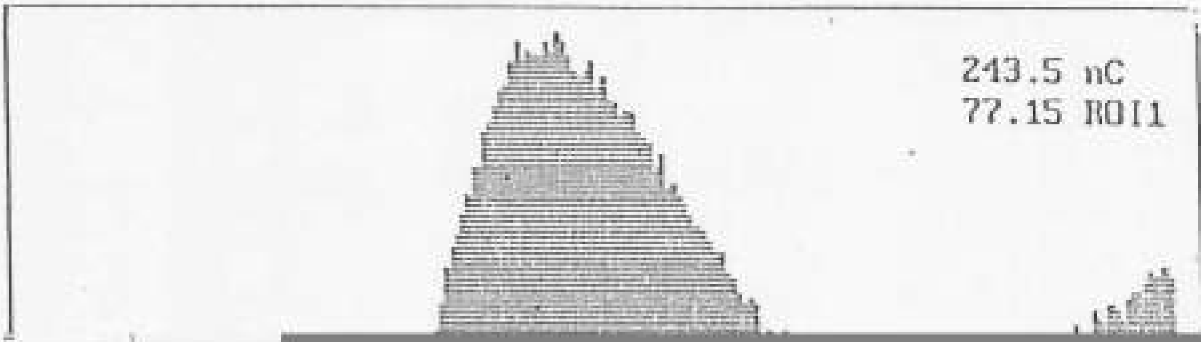


Fig. (2) TL Glow Curve 1 for the Minerals Isolated from the Irradiated Dates (0.3 kGy) at Zero Time.


243.5 nC
77.15 ROI1

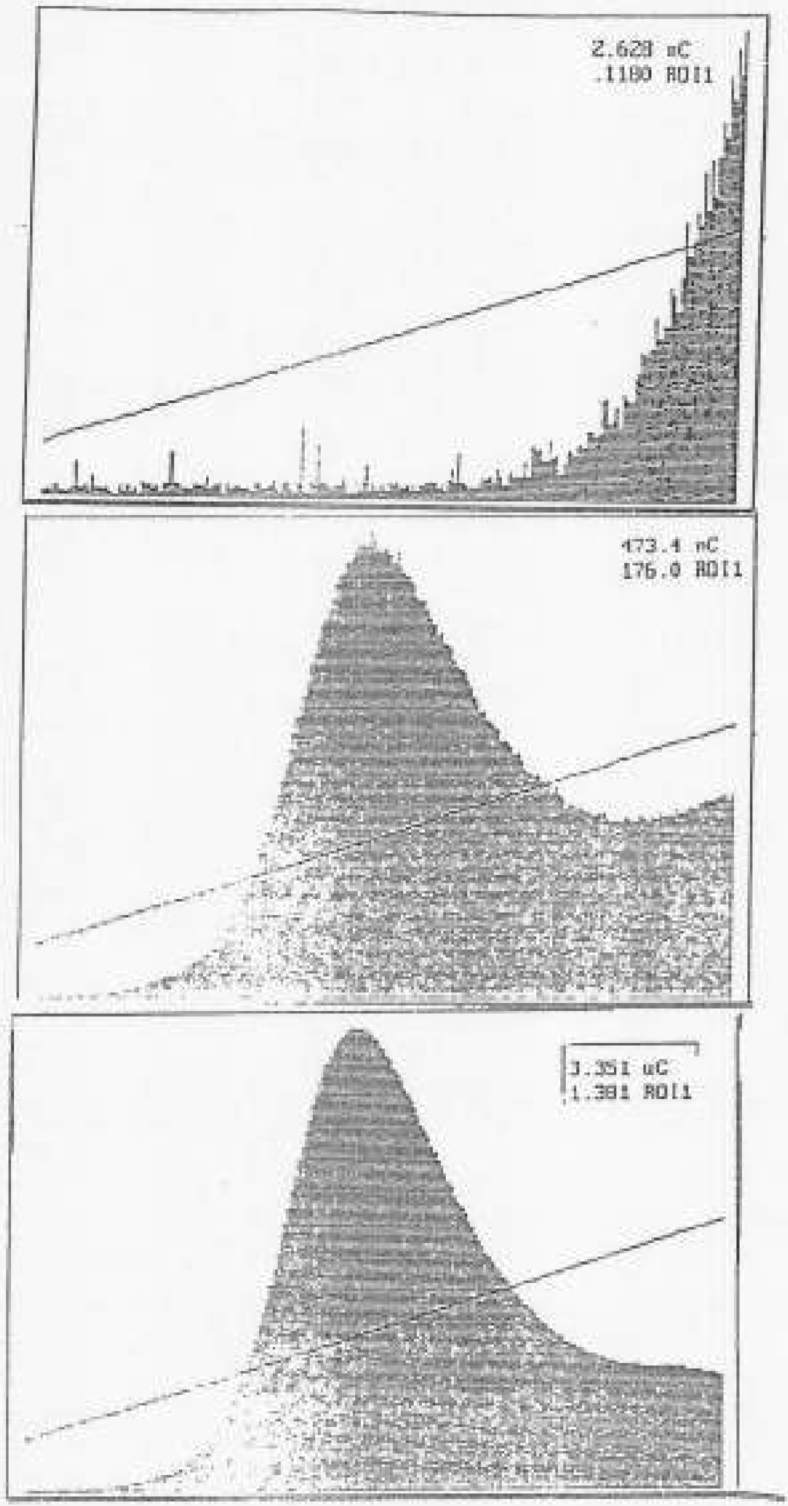


Fig. (4): TL Glow Curve I for the Minerals Isolated from Dates (Khalas-Variety C) after One Month. Unirradiated Dates (Top), 0.3 kGy-Irradiated Dates (Middle) and 0.9 kGy-Irradiated Dates (Bottom).

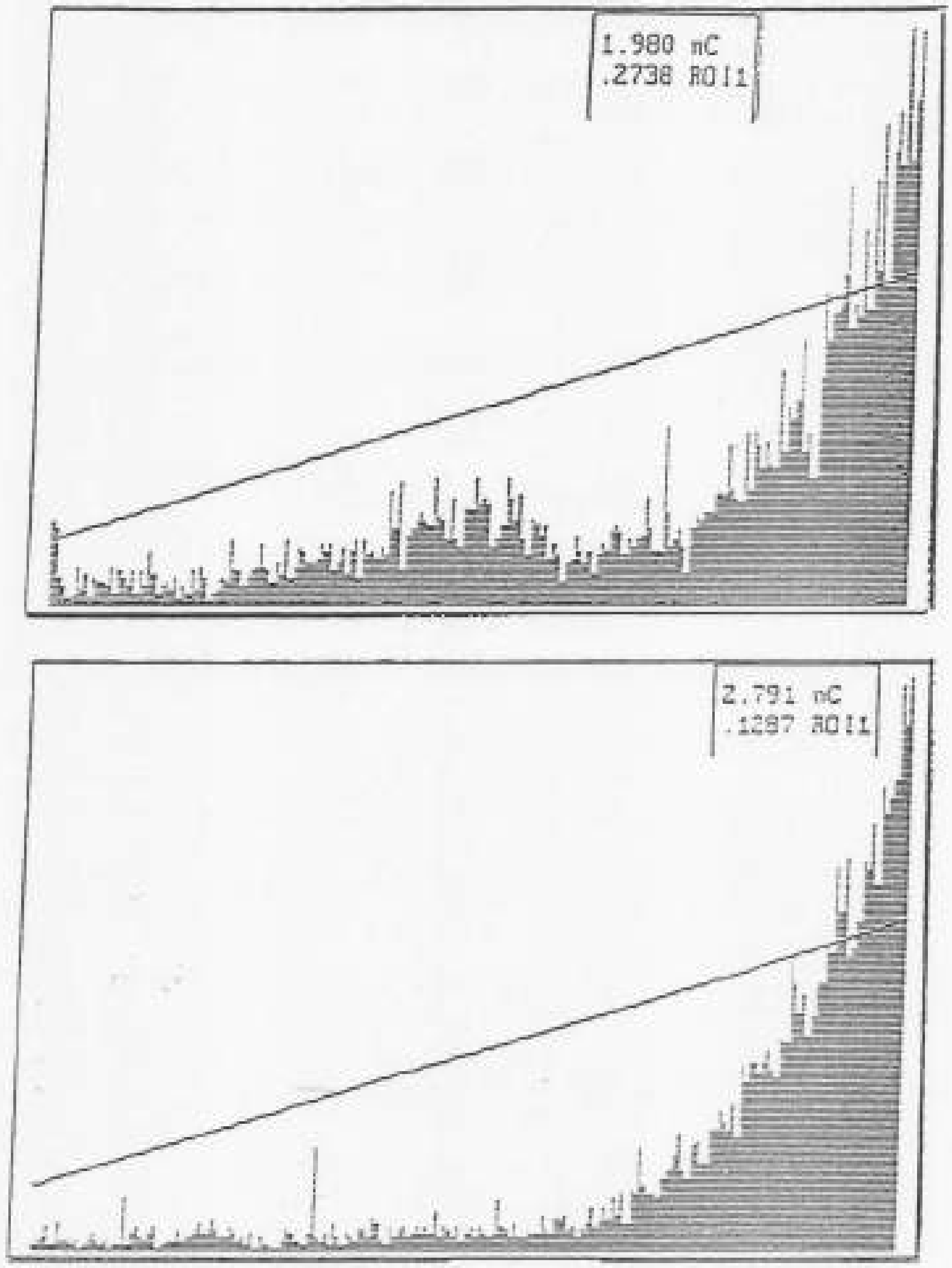


Fig. (5): TL Glow Curve I for the Minerals Isolated from Unirradiated Dates (Khalas-Variety C) After 3 Months (Top) and 6 Months (Bottom) at Room Temperature.

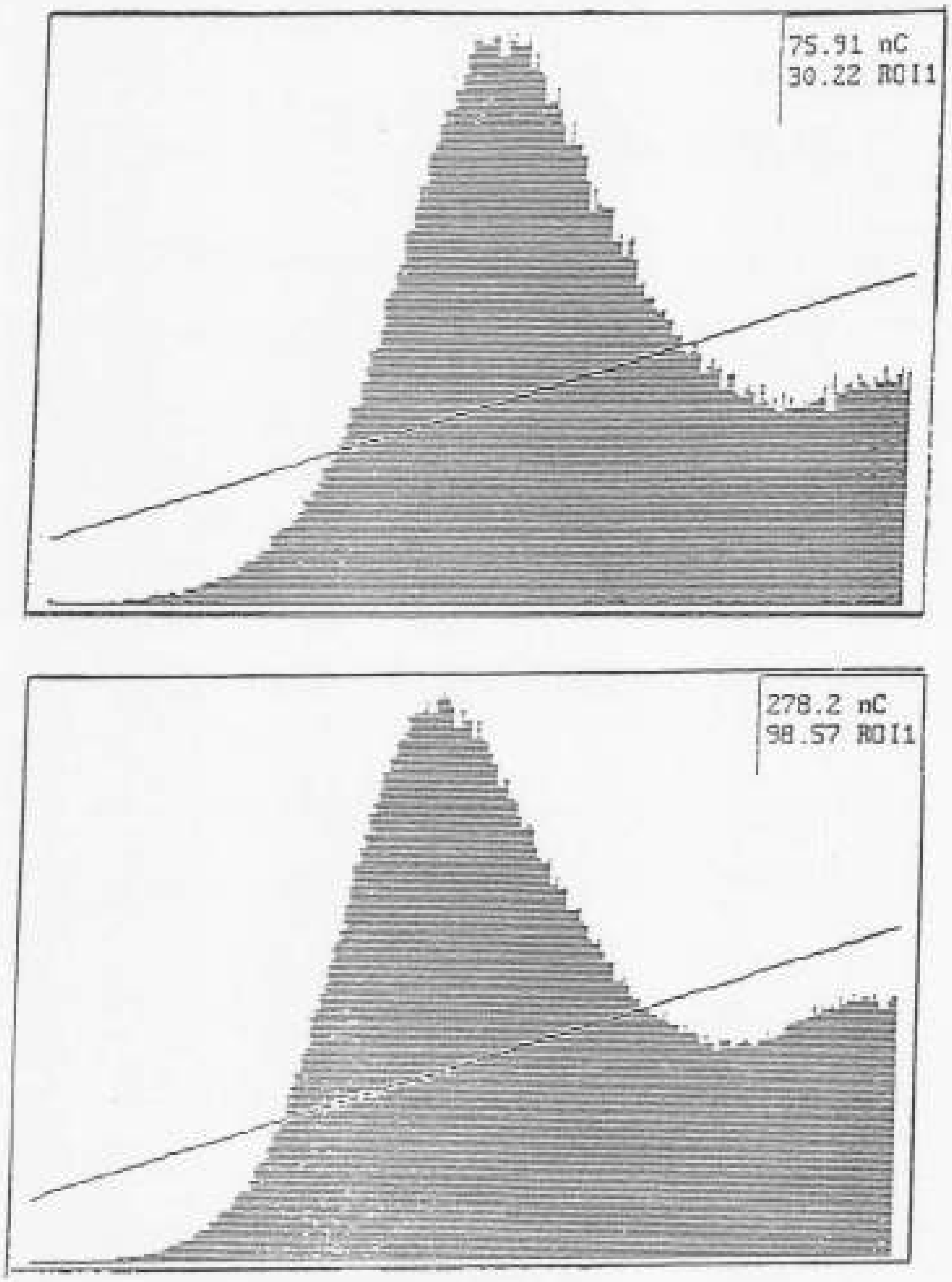


Fig. (5) : TL Glow Curve I for the Minerals Isolated from 0.3 kGy-Irradiated Dates (Khalas-Variety C) After 3 Months (Top) and 6 Months (Bottom) at Room Temperature.

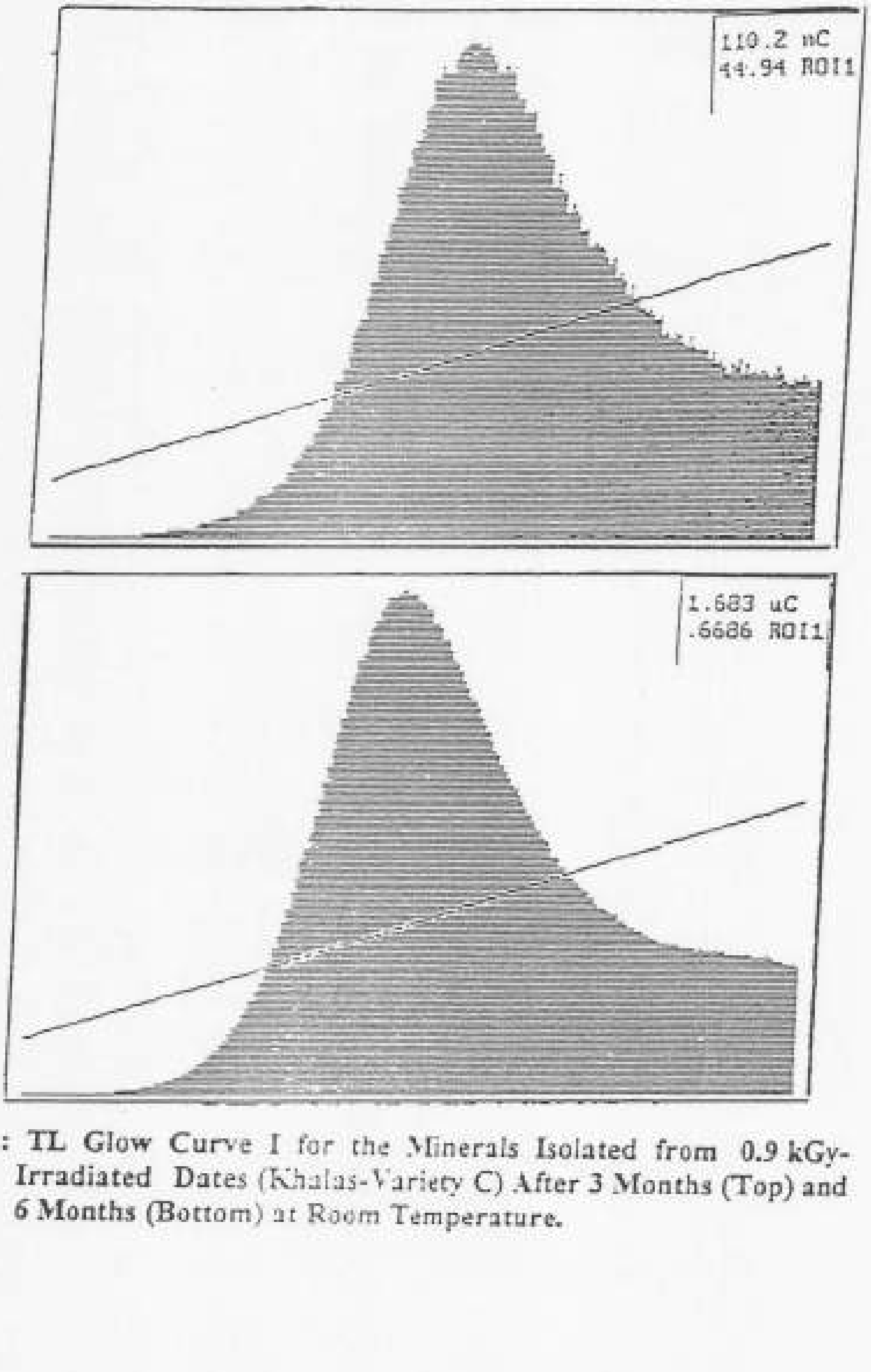


Fig. (٦) : TL Glow Curve I for the Minerals Isolated from 0.9 kGy-Irradiated Dates (Khalas-Variety C) After 3 Months (Top) and 6 Months (Bottom) at Room Temperature.

IN VITRO PROPAGATION OF EGYPTIAN DATE PALM:

II- DIRECT AND INDIRECT SHOOT PROLIFERATION FROM SHOOT-TIP EXPLANTS OF *Phoenix dactylifera* L. CV. ZAGHLOOL.

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ABSTRACT

Both direct and indirect shoot proliferations, with their advantages to produce either true-to-type plantlets or valuable variations, respectively are reported from the Egyptian date palm cultivar, Zaghlool. Shoot tip cultures were established on Murashige and Skoog (MS) medium supplemented with 100 mgl^{-1} myo-insitol, 50 mg e-1 adenine sulfate, 1.5 gl^{-1} activated charcoal, 2 mgl^{-1} 2-ip and 0.1 mgl^{-1} NAA. Direct shoot proliferation was observed after two subcultures on MS-medium supplemented with 4 mg e-l 2-ip, 4 mgl^{-1} 1 BA and 0.5 mgl^{-1} NAA. Subculturing the proliferated shoots onto MS-medium containing 1 mgl^{-1} NAA led to root formation. Embryogenic callus proliferated from shoot tip explants on MS medium supplemented with 10 mgl^{-1} 2,4-D giving rise to plantlets after three subcultures, with one month interval, on MS medium containing 3 mgl^{-1} 2-ip and 1 mg e-l NAA.

Additional index words: Date palm, callus, regeneration

Abbreviation: BA, benzyl adenine; 2,4-D, 2,4-dichlorophenoxyacetic acid; 2-ip, 6-(γ-γ dimethyl-allylamino)-purine; Kin, kinetin; NAA, α-naphthaleneacetic acid; IAA, indole 3-acetic acid and IBA, indolebutyric acid.

INTRODUCTION

Date palm historically and currently is the most important horticultural crop in the Arab region. One of the major problems in date palm cultivation that prevents rapid crop improvement is the lack of an adequate method of asexual propagation. Traditionally, date palm is propagated vegetatively by offshoots produced by desirable trees. The low rate of propagation (1-20 offshoots in the lifetime of a palm tree, depending on the cultivar) has limited the multiplication of healthy plants, and also hindered effective work on clonal selection (Tisserat, 1982).

Plant tissue culture techniques have developed into very powerful tool not only for quick clonal multiplication of superior cultivars, but also for elimination of diseases transmission. Moursy and Saker (1996) detailed date palm problems and the need for biotechnology. Most of palm tissue culture work have been restricted to the production of plantlets through direct and indirect somatic embryogenesis (Ammar

This work was sponsored by ICGEB, project no. CRP/EGY 96-01 (11).

Correspondence should be addressed to Shawky A. Bekheet and
Benbadis, 1977 and Sudhersan *et al.* 1993). This article describes the direct proliferation and indirect regeneration of shoot-tips cultures of Egyptian date palm cv. Zaghlool.

MATERIAL AND METHODS

Plant material: Zaghlool offshoots (1-1.5 meter height and 10-20 kg weight) grown in the region of Giza governrate were used.

Sterilization and preparation of explants: For the preparation of shoot tips explants, offshoots were dissected acropetally using serrated knife. Mature leaves were carefully separated. During dissection process, anti-oxidant solution (150 mgl^{-1} each of ascorbic and citric acid) was sprayed over hands and the offshoot. When all outer leaves are removed, the shoot tip was kept in antioxidant solution and transferred to a laminar follow cabinet for surface sterilization. Different sterilization treatments were tested (Table 1), where the following procedure showed the lowest percentage of contamination:

1- Explants were soaked in 50 % Clorox (5.25% NaOCl) for 20 min and thoroughly washed with sterile distilled water.

2- The pale white leaves were trimmed till obtaining the desired size (1 cm).

3- The explants were soaked in 30 % Clorox for 10 min, washed with sterilized distilled water, and soaked in sterilized anti-oxidant solution.

4-Leaves were removed acropetally and transferred to a new sterilized petri-dish and additional leaves were removed till obtaining the shoot tip explants (2 mm).

Initiation of in vitro cultures: Media presented in Table (2) were tested for *in vitro* culture of shoot tip explants. The media were selected based on the results of morphogenic responses of immature embryos *in vitro* (Saker *et al.* 1998) and the published results on date palm tissue culture. pH of all media were adjusted to 5.6 using 0.1 N NaOH or HCl prior to autoclaving for 20 min at a temperature of 121 ^{o}C, of 1.2 kg/cm^2. Cultures were maintained at 25 $\pm$ 2 ^{o}C under a photoperiod of 16 hrs light (2000 Lux) and 8 hrs darkness. To evaluate media efficiency, the following parameters were recorded: frequency of shoot, callus and root proliferation and number of viable shoots formed.

RESULTS AND DISCUSSION

After four weeks of cultivation of shoot tip explants on MS medium supplemented with 2 mgl^{-1} 2iP + 0.1 mgl^{-1} NAA (Fig. 1-A), the surviving shoot tips were subcultured onto either MS + 10 mgl^{-1} NAA+ 3 mgl^{-1} 2iP, or 0.5 mgl^{-1} NAA + 4 mgl^{-1} 2iP + 4 mgl^{-1} BA. Direct shoot proliferation was confined to media containing BA (Fig. 1-B). Moreover, low rate of axillary budding was observed after two subcultures onto the same fresh medium.

Rooting of proliferated shoots, was achieved upon supplementation of culture medium (basal MS salts) with 1 mgl^{-1} NAA, which was more efficient than IAA and IBA, at the same concentration. Moreover, the rooting response was earlier (four weeks only) in the presence of NAA. As shown in Fig 1-C, the numbers of roots as well as their length are enough for successful transplanting to the free-living conditions. The obtained results are in agreement with those obtained by Tisserat (1984) and Al-Marri and Al-Ghamdi (1995). These authors found that the addition of NAA at 0.1 and 0.2 mgl^{-1}, respectively, induced root proliferation of *in vitro* grown date palm. However, Drira (1983) used 1 mgl^{-1} IBA for the same purpose.

It is clear from the present results that the presence of cytokinins, such as BA and 2ip, in the culture media is an important factor for shoot differentiation and budding. This may be due to its role in cell division and inhibition of apical dominance. These results are in agreement with those obtained by Al-Marri and Al-Ghamdi (1995). They used BA and 2ip for starting and multiplication of date palm shoot tip cultures. On the other hand, Tisserat (1984) reported that the addition of cytokinin at any level to date palm tissue culture media did not enhance shoot differentiation.

Regarding shoot organogenesis after a phase of callus formation, it was noticed that only culture medium containing 10 mgl^{-1} 2,4-D showed evidences of callusing responses. Proliferation of healthy light green callus

(Fig.2-A) was recorded after two subcultures with one month interval. Embryogenic callus was proliferated from this callus line after four weeks of cultivation on MS medium containing 3 mgl^{-1} 2iP + 1 mgl^{-1} NAA (Fig.2-B). Subculturing of the embryogenic callus onto either basal MS medium or the same fresh callus proliferation medium led to shoot and root proliferation (Fig. 2-C). The present results are in accordance with those obtained by Ammar and Benbadis (1977), Reuveni and Lilien-Kipnis (1979) and Saker *et al.* (1998). They obtained callus from date palm explants on modified MS medium containing 2,4-D and NAA. In this connection, Reynolds (1979) and Tisserat (1979) reported that the inclusion of activated charcoal to a modified MS medium and increasing the auxin levels allowed various date palm explants to produce prolific callus. Moreover, Tisserat (1979) reported that the type and concentration of auxin are critical factors in callus proliferation from somatic date palm tissues.

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Table (1): Effect of different sterilization treatments on explant survival and percentage of contaminations

% of survival	% of contaminated cultures	Sterilization treatments
0.0	100	70% ethanol (1 min)
90	80	70 % ethanol + 25% Clorox (20 min)
85	60	70% ethanol + 50% Clorox (20 min)
55	60	70% ethanol + 75% Clorox (20 min)
34	30	70 % ethanol +100% Clorox (20 min)
70	85	70% ethanol + 0.1% $HgCl_2$ (20 min)
62	48	70% ethanol + 0.2% $HgCl_2$ (20 min)
40	28	70% ethanol + 0.4% $HgCl_2$ (20 min)
35	24	70% ethanol + 0.4% $HgCl_2$ (20 min), followed by 0.4 % $HgCl_2$ (20 min)
75	25	70% ethanol + 50% Clorox (20 min), followed by 30% Clorox (10 min)

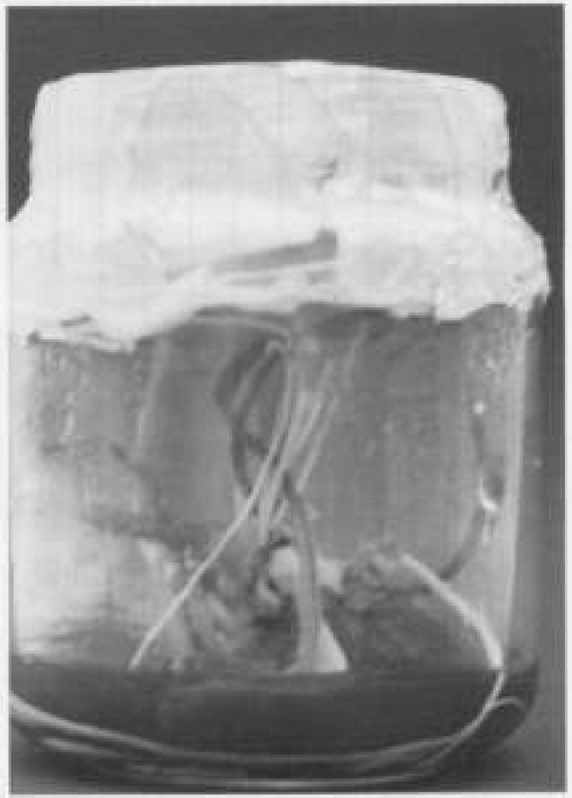
Table (2): Culture media examined for date palm, cv. Zaghlool.

Code	Media*
MD1	MS+ 0.1 mg/l NAA + 2 mg/l 2iP
MD2	MS+ 10 mg/l NAA + 3 mg/l 2iP
MD3	MS+ 0.5 mg/l NAA + 4 mg/l 2iP + 4 mg/l BA
MD4	MS+ 1 mg/l NAA
MD5	MS+ 5 mg/l 2,4-D
MD6	MS+ 10 mg/l 2,4-D
MD7	MS+5 mg/l NAA
MD8	MS+ 10 mg/l NAA
MD9	Basal MS
MD10	MS+ 1 mg/l NAA+ 3 mg/l 2iP
MD11	MS+ 1 mg/l IBA
MD12	MS+ 1 mg/l IAA

* All culture media consisted of basal MS salts (Murashige & skoog 1962): 200 mg/l KH_2PO_4, 50 mg/l adenine sulfate, 1.5 g/l activated charcoal, 30 g/l sucrose and100 mg/l myo-insitol and 7 g/l agar.

(A)

(B)

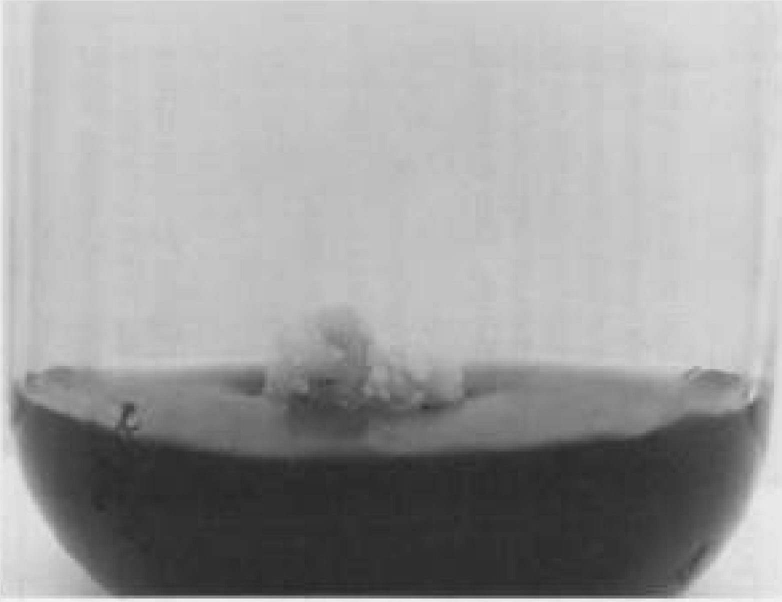


(C)

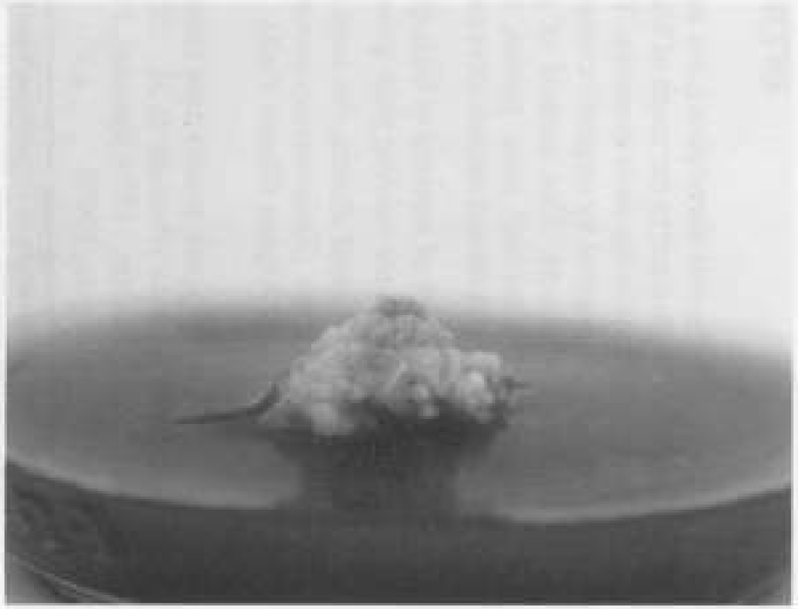
Fig. 1: A) Shoot-tip after four weeks of culturing on MS+2 mg /l 2ip+ 0.1mg /l NAA

B) Direct shoot proliferation on MS + 0.5mg/l NAA + 4 mg /l 2ip + 4 mg /l BA

C) Rooting of proliferated shoots on MS + 1mg/l NAA



(A)



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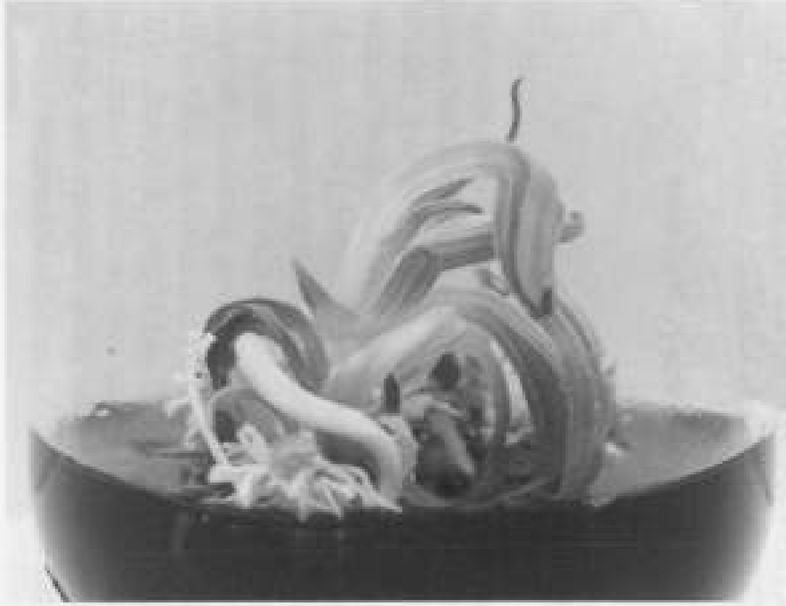

Fig.1: A) Callus proliferation from shoot-tip explant cultured on MS + 10 mg /l 2,4-D.

B) Proliferation of embryogenic callus onto MS + 3 mg /l 2ip + 1mg /l NAA.

C) Proliferated shoots and roots on basal MS- medium.

SOMATIC EMBRYOGENESIS AND MASS MICROPROPAGATION OF DATE PALM (*Phoenix dactylifera* L.). CHARACTERIZATION AND GENETIC STABILITY OF REGENERATED PLANTLETS BY RAPD MARKERS.

R. Letouzé [(*)], F. Daguin [(*)], P. Satour [(*)] L. Hamama [(*)] and F. Marionnet [(**)]

ABSTRACT

In the last few decades plant regeneration of date palm (*Phoenix dactylifera* L.) through tissue culture has been succeeded, but mass production true-to-type from the mother plant is still a long and difficult process. Since 1985 our laboratory has successfully regenerated date palm of more than 50 cultivars through somatic embryogenesis. We report here, a protocol for mass regeneration of date palm through somatic embryogenesis and the use of molecular technique for plant material characterization and genetic stability. Thirteen date palm cultivars were screened for polymorphic RAPD (Random Amplified Polymorphic DNA) markers with five arbitrary 10-mer primers (A02, A08, B07, B10 and E07). This set of five primers provided fourteen polymorphic markers that can be used to distinguish the thirteen date palm cultivars. A set of six primers was used for Barhee (E07, A02, A05, A08, A13 and A20) and Mejool (E15, A02, A03, A05, A08 and A13) to evaluate the genetic stability of somatic embryo-derived plants. The utilization of RAPD markers both for the identification of date palm cultivars and for the assessment of genetic stability through the process of somatic embryogenesis is reported.

Key words : date palm, plant tissue culture, somatic embryogenesis, RAPD markers.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is an essential plant crop for several million people in the Mediterranean region and in the south of Maghreb countries. The crop has been for centuries one of the key elements in the oasis economy. The date palm is a dioecious and heterozygote species and has to be propagated by vegetative means. The multiplication of the species is carried out by the means of offshoots. This method of propagation is limited and reduces considerably the expansion of the existing palm groves, especially in the north of Africa. This method of propagation is very slow and cannot solve two important problems :

- the lack of material of high quality for the expansion and development of some of the existing palm groves, especially in the north of Africa ;
- the Bayoud disease, the most lethal disease known to date palm caused by a soil fungus (*Fusarium oxysporum* f. sp. *albedinis*) in the south of Morocco and Algeria (Djerbi 1988).

For the last 20 years, results have shown that date palm can be propagated by tissue culture both by organogenesis (Poulain et al., 1979; Beauchesne, 1983; Drira, 1983) or by somatic embryogenesis (Tisserat, 1979; Reuveni, 1979; Sharma et al., 1984; Daguin and Letouzé, 1988; and Letouzé and Daguin, 1989).

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Currently, the process of somatic embryogenesis seems to be more attractive for an industrial production but the date palms derived from somatic embryos must be true-to-type. Proteins and isoenzymes have been used in date palm cultivar identification and somaclonal variability analysis during the past years. (Torres and Tisserat, 1980; Baaziz and Saadi, 1988; Stegemann et al., 1987; and Bendiab et al., 1998). This method presents some inconvenients: the products of gene expression may vary at different developmental stages or under environmental conditions. The advent of molecular techniques DNA-based procedures have been proposed for cultivar identification. Williams et al. (1990) and Welsh and McClelland (1990) reported a technique based on the amplification of random DNA sequences by polymerase chain reaction (PCR) with arbitrary primers. RAPD (Random Amplified Polymorphic DNA) markers are now used for identification (Hu and Quiros, 1991; Koller et al., 1993; and Aruna et al., 1995) to evaluate genetic integrity (Isabel et al., 1993) or analysis of somaclonal variants (Hashmi et al., 1997).

In 1976, our Laboratory first succeeded in the regeneration of date palm by tissue culture through the process of organogenesis. Since 1985 our laboratory successfully regenerated date palm of more than 50 cultivars through somatic embryogenesis. For about 10 years our Laboratory is working by contract with an industrial Laboratory which is now established in UAE : Al Wathba-Marionnet L.L.C. Now, in relation with this industrial partner, a capacity of production more than one hundred thousand plantlets per year is obtained.

This research reports 13 years of work on the regeneration / micropropagation of date palm through somatic embryogenesis for industrial propagation purpose as well as the use of RAPD markers to characterize the plant material and to study the genetic stability of somatic embryo-derived plants.

MATERIALS AND METHODS

Plant Material

Plant material (offshoots) were received from USA (Barhi, Khalas, Zahidy, Medjool) UAE (Barhi, Khalas, Nabtha saif, Kowaiz, Owaid, Hasawy, Umm Dahan, Saggai, Abu Man, Rothana) and Morocco (Medjool).

Somatic embryogenesis

Plant regeneration has been established using shoot tips from offshoots through the process of indirect somatic embryogenesis based on the method described by Tisserat (1979). The induction of embryogenic callus is achieved using a Murashige and Skoog (MS) medium (Murashige and Skoog, 1962) supplemented (Table 1) with plant growth regulators (2,4-D, 2-iP). Two other culture media (Table 1) are used for the multiplication/elongation and rooting stages.

In the culture room, plant material were exposed under photoperiodism (light period : 15h/15 μmol m^{-2} s^{-1} or 15 h/50 μmol m^{-2} s^{-1} / 28 ± 0.5° C — dark period : 9 h/24 ± 0.5° C).

DNA extraction

Plant genomic DNA samples were extracted from the offshoots, vitroplants and acclimatized plants following the CTAB method (Doyle and Doyle, 1990). DNA concentration was measured with the use of a TKO 100 minifluorometer (Amersham Pharmacia Hoffer, Uppsala).

Table 1. Composition of the culture media for date palm somatic embryogenesis (mg per liter). Basal medium of Murashige and Skoog (1962) with modifications.

Component	Stage of the Culture		
	Induction	*Multiplication / Elongation*	*Rooting*
Macronutrients Oligonutrients Fe-EDTA Vitamins	Murashige and Skoog (1962) nutrient and vitamin salts		
Sucrose	45 000	50 000	50 000
Meso-Inositol	100	100	100
Gelling Agent	(Agar) 7 000	(Karraghenan) 6500	
Activated Carcoal	3 000	500	1 000
Glutamin	100	200	100
Asparagin	100	-	-
di-Hydrogeno ammonium citrate	100	100	50
KH_2PO4	-	100	100
NaH_2PO_4, $2H_2O$	-	170	170
2,4-D	100	-	-
2-iP	3	-	-

DNA amplification

Decanucleotide primers from Operon Technologies (Alameda, California) were used for the RAPD analysis based on the protocol of Williams et al. (1990) with minor modifications. Amplification reactions were performed in a 25-µl reaction mixture consisting of 10 mM Tris-HCl pH 8.3 ; 2 mM $MgCl_2$; 100 µM each of dNTP ; 0,2 µM of primer ; 25 ng of DNA and 0,5 unit of Taq DNA Polymerase (Perkin Elmer Cetus). The mixture was covered with 25 µl of mineral oil. For the DNA amplification a Perkin Elmer Cetus 480 DNA thermal cycler was programmed for 4 min at 94 °C for 45 cycles, each consisting of a denaturation step (1 min at 94 °C), followed by an annealing step (1 min at 36 °C) and of an extension step (2 min at 72 °C). The last cycle was followed by 10 min at 72 °C to ensure that primer extension reactions proceeded to completion. After the amplification was completed, amplified samples were loaded and electrophoresed on 1.4 % agarose gel, followed by staining with ethidium bromide. The gels were photographed under UV with Polaroid films (Polaroid 572). The pictures were used for the analysis of the amplification products. DNA amplifications were repeated three times.

RESULTS AND DISCUSSION

Plant regeneration

Apical tissues of offshoots were fra10 explants. A callus induction medium containing MS salts, supplemented with organic nitrogen (glutamin 100 mg/L, asparagin 100 mg/L, di-ammonium citrate 100 mg/L). and with an enriched sugar concentration (sucrose 45 g/L) proved to be effective to initiate somatic embryogenesis in date palm tissues. Microbial contaminations of the cultures occurred in only few cases less than 3 to 5 %. Cultures were maintained in the dark during the first three months, the pro-embryogenic calli appeared about two to three months later and embryogenic calli were formed within four months of culture. After being maintained in the dark, the cultures were placed under low intensity light (15 μmol m^{-2} s^{-1}).

Embryos development began when the embryogenic calli were transferred on a hormone free medium. At this stage, the tissue culture was maintained under a light intensity of 50 μmoles m^{-2} s^{-1}. Embryo development could be improved if they were transferred in a liquid medium containing half strengh MS salts, 30 g/L sucrose, 3 g/L activated charcoal and placed on a rotary agitator. After 30 days in the liquid medium the embryos larger than 5 mm were placed on a solid medium for embryo maturation while embryos between 50 µm and 5 mm in size were placed again in a fresh suspension medium (Daguin and Letouzé, 1988). This process led to a better individual development of embryos.

At the last stage of the *in vitro* culture, plantlets were transferred for further plant development on a rooting agar-free medium (Table 1). After two or three subcultures, the plantlets were well formed with strong roots. The acclimatization of the plantlets was performed in the glasshouses at the industrial (GFA-Marionnet, France) with a success above 90 %.

The process of plant regeneration through somatic embryogenesis led to 10 000 to 12 000 date palm trees regenerated per offshoot within 16 to 20 months for the complete *in vitro* steps. Such results were assessed for more than 30 different cultivars and for several lines per cultivar.

Identification of date palm cultivars with RAPD markers

Figure 1 reports the amplification of genomic DNA of different date palm cultivars in the same PCR run. A key was developed for 13 cultivars (Table 2) using five primers (A02, A08, B07, B10 and E07). These primers were selected after preliminary experiments. A total of 48 fragments were generated by the selected primers and could be used as potential genetic markers but only 14 were used as polymorphic markers. The primer A02 (Fig. 1) amplified four RAPD bands (A02-930, A02-1020, A02-1150 and A02-1230). Three bands were amplified by the primer A08 (A08-500, A08-630 and A08-870). Four bands were amplified by the primer B07 (B07-630, B07-830, B07-910 and B07-1020), two bands by the primer B10 (B10-830, B10-1740) and only one fragment was amplified by the primer E07 (E07-1480).

These 14 RAPD fragments produced by the five primers permit a theoretical differentiation of 16 384 combinations. This technique provides a faster and easier approach to detect extensive polymorphisms and needs very small amounts of genomic DNA. Amplifications were reproducible over time and gave the same RAPD profiles. The technique can be routinely applied for varietal identification (Isabel et al., 1993).

Table 2 : Differentiation of 13 date palm cultivars using 5 primers (A02, A08, B07, B10 and E07). This set provided 14 polymorphic markers that can be used to distinguish the 13 cultivars.

(+) presence of the chosen RAPD band
(-) absence of the chosen RAPD band

		Cultivars												
		Zahidy	Barhi	Nabtha Saif	Sukkari	Khalas	Kowaiz	Owaid	Hasawy	Medjool	Umm Dahan	Saggai	Abu Man	Rothana
Primers	1: A02-1230	+	+	+	+	+	+	+	+	-	-	+	+	+
	2: A021150	+	+	+	-	-	+	+	+	+	-	+	-	-
	3: A021020	-	-	-	+	+	-	-	-	-	+	-	+	+
	4: A02-930	+	+	+	+	+	+	+	+	+	+	+	-	+
	5: A08-870	+	+	-	+	+	+	+	-	+	-	+	-	+
	6: A08-630	+	+	+	+	+	+	+	+	+	+	+	+	+
	7: A08-500	+	-	+	-	-	+	-	-	-	+	-	-	-
	8: B071020	+	+	-	-	-	+	-	+	-	+	+	-	-
	9: B07-910	+	-	+	-	+	-	-	+	+	-	-	+	-
	10: B07-830		+	+	-	+	-	-	+	+	-	+	+	+
	11: B07-630	-	+	+	-	-	-	+	+	-	+	+	+	+
	12: B10-1740	-	+	+	-	+	+	+	+	+	+	+	-	+
	13: B10-830	+	+	+	+	+	-	-	+	+	-	+	+	+
	14: E07-1480	-	+	-	+	+	+	+	-	-	+	+	-	+

Genetic stability of somatic embryo-derived plants

The genetic stability of somatic embryo-derived plants was evaluated with the aid of RAPD method (Isabel et al., 1993). We report here only the work done on two high economic value cultivar : Barhee and Medjool. Genomic DNA amplification was performed using a set of 6 primers : E07, A02, A05, A08, A13 and A20 for the cultivar Barhee and E15, A02, A03, A05, A08 and A13 for the cultivar Medjool to evaluate the genetic stability of somatic embryo-derived plants.

For each cultivar, three stages were evaluated (Fig. 2): offshoot, embryogerminating and acclimatized plantlets. The results (Fig. 3) show that the polymorphism revealed by RAPD markers differed towards cultivars and primers used but that for a cultivar and a given primer chosen, no genetic change was detected regardless of the stage.

CONCLUSION

During the last five years in our laboratory, somatic embryo-derived plants led to true-to-type date palms from the mother plant and no variation was detected within clones. For the past ten to twenty years isoenzyme systems have been used in cultivar identification (Weeden and Lamb, 1985) but these markers were limited and gave no direct assessment of the potential variation in the genome. The use of RAPD marker analysis for characterization and for varietal identification is a technique of high efficiency to distinguish cultivars by comparing their amplified DNA patterns.

The utilization of RAPD markers can now be used for cultivar identification and for assessing the genetic stability of somatic embryogenesis-derived materials.

ACKNOWLEDGEMENTS

Plant material was provided by Marionnet G.F.A. France, we thank C. Tallon, assistant engineer, for his appreciate help in tissue culture. This research was supported in part by EU-STD Contract TS2A 0097 F.

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Fig.1 : Amplification of genomic DNA of 13 different Date Palm cultivars in the same PCR run using five primers (A02, A08, B07, B10 and E07). The arrows (→) indicate the RAPD markers.

Date Palm cultivars - **1** : Zahidi **2** : Barhee **3** : Nebusiaf **4** : Sukkari **5** : Khalass **6** : Howaiz **7** : Owaid **8** : Hasawi **9** : Medjoul **10** : Oum Dahan **11** : Saggai **12** : Abu Maan **13** : Rothana

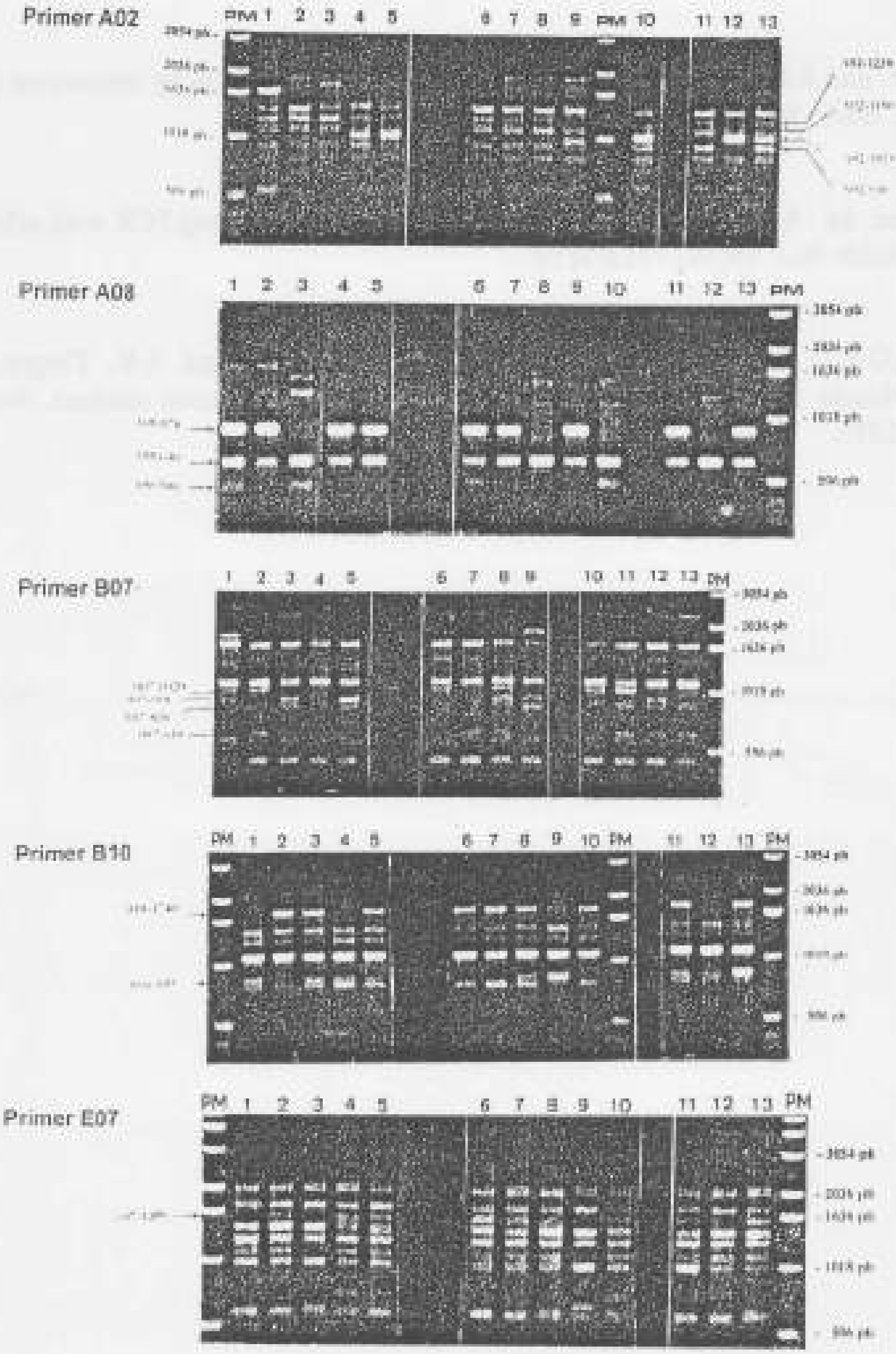
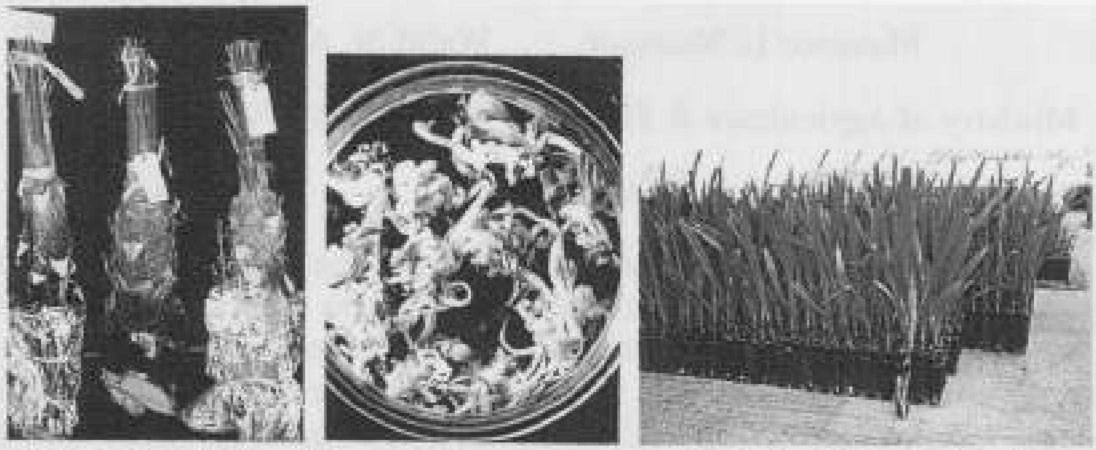


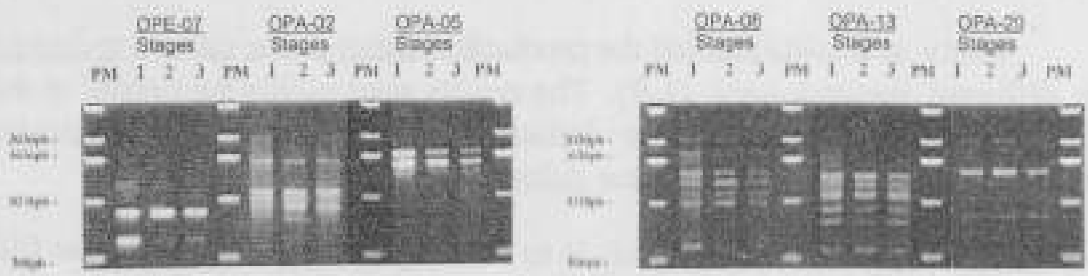
Fig.2 : Stages of plant material evaluated for genetic stability of somatic embryo-derived plant.



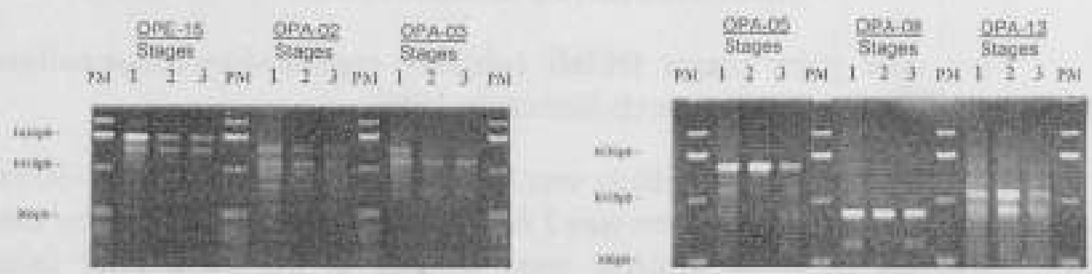
Stage 1 : Offshoot Stage 2 : Embryo germinating Stage 3 : Acclimatized plant

Fig.3 : Banding patterns of two cultivars (Barhee and Medjoul) at three stages using a set of six primers.

-Barhee : Primers OPE-07, OPA-02, OPA-05, OPA-08, OPA-13 and OPA-20.



-Medjoul : Primers OPE-15, OPA-02, OPA-03, OPA-05, OPA-08 and OPA-13.



COMPARISON BETWEEN DATE PALM FRUITS PRODUCED FROM TISSUE CULTURE AND OFFSHOOT PLANTS (HILALI CULTIVAR)

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ABSTRACT

An experiment was conducted to compare the fruit of Hilali cultivar grown from tissue culture and from the offshoots during 1994 and 1995 seasons. The physical characteristics such as average weight, volume, length and width of both the fruit and the seed, the colour of the fruit, its shape, location of the cap and its colour were measured. The chemical characteristics such as percentage TSS value and the moisture content percentage were measured too. The results showed that there were no significant differences in the chemical and physical characteristics of fruit grown from tissue culture or the off shoots.

INTRODUCTION

In the last three decades a big demand in several countries for good quality cultivars of date palm trees was increasing. This demand encouraged fruit tree propagation companies to use tissue culture technique to produce plants.

Many scientists studied the production using tissue culture technique in different methodology (1-9). The results were highly successful in this field. Therefore studies were initiated to investigate the identicality between plants produced by tissue culture and the mother trees.

The objective of this study is to investigate the similarity of the fruit characteristics of tissue culture plants & mother plants for Hilali cultivar.

MATERIALS AND METHODS

Four date palm plants (Hilali cultivar) produced by tissue culture, planted at Al-Hamrania Research Station in 1989.

The spacing between plants was 8m x 8m. The height was 15-30 cm and the number of the leaves was 2 or 3 per plant. At the same time date palm offshoots of Hilali cultivar were planted in the same field using similar spacing. Same agricultural practices were used for both types of plants. In 1994 trees started fruiting

Replicates of 50 fruits per bunch were used. The following measurements were taken:

1. Weight of the fruit & seed.
2. Volume of the fruit & seed.
3. Length & width of the fruit.
4. Ratio of the fruit length to its width.
5. Total soluble solids of the fruit. A refractometer was used.
6. Moisture content of the fruit. An oven at 105 c for 24 hours was used.
7. Morphology of the fruit, (fruit color, shape, perianth color, location, seed color, embrion location, cleft shape) and fruit test.

Experiment was complete randomize design at 4 replications.

RESULTS AND DISCUSSION

Table (1) contains fruit physical characteristics for tissue culture and offshoots plants. The weight and volume of the tissue culture were significantly higher. The average weights were 20.43 & 18.49 gm. While the volumes were 19.00 & 17.33 cc for tissue culture and offshoots respectively.

Fruit dimensions (length & width) of tissue culture trees were significantly higher. The main factor limiting fruit shape is the ratio between length and width Table (1) shows no difference in ratio of the fruit from both sources.

The moisture content was lower in tissue culture trees than that of offshoots.

There was no significant difference in total soluble solids percentage of fruit from the two sources.

Table (2) contains morphological characteristics of fruit of tissue culture and offshoots trees, the Table shows there are no difference in fruit color and shape, perianth fruit color and location, seed color, embrion location, seed cleft shape and fruit taste, for both sources of fruit. Therefore it is reasonable to conclude that fruit from tissue culture trees are true to fruit from offshoots trees for (Hilali cultivar).

Most of the fruit characteristics of both sources were identical. Based on these results it could recommended that tissue culture technique was viable to produce "Hilali" cultivar.

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Table (1)

Physical and chemical characteristics of "Hilali" cv. Date Palm fruit from tissue culture and offshoots at khalal (Bisir) stage

Date Palm sources	Fruit weight gm	Fruit volume cc	Seed weight gm	Seed volume cc	Ratio	Fruit length cm	Fruit width cm	Fruit Length/Width Ratio	Moisture %	T.S.S %
Offshoots	18.49	17.33	0.84	0.73	95.46	3.97	2.93	1.35	84.80	42.00
Tissue culture	20.43	19.00	0.82	0.73	95.99	4.07	3.02	1.35	70.84	40.00
L S D 5%	1.67	1.22	0.60	0.04	1.03	0.13	0.12	0.09	7.32	3.48

Table (2)

Morphological characteristics of Date Palm Fruits reproduced by tissue culture or offshoots tree (Hilali cultivar) at khalal stage.

Fruit source	Fruit Color	Fruit Shape	Perianth Color	Perianth Location	Seed Color	Embrion Location	Seed cleft shape	Fruit Taste
Tissue culture	Light yellow	Ovate	Yellow	Little deep	Brown and light at the base	Middle seed back	Narrow and shallow	Sweet and low fiber
Offshoots	Light yellow	Ovate	Yellow	Little deep	Brown and light at the base	Middle seed back	Narrow and shallow	Sweet and low fiber

MOLECULAR CHARACTERIZATION OF EGYPTIAN DATE PALM:

II. RAPD FINGERPRINTS

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ABSTRACT

RAPD fingerprints were performed on DNA extracted from the internal leaves of the offshoots of five date palm cultivars (Samanie, Seaweae, Hyeane, Amhat and Zaghlool). Two random primers (OPC2 and OPD16) out of ten were selected on the basis of the number and frequency of polymorphic bands produced. Distinguishable RAPD fingerprints among the different varieties were obtainable if suitable primers were used and PCR conditions were optimized. Genetic relationships of the different cultivars and the efficiency of RAPD as a simple molecular marker for cultivar identification are discussed.

Additional index words: ***Phoenix dactylifera* L.,** PCR, cultivar identification.

INTRODUCTION

Improvement of date palm is very difficult due to its long life cycle, strongly heterozygous nature and impossibility to determine sex at early stages of development (Moursy and Saker, 1996). Most of the published studies on genetic characterization, detection of genetic variations and gene mutation have concentrated on the variations in chromosome numbers, isozyme polymorphism and biochemical diversity. Unfortunately, palm chromosomes are numerous and small and mitotic examination of tissue culture-derived palm plants are unreliable (Corley *et al.*, 1976).

Numerous publications have demonstrated the utility of RAPD markers for the analysis of the genetic diversity among cultivars and within plant populations, for instance Skrotch *et al.* (1992), Bagheri *et al.* (1995) and Debener *et al.* (1996) in pea and rose.

This work was sponsored by ICGEB, Project no.CRP/EGY 96-01(11).

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Employment of isozyme polymorphisms as descriptive markers in date palm programs have been reported by many workers, among them, Al-Jibouri and Adham (1990). They noticed marked intercultivar but not intracultivar differences in a number of isozymes, Rf values and intensity of banding. Genetic diversity of date palm using isozyme polymorphisms as molecular markers was also reported by Torres and Al-Jibouri (1989). In this context, Booij *et al.*, (1995) distinguished nine cultivars out of 13 palm cultivars using isozyme polymorphisms. Various zygograms were obtained for five of the ten enzymes tested.

Also, biochemical classification of date palm male cultivars has been reported. Quafi *et al.*, (1988) reported that flavonoids from acid hydrolysates of palm leaves could be used in taxonomy and classification of palm cultivars. They found that the presence of individual flavonoids and their levels allowed cultivars to distinguished from each others.

Recently, RAPD (Random Amplified Polymorphic DNA) fingerprints developed by Williams *et al.*, (1990) showed several advantages over the more traditional methods mentioned previously, namely isozyme polymorphism and RFLP (restriction fragment length polymorphism). Isozymes is limited to a number of genes coding for soluble proteins, consequently they have limited power of discrimination among cultivars and strains (Castiglione *et al.*, 1994). Moreover, these methods are limited by environmental conditions. RFLP technology has been till now the most frequently used tool to evaluate DNA polymorphisms among cultivars. Its limitation is due to complex methodology and radioactive needs, in addition to micrograms of genomic DNA required to perform RFLP hybridization.

A glance at the potential applications of RAPD marker technology reveals its importance as a powerful tool in genetics and breeding which can play an important role in palm molecular biology. In this connection, Shah *et al.*, (1994) reported the utility of RAPD markers for the determination of genetic variations in oil palm. Electrophoresis of the amplification products indicated that nine out of 20 primers were able to generate polymorphic products. Great diversity was seen but no individual palm-specific band was observed. Results of Fernandez and Tantaoui (1994) showed that random amplification of polymorphic DNA (RAPD) of different *Fusarium oxysporium* isolates is a promising tool for evaluating genetic diversity within *F. oxysporium* populations associated with wilted date palm. Corniquel and Mercier (1994) also used RAPD as molecular markers for cultivar identification.

The aim of this study was to optimize experimental conditions for the generation of reproducible RAPD markers, which could be used in cultivar identification, and determination of taxonomic and genetic relationships of known and unknown Egyptian date palm cultivars.

MATERIAL AND METHODS

Plant material: Offshoots of five date palm cultivars, namely Zaghlool, Samanie, Hyeanee, Seaweae and Amhaat, grown in the region of Giza governorate, Egypt were used.

Isolation of genomic DNA: DNA isolation was performed using the CTAB method of Doyle and Doyle (1990). One gram fresh weight samples were ground to powder in liquid nitrogen with a prechilled pestle and mortar, suspended in 5 ml preheated CTAB buffer, and incubated at 65° C for 1 hour with occasional shaking. The suspension was then mixed with 1/3 volume of chloroform, mixed gently, centrifuged and the upper phase was transferred to a new sterilized tube. Extraction was repeated with an equal volume of chloroform. The aqueous layer was transferred to a new tube, 2/3 volume of isopropanol was added and DNA was either spooled using a Pasteur pipette or sedimented by centrifugation. The pellet was washed carefully twice with 70% ethanol, dried at room temperature and resuspended in 0.5 ml TE buffer. DNA was purified by incubation of the resuspended sample at 37° C for 30 min with RNAase (Boehringer Mannheim). DNA concentration was determined by electrophoresis of 5 µl of sample along with serial dilutions of Lambda DNA in 0.8 % agarose (Castiglione *et al.*, 1993).

PCR amplification: Amplification was performed in 10µl reaction mix containing 20 ng template DNA, 0.5 units Taq polymerase (Promega), 200 µM each of dATP, dCTP, dGTP, dTTP, 10 p moles random primer and appropriate amplification buffer. The mixture was assembled on ice, and overlaid with a drop of mineral oil. Amplification was performed for 45 cycles, using UNO thermal cycler of Biometra as follows: One cycle at 92° C for 3 min and then 45 cycles at 92° C for 30 sec, 35° C for 60 sec and 72° C for 2 min (for denaturation, annealing and extension, respectively). Reaction was finally incubated at 72° C for 10 min and a further 10 min at 62° C.

Electrophoresis: The amplification products were analyzed by electrophoresis in 2% agarose in TAE buffer, stained with 0.2 μg/ml ethidium bromide and photographed under UV light.

RESULTS AND DISCUSSION

The reproducibility of RAPD analysis is known to be highly influenced by experimental conditions. It is therefore essential to optimize the PCR conditions to obtain reproducible and interpretable results before going on to routine analysis. The PCR conditions for RAPD analysis were optimized by investigating each factor individually, including genomic DNA quality and concentrations, primer annealing and extension temperatures and denaturation time and temperature. The optimized conditions are detailed in Material and Methods. It was found that genomic DNA extracted as described here was found to be a good template for PCR amplification. The quality of isolated DNA was also a good substrate for endonuclease enzyme Hind III/ EcoR I (Fig. 1). No clear differences in amplification products were detected when template DNA from different DNA preparations was used. However, treatments of DNA with protease K gave sharp and clear amplification products, compared with untreated DNA. This may have resulted from the inactivation of endogenous endonucleases. Corniquel and Mercier (1994) and Castiglione *et al.* (1993) also reported similar observations. Annealing temperatures lower than 35^0 C led to the generation of very crowded RAPD patterns, while higher annealing temperatures gave insufficient amplification products. In this connection, Castiglione *et al.* (1993) reported that an annealing temperature of 30^0 C gave more polymorphic bands.

After optimization of the reaction conditions, polymorphisms among the different cultivars were detected using the different random primers. The RAPD analysis was performed on DNA extracted from the internal leaves of the offshoots of the five date palm cultivars. Ten random primers, namely (OPA1, OPA2, OPA9, OPC2, OPD16, OPD20, OPF10, OPF13, OPF16, and OPF20) showed sufficient amplification products (Table 1). Only two primers out of the tested random primers (OPC2 and OPD16) were selected on the basis of the number and frequency of polymorphic bands produced. With these two primers, 8 and 12 polymorphic bands were recorded with OPC2 and OPD16, respectively. The five date palm cultivars examined, can be arranged into two main groups, as suggested previously based on the results extracted from isozyme analysis (Fig.2-A& B). Table 2 summarizes the results of amplification of DNA extracted from different palm cultivars using the random primers OPC2 and OPD16.

To our knowledge, the results of the present study have produced the first informative DNA-based markers for Egyptian date palm cultivar identification. Also optimization of physical experimental conditions of PCR amplification are prerequisites for the performance of RAPD analysis by an automated procedure, this increases the reproducibility and efficiency of RAPD's as molecular markers. The five date palm cultivars analyzed were selected from commercial palm cultivars domesticated in Egypt. Although, ten random primers gave sufficient amplification products, only two informative RAPD patterns with sufficient polymorphism among the five date palm cultivars were obtained with OPC2 and OPD16. The five date palm cultivars examined, could be arranged into two main groups, as suggested previously based on the author's results extracted from isozyme analysis (unpublished data). It could be concluded that distinguishable RAPD fingerprints among the different varieties were obtainable if suitable primers were used and PCR conditions were optimized.

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Table 1. Random primers gave sufficient RAPD amplification products with the different date palm cultivars.

Primer	Sequence 5\ →3\	Total number of bands	Number of polymorphic bands
OPA1	CAGGCCCTTC	8	--
OPA2	TGCCGAGCTG	7	1
OPA9	GGGTAACGCC	4	--
OPC2	GTGAGGCGTC	8	5
OPD16	AGGGCGTAAG	14	12
OPD20	ACCCGGTCAC	10	3
OPF10	GGAAGCTTGG	9	--
OPF13	GGCTGCAGAA	8	2
OPF16	GGAGTACTGG	8	--
OPF20	GGTCTAGAGG	6	1

Table 2. The two random primers that produced polymorphic bands useful for identifying different date palm cultivars.

Primer	Sequence 5\ →3\	Total number of bands	Number of polymorphic bands	Size of bands (bp)	Amhat	Samanie	Hyeane	Seaweae	Zaghlool
OPC2	GTGAGGCGTC	8	5	850	--	--	+	+	+
				800	+	+	--	--	--
				750	--	--	+	+	+
				650	+	+	--	--	--
				600	--	--	+	+	+
				550	--	--	+	+	+
OPD16	AGGGCGTAAG	14	12	2050	--	--	+	+	+
				1550	--	--	+	+	+
				1500	--	--	+	+	+
				1450	+	+	--	--	--
				1400	+	+	--	--	--
				1000	--	--	+	+	+
				900	--	--	+	+	+
				800	--	--	+	+	+
				750	--	--	+	+	+
				600	+	+	--	--	--
				550	--	--	+	+	+
				500	+	+	--	--	--

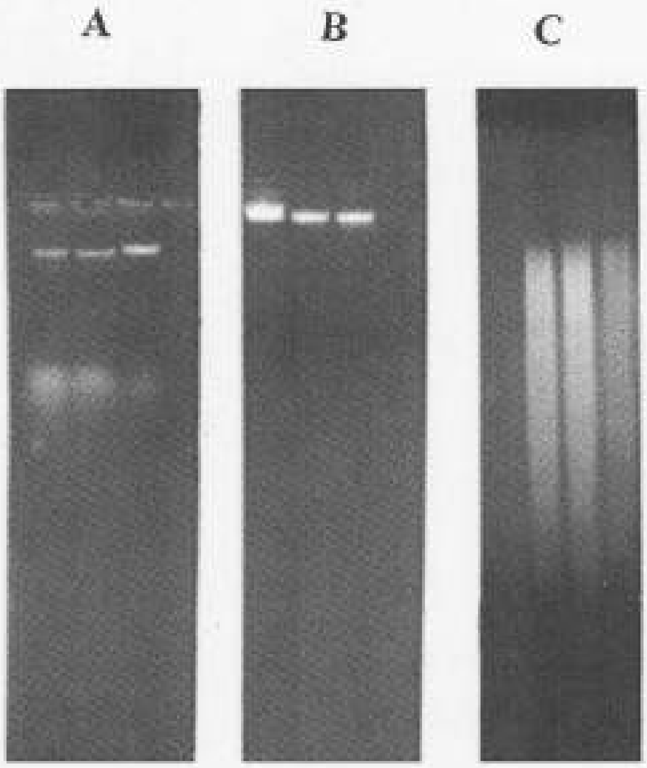

Fig. (1): DNA isolated from different date palm cultivars, from left to right, Amhat, Hyeane and Zaghlool (A). DNA after purification from RNA (B) and Hind III/ EcoR I digested DNA (C).

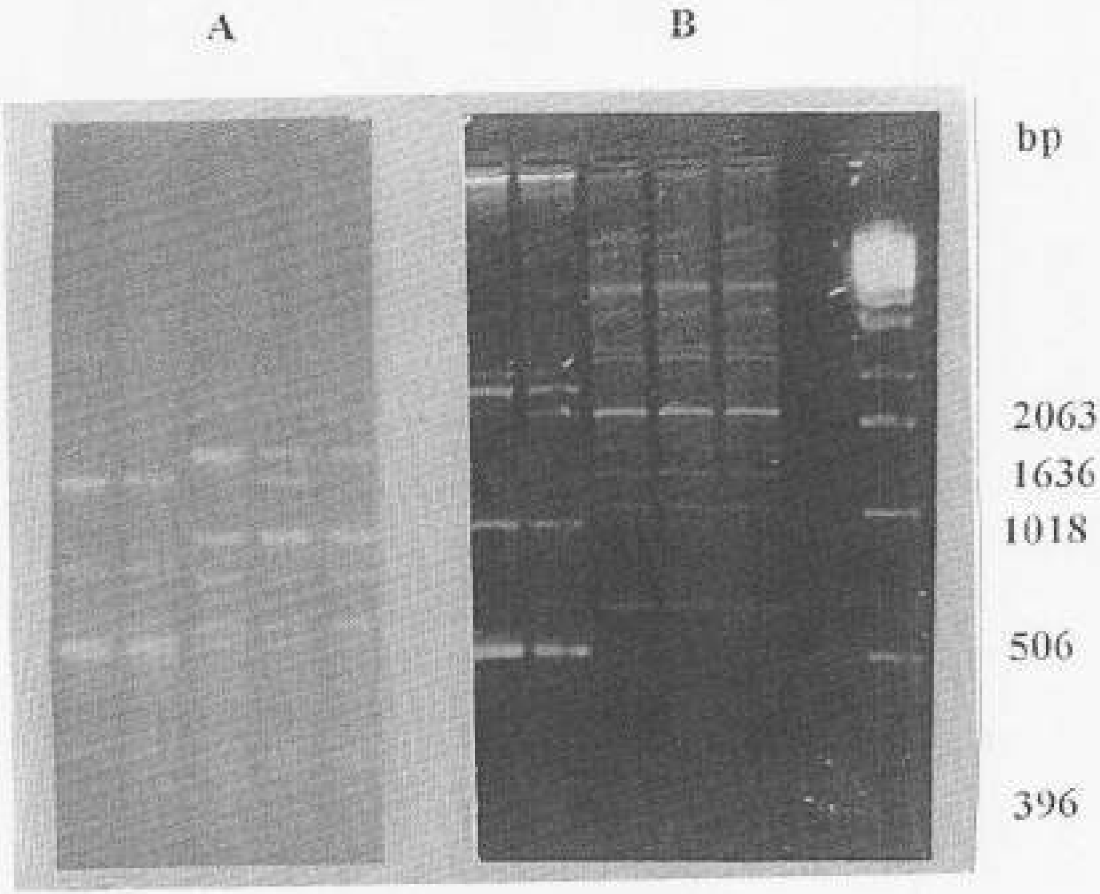

Fig. (2): Gel electrophoresis of RAPD fingerprints of Amhat (lane 1), Samanie (lane 2), Hyeane (lane 3), Seaweae (lane 4) and Zaghlool (lane 5), obtained with the primers OPC2 (A) and OPD16 (B). Marker is shown at the right of figure in bp.

MOLECULAR CHARACTERIZATION OF TUNISIAN DATE PALM VARIETIES

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ABSTRACT

The vascular fusariosis (bayoud disease) is currently destroying the North African date palm plantations. Until now, Tunisian groves appear to have been spared. However, they are continuously menaced by this disease due to its rapid propagation into the East. Thus many strategies have been developed aiming at the molecular characterization of Tunisian date palm varieties and the elaboration of a preventive procedure for their protection by the help of RAPD and mitochondrial plasmid-like DNAs markers.

As a first step, we have used a large number of universal primers to amplify bzagments of each DNA. Some of them are retained as potential markers for identifying Tunisian date palm varieties and ecotypes.

In a second step, we have amplified mitochondrial plasmid-like DNAs employing to PCR procedure using appropriate oligonucleotides. It is now established that this technique could be currently used as an efficient method of screening bayoud-resistant varieties due to the great correlation between these molecules and the date-palm trees comportment within fusariosis.

Additional Index Words: *Phoenix dactylifera*, bayoud disease, PCR and RAPD

INTRODUCTION

For several decades, most North African date palm (*Phoenix dactylifera*) plantations are seriously threatened by a vascular fusariosis (bayoud disease) due to the fungus: *Fusarium oxysporum albedinis*. In Morocco as in west Algeria, several varieties are resistant to bayoud disease. However, they have a poor date quality (Saaidi, 1992; Sedra, 1992). Thus, works aiming at the screening of bayoud-resistant varieties with a good date quality is currently in progress aiming at the protection of date palm groves in these countries. Until now, Tunisian plantations appear to have been spared. However, they are continuously menaced by this fusariosis due to its rapid spread into the East. In order to elaborate a preventive fighting strategy for Tunisian date palm varieties, many strategies have been developed aiming at their molecular characterization.

A large number of reports have described molecular biology methods for the detection of plant DNA polymorphism: Restriction Fragment Length Polymorphism, (RFLP) Polymerase Chain Reaction (PCR), Random Amplified Polymorphic DNA (RAPD), Amplification Fragment Length Polymorphism (AFLP), Multiple Arbitrary Amplicon Polymorphism (MAAP) (Caetano-Anolles, 1994; Devos and Gale, 1992; D'ovido et al., 1990; Kiss et al., 1993; Miller and Tanksley, 1990; Thormann and Osborn, 1992; Tinker et al., 1993; Welch et al., 1991; Williams et al., 1992). So far, the most used techniques seems to be PCR and RAPD (Chong et al., 1994; Lowe et al., 1996; Saiki et al., 1985; Weining and Langridge, 1991; Williams et al., 1991). These procedures, due to their great sensitivity, constitute a powerful technique widely used for enzymatic amplification of stretches from small amounts of DNA and provide an alternative approach to distinguish genotypic variants. Therefore, the molecular characterization of Tunisian date palm varieties was investigated with the help of these procedures. As a short-term objective, it has been assumed that these procedures allow us to know how this molecular polymorphism is associated to bayoud-resistance. And, as a long-term objective, to know how such strategy could provide a useful early molecular marker related with bayoud-resistance. Benslimane et al. (1994) and Benslimane (1995) reported the presence of plasmid-like DNAs in date palm mitochondria and molecularly characterized these minicircular molecules called S (1 454 bp) and R (1 346 bp) plasmid-like DNAs. Both forms were detected in bayoud-sensitive and bayoud-resistant trees, respectively. Sequence examination between R and S demonstrates that S shares a very strong homology with R except for a deletion of 109 bp (from 1 145 to 1 253). Thus, it has been suggested that these two plasmids seem to be correlated with the phenotype of date palms. Up to now, correlation between this minicircular polymorphism and bayoud-resistance or sensitivity has not been clearly established.

Within this scope, we have decided to extend a similar study on Tunisian date palm varieties and to establish the possible correlation between these molecular markers and bayoud-resistance.

Here, we report the use of RAPD and PCR procedure as powerful techniques aiming at the molecular characterization of Tunisian date palm varieties and the screening of S and R plasmids from a set of Tunisian set of female and male date palms.

MATERIALS AND METHODS

Plant material:

We have used a set of date palm varieties characterized by their good fruit quality. The material (young leaves) was kindly provided by the «Centre de Recherches Phoénicicoles, INRA, Degache», south of Tunisia. The commercial nomenclature of the varieties included in this study has been conducted according to Rhouma (1994).

DNA preparation:

Nucleic acids were prepared from frozen leaves of adult trees. Total cellular DNA was extracted according to Aitchitt et al. (1993) with several modifications. After purification, the DNA was quantified using Gene-Quant spectrophotometer (Pharmacia) and its quality was determined by agarose minigel electrophoresis as described by Maniatis et al. (1982).

RAPD analysis:

For RAPD analysis, a large number of universal primers (decamers) purchased from Operon Technologies Inc. (California, USA) were used. These were OPA, OPB, OPD, OPF, OPG, OPI, OPK, OPM and OPN. The G+C content of all primers is about 60%.

A 25 µl reaction mixture is used containing: 20 ng total cellular DNA, 50 pM (1µl) primer, 0.25 µl of 10X Taq DNA polymerase reaction buffer, 1.5 U (0.3 µl) Taq DNA polymerase (Appligène-Oncor, France), 200 mM each dNTP (DNA polymerization mix, Pharmacia). The reaction mixture was covered with 25 µl of sterile mineral oil to avoid evaporation. Amplification was then performed in a thermal cycler (bio-med GmbH, thermocycler 60) using the following conditions: samples were first heated at 94°C for 5 minutes before entering 35 cycles PCR procedure of 94°C for 30 seconds, 35°C for 1 minute and 72°C for 1 minute. A final delay phase of 72°C for 5 minutes was always included.

To reduce the possibility of cross contamination and variation in the amplification reactions, master-mixes of the reaction constituents were always used. Standardisation between enzyme batches and experiments was ensured by including a standard control: a first control consists of reaction mixture excluding any DNA whilst a second control was reaction mixture including DNA without any enzyme or primer.

Amplified fragments were electrophoresed in 1.4 % TBE agarose gels and detected by ethidium bromide (1 µg/ l) staining, according to Sambrook et al.,(1989).

PCR analysis:

For PCR analysis, two appropriate primers were used. These enclose plasmid S sequence flanking the 109 bp deletion.

A 100 µl PCR reaction mixture is used containinx: 20 ng (1 µl) of total cellular DNA, 50 pM (2 µl) of each primer, 10 µl of 10 Taq DNA polymerase reaction buffer, 1.5 U (0.3 µl) of Taq DNA polymerase (Appligène-Oncor, France), 200 mM of each dNTP (DNA polymerization mix, Pharmacia). The reaction mixture was covered with 100 µl of sterile mineral oil to avoid evaporation. PCR was then performed in thermal cycler (bio-med GmbH, thermocycler 60) using the following conditions: samples were first heated at 94°C for 5 minutes before entering 35 cycles PCR procedure of 94°C for 30 seconds, 48°C for 1 minute and 72°C for 2 minutes. A final delay phase of 72°C for 10 minutes was always included.

In each set of amplification a number of controls were also included. One was a reaction mixture excluding any DNA whilst a second control was reaction mixture including DNA without any enzyme. Standardisation between enzyme batches and experiments was ensured by including in each a standard PCR amplification of R and/or S DNA.

PCR products were resolved by electrophoresis in 1.5 % TBE agarose gels and stained with ethidium bromide (1 µg/ l) according to Sambrook et al.,(1989).

RESULTS AND DISCUSSION

RAPD patterns analysis:

In this study, we have screened about 200 universal primers. These could be regrouped in three different classes: the first constitutes the primers unable to generate any stretches from total cellular DNA extracted from any date palm variety; the second is composed of primers generating amplified products from DNAs from several varieties only, and the third correspond to those able to amplify subfragments using

DNAs isolated from any variety. Our data indicated that several DNA segments were amplified in each sample and polymorphisms were apparent for a set of primers. These, based either on the number or the size of the amplified DNA products, allow potential genetic markers permitting to distinguish a given variety from the others. Computer assisted analysis of RAPD profiles with the help of appropriate software will reveal on the average linkage clusters of all varieties and ecotypes. At present, work is in progress to resolve this problem.

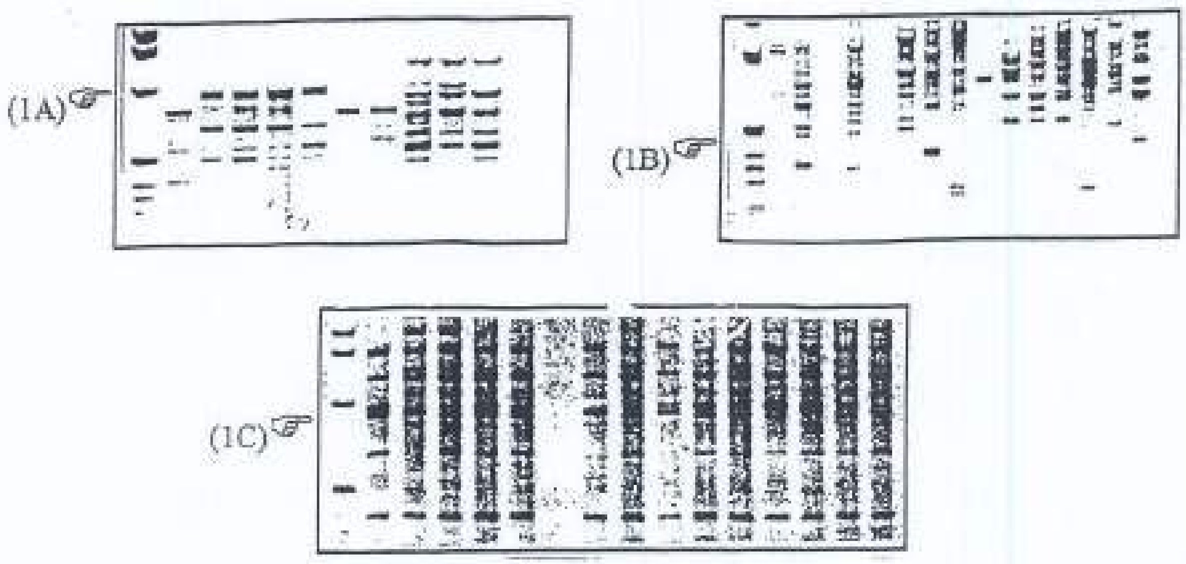

Figure 1: Example of DNA fragments randomly amplified using universal primers and resolved by electrophoresis in 1.4% agarose. M: 1 Kb ladder (BRL) Mpl. weight standard controls included: reaction mixture without any DNA (C1) and reaction mixture without any enzyme (C2). Panels show the amplified products using OPD18 (1 A), OPD20 (1B) and OPA01 (1C).

PCR analysis and evidence of the presence of R and S plasmid-like in Tunisian date palm varieties:

We first attempted to determine whether it was possible to develop a PCR analysis using plasmid-like DNAs isolated according to a minipreparation of alkaline described by Maniatis et al. (1982). Thus experiments were performed using for each R and/or S DNA varying annealing temperature (from 38 to 52°C). It has been established that the optimal amplification was obtained when using 48°C as annealing temperature in our conditions.

As a rapid screening procedure for detection of amplified subfragments corresponding to S or R DNAs in target DNA, total cellular DNAs was isolated from several Tunisian date palm varieties characteriezed by their good date quality. Obtained results have been summarized in table 1. The analysis of which indicates that:

* The presence of different amplified products in all varieties suggesting that these plasmid-like DNAs are present in mitochondria of date palm (*Phoenix dactylifera*).

* 7 female varieties considered as bayoud-sensitive (Saaidi, 1992; Sedra, 1992), present S subfragment in the resultant PCR patterns. These are: Boufagous, Kenta, Kentichi, Ftimi, Khouat-Ftimi, Ghondi and Besser-Hlou.

* Deglet Nour, Zehdi, Ghars-Metig and Hlaoui, sharing R subfragments, constitute bayoud-resistant varieties if noting the availability of correlation hypothesis. However, for the Deglet Nour variety, possessing R subfragment, our data seem to be discordant in spite of its sensitive character. So far, Deglet Nour has been considered as an intermediate variety among those which are completely bayoud-sensitive and completely bayoud-resistant varietiess (Saaidi, 1992).

* Surprisingly, as Horra's PCR pattern, several varieties show simultaneously both of subfragments R and S in the PCR amplifiat.

Table 1: Phenotype and plasmid patterns of the tunisian date palm varieties included in the study. The sign of + indicate the greatness of the relative amount.

Commercial name	Phenotype	Plasmid	Relative amounts
Boufagous	Sensitive	S	
Ftimi	Sensitive	S	
Khouat-Ftimi	Sensitive	S	
Kenta	Sensitive	S	
Kentichi	Sensitive	S	
Ghondi	Sensitive	S	
Besser-Hlou	Sensitive	S	
Deglet-Bey	?	S	
Deglet-Nour	Sensitive	R	
Zehdi	?	R	
Ghars-Metig	?	R	
Hlaoui	?	R	
Hourra	Sensitive	S / R	S:++; R:++
Arichti	?	S / R	S:+++; R:+
Rhimia	?	S / R	S:++; R:+++
Tronja	?	S / R	S:+++; R:+

The following explanations were considered for these results:

(i) Both R and S plasmids could be present in an mitochondria with greatly varying relative amounts. This fact is strongly supported: first, S and R DNAs seem to have a common DNA ancestor suggested by their extended sequence homology (Benslimane, 1995); second, they may derived from each other through direct repeated sequences recombination as established by Benslimane et al. (1996), and third, they may be maintained within a given variety in a variable arrangement.

(ii) For the varieties sharing only S Plasmid DNA, inhibition of recombination events due to nuclear genes control could maintain this shape in mitochondria. However, through direct repeated sequence, possible recombination events allow for an R minicircle and a stretch of 109 Bp. This fragment, without a replication origin, will be lost. Thus, PCR analysis shares only subfragments corresponding to R plasmid. Search of subfragment corresponding to the deletion of 109 bp could provide evidence of this argumentation.

(iii) The evolution of bayoud-sensitive phenotype to resistance could be accompanied by conversion of plasmid-like S to R minicircle. Thus to reach a fixed equilibrium a great number of intermediate situations could have occurred. Our data effectively reflect several forms regarding the different amounts of amplified subfragments S and R from a given target DNA (Figure 2).

(iiii) Regarding the variable amounts of the generated subfragments, it seems to be ensured the hypothesis of existence of common features between the mitochondrial plasmid-like molecules and the main mitochondrial genome in higher plants (for example, structural forms and recombination) Arganoza and Akins, 1995; Debets et al.; 1995 Flamand et al., 1993).

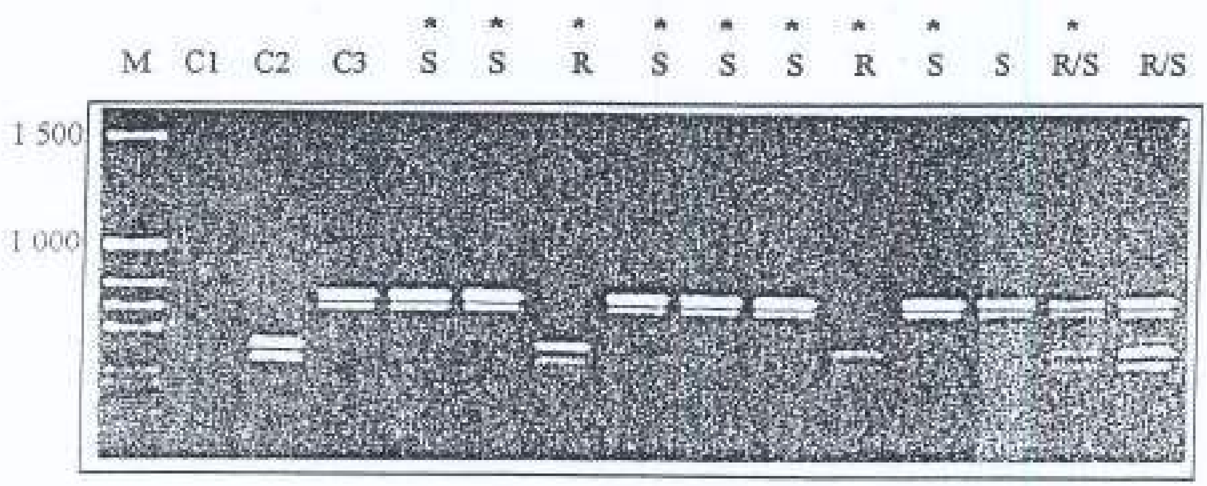

Figure 2: Example of resultant PCR plasmid patterns from total cellular DNA templates extracted from good date quality varieties. M: 1 Kb ladder (BRL) standard size; controls included: reaction mixture without any DNA (C1) and standard PCR amplification of R (C2) and S (C3); R labelling varieties possessing subfragment of R alone; S those with subfragment of S alone, S/R varieties with R and S subfragments simultaneously. Fragment sizes are in bp; lanes labelled with n* indicate varieties tested with the fungus.

CONCLUSION

In this work, we have described the importance of RAPD and PCR procedure as current methods aiming at the molecular characterization of a set of Tunisian date palm varieties. As a first step, a large number of universal random primers were screened. It has been established that some of them could be retained as potential markers for date palm varieties identification. The use of a large number of primers and other varieties allows an efficient tool for genetic polymorphism analysis in these varieties and ecotypes.

As a second step, for PCR analysis using appropriate oligonucleotides, we can routinely generate subfragments corresponding to R and S DNAs. The resultant PCR products shows three different plasmidic patterns. Several possible explanations based on recombination were considered for this polymorphism. Work is currently in progress either to provide evidence of this argumentation or to elucidate the interest of identifying plasmid-like in date palm mitochondria in relation with bayoud-disease.

ACKNOWLEDGEMENTS

Support for this research was provided in Tunisia by grants from the « Ministère de l'Enseignement Supérieur », the « Secrétariat d'Etat à la Recherche Scientifique et à la Technologie » and in France by the CNRS (Institut de Biotechnologie des Plantes, Université Paris-Sud) and the « Institut Français de Coopération »

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Towards The Construction of a Genetic Map Of Date Palms Using the Amplified Fragment Length Polymorphism Technique (AFLP).

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ABSTRACT

A genetic map would enhance the strategies for breeding and selection of new date palm cultivars of better quality and wider adaptability, and facilitate varietal fingerprinting. It would also help in solving genetically controlled problems. Also, male palms positively affecting fruit quality could be selected. For this purpose, two F_1 and four back cross populations were developed. DNA from one of them was used for the AFLP analysis. As a first stage, 35 primer combinations were used on the parental clones. Fruits weight, TSS and seed weight and volume were determined to be compared later with those from the seedlings. Morphological traits of these seedlings were recorded to localize such traits on the genetic map. ***In vitro*** development of excised embryos and their regeneration ability are under investigation. In addition, regeneration competence will, also, be mapped. The genotypes with high regeneration ability will be screened for transformation efficiency.

Additional Index Words: Molecular analysis, *Phoenix dactylifera* L., Regeneration.

INTRODUCTION

The date palm is facing the challenges of the global warming, increase of the CO_2 in the atmosphere, the insect and disease populations; salinity and socio-economic changes. These necessitate the development of new varieties through breeding programs to save the date palm culture.

As tissue culture of date palm is being commercialized, the regeneration competence of a cultivar is an extra advantage. Competence for regeneration and genetic transformation are genetically controlled and can be localised and transferred to other genotypes (Koornneef et al., 1993; El-Kharbotly et al., 1995).

Propagation of the date palm is usually carried out using offshoots. Most of the good cultivars produce few offshoots. This situation encouraged the establishment of commercial tissue culture laboratories to satisfy the demand. Tissue culture techniques have the following disadvantages:

a. Callus obtained from clonal tissue is highly heterogeneous (Reynolds and Murashige, 1979; Tisserat and Demason, 1980) and it is highly susceptible to mutation development during somatic emberyogenesis (Tisserat and Torress, 1979; Torres and Tisserat, 1980). Somaclonal variations can not be discovered before the reproduction stage. This problem would be avoided if an accurate identification method were utilized at an early stage of propagation.

b. The mass production of these few good cultivars is expected, eventually, to replace old and low quality palms as well as establishing new orchards. This will put forward the problem of reducing the heterogeneity in the date palm genetic pool in the regions where these cultivars dominate. As a result of this type of monoculture any unfavorable condition(s) can destroy a large area which may cause an economical disaster. Unfavorable conditions could be a change in the environmental conditions or the introduction of new insects or diseases. Many such examples are known in the history of agriculture.

Using many cultivars, which are selected through breeding programs is the way to maintain diversity and high quality of the desired character for the industry of fresh date production. Also, it is important to select proper male palms because the pollen type influences fruit quality, time of ripening and production as the result of compatibility and metaxenia effects.

In view of the above, accurate identification procedures are needed for the classification and registration of date palm cultivars. Selection of new cultivars is a long and costly process. Selection at an early seedling stage is an ideal solution to eliminate male or low quality female palms. Molecular techniques would provide a promising approach to solve these problems.

The Clonal Fingerprinting technique can successfully be used in the identification of true-to-type clones developed through indirect somatic embryogenesis.

Molecular techniques are extensively used in constructing genetic maps, marker-based selection, cloning useful genes and fingerprinting in several crops like tomato and potato as well as in weed-like Arabidopsis. In palms, molecular breeding is still in its infancy. It would be possible to screen for a desirable cultivar at the seedling stage by using marker-based selection strategy. The same method can be used to distinguish between male and female palms before flowering. The prerequisite for marker-based selection is the identification of a marker tightly linked to a trait of agronomic interest. The most general approach to achieve this objective is the initial construction of a complete linkage map (Gebhardt and Salamini, 1992). The cosegregation of the molecular marker and a trait of interest, in a progeny segregating for this trait, is an indication of linkage between them. This marker could then be used for selection instead of the morphological characters. Molecular analysis can predict the superior heterotic combination within a set of genotypes (Smith *et al.*, 1990). This is helpful in shortening the breeding program especially in date palms, which requires many years before flowering. Cultivar identification and the true-to-type plantlets produced by tissue culture can be done using the Clonal Fingerprinting technique.

The Amplified Fragment Length Polymorphism (AFLP) is a powerful technique, which has been developed recently for molecular analysis (Vos *et al.*, 1995). The AFLP technology is a DNA fingerprinting technique, which is based on selective amplification of a subset of genomic restriction fragment using Polymerase Chain Reaction (PCR). This technique visualises DNA polymorphism among individuals. The technique gave promising results in plants, animals and human genome analysis (Prabhu and Gresshoff, 1994; Chung *et al.*, 1994; Lienert et al., 1993). This technique could be used in all of the above mentioned applications.

MATERIALS AND METHODS

In this paper an AFLP genetic map for date palm has been initiated. Five cultivars were used to establish F1 populations. These populations will be used in localising the agronomic traits on a genetic map. Four of these cultivars give high quality fruits with economical value. Um-Assla (the fifth cultivar) has low quality fruits but it is tolerant to salinity and high humidity.

Plant materials:

Male palms coded BN-96, DM-96, FR-96, KL-96 and KN-96 were used as pollen source to establish date palm populations. They were the F1 offspring of the cultivars Bunarenga, Damous, Fardh, Khalas and

Khenizi, respectively. The pollen and offshoots from these males were kindly supplied by the Rumais Agriculture Research Station, Rumais, Sultanate of Oman. The cultivars Bunarenga, Fardh, Khalas and Khenizi were crossed with their respective F1 males to establish back cross populations (coded BN-BN-96, FR-FR-96, KL-KL-96 and KN-KN-96). Cultivars Khalas and Um-Assla were crossed with DM-96 and KH-96, respectively to establish F1 populations (KL-DM-96 and UM-KL-96, respectively). Pollination was carried out under controlled conditions to avoid contamination with other pollen sources. After disinfecting the closed inflorescence (male or female) with 70% ethanol a small cut was made from which five male strings were inserted. The female inflorescence was then covered with a paper bag and shaken for three successive days to free and disseminate the pollens. The paper bags were removed three weeks after pollination.

Establishment of the populations:

Fruits at Rutab stage were harvested and the seeds were collected. Four harvests were carried out at two weeks intervals. Seed volume and weight; flesh weight, TSS and ash weight were recorded. Randomly selected two-hundred seeds per population (50 per harvest) were sown, after soaking in running water for three weeks, in pots (No. 3) filled with peat moss. For the shortage of seeds of KL-DM-96 population, only 80 seeds were sown (20 per harvest). Six months after sowing the seedlings were transplanted to the full ground (sandy loamy soil). Survival of the seedlings was recorded after one year. Observations on seedling abnormalities were also recorded.

Germination and growth responses in *in vitro*:

Seeds from KL-KL-96 and KL-DM-96 populations were scarified with 96% H_2SO_4, and soaked in distilled water for a week. They were then longitudinally halved and sterilized for 30 minutes in 20% Clorox and few drops of Tween-Twenty. Germination and growth were evaluated on an MS modified medium supplemented with 170 mg/L sodium orthophosphate, 30 g/L Sucrose, 2 mg/L activated charcoal, 8 g/L agar, 100 mg/L myoinositol and 0.4 mg/L thiamins HCl. Tested growth regulators include 1 mg/L 2 IP, 2 mg/L GA_3 either separately or combined with 2 IP. The tests were carried out using four replicates in a complete random design.

DNA isolation and AFLP procedure:

Total genomic DNA from mature leaves of the parental clones (Um-Assla and KL-96) was extracted as described by Al-Shayji *et al.* (1994). DNA of UM-KL-96 population was isolated from the second leave of the eight months old seedlings. The AFLP procedure was carried out according to Vos *et al.* (1995) using the AFLP Kit (GCBOBRL, UK). The PCR reactions, electrophoresis procedure, gel drying and the exposure to X-ray film was done according to the manufacturer's instructions. A salt gradient in the electrophoresis buffer was established to slow down the migration of the smallest fragment as described by Li *et al.* (1998). Selective reactions were carried out with primers extended with three nucleotides (see Table 6). Eight-labeled (^{32}P) Eco-primers (E+3) were used in different combinations with Mse-primers (M+3) for the selective amplification. Thirty-five combinations .were used on the parental clones. Further, the segregation pattern of the bands in the progeny was tested using one combination on ten genotypes and parental clones.

RESULTS AND DISCUSSION

The agronomic traits:

The data of early and late ripening as well as the fruit quality were kept in a data base file. They will be compared when the seedlings reach maturity and the genetic correlation will be determined. The germination of seeds ranged from 95-99 %. Almost 50% of the seeds germinated within three weeks after sowing, except for the BN-BN-96 population (only 10 % germinated). Damping off after emergence took place in 50 % of the seedlings. The survival in the field after one year ranged from 53-97% (Table 1). The date palm is expected to be heterozygous in many of its traits because of its dioecious nature. The low survival rate of the BN-BN-96, FR-FR-96 and KL-DM-96 most probably because of the inbreeding depression or the low adaptability to the environment of the Batinah region. Selection can be done from the population produced in this study for environmental adaptability as well as for the resistance to different pests.

Table 1. Number of transplanted seedlings and their survival in the field after one year.

Population	Number of seedlings		Percentage of survival
	Transplanted	Survived after one year	
BN-BN-96	171	130	76
FR-FR-96	152	81	53
KL-KL-96	111	103	93
KL-DM-96	46	25	54
KN-KN-96	103	94	91
UM-KL-96	159	154	97

The first leaf of most seedlings from all populations grew erect, but few were slanting. Data taken from three-week old seedlings showed that the populations were segregating with 1:0, 1:1 or 3:1 ratios for erect and slanting, respectively (Table 2). The erect and slanting leaf was controlled with a simple genetic factor following Mendelian inheritance. Erect leaf appeared to be the dominant character over the slanting (recessive). The lack of slanting in FR-FR-96 indicated that at least one of the parents is homozygous in this trait. One of the parents of the BN-BN96 population is heterozygous for erect leaf, while the other parent contains the recessive factor. In the other population the parental clones might be heterozygous. Since information on germination leaf of these parents is not known, further crosses need to be conducted once these seedlings reach flowering stage in order to confirm this hypothesis. The population also varied in producing the second leaf, from 10% in KN-KN-96 to 59% in FR-FR-96 with an average of 33% but no clear segregation ratios were observed

Table 2. Segregation of different populations for the direction of growing of the first leaf of three-week old seedlings and the P value of X^2 test.

Population	Number of germinated seedlings after 3 weeks	Number of seedlings with		X^2		P
		Erected leaf	Slanting leaf	1:1	3:1	
BN-BN-96	20	11	9	0.2		> 0.70
FR-FR-96	105	105	0	no segregation		----
KL-KL-96	99	73	26		0.084	> 0.80
KL-DM-96	30	23	7		0.044	> 0.85
KN-KN-96	109	78	31		0.69	> 0.45
UM-KL-96	163	118	45		0.59	> 0.45

A remarkable phenomenon was observed in one of the KN-KN-96 seedlings. Out of 200, one seed produced two seedlings attached together in the hypocotyle region. Each had its own root and shoot. The seedling survived in the field. AFLP fingerprinting analysis will be carried out to test whether the two seedlings are identical twins or not.

***In vitro* development:**

The germination test of (KL- KL-96) and (KL-DM-96) showed a significant effect of the genotype. In the former population a larger number of seeds germinated than in the latter (P=0.16). No significant differences were found between the germination percentage of seeds from different harvests.

The effect of growth regulators and harvest dates on the growth rate of the KL-KL-96 population is shown in Table 3. The application of GA_3 alone, in the first harvest date, resulted in the slower growth rate than the other three treatments. The effect of GA_3 and 2 iP disappeared in the seeds of the second and third harvest dates. However, in the seeds of the fourth harvest date, GA_3 and 2 iP significantly increased the growth rate when applied separately or in combination. These results suggest that application of GA_3 alone to the first harvested seeds suppressed the action of the endogenous gibberellins. However, in case of the fourth harvest, it seems that the concentration of endogenous gibberellins, was much reduced to allow the action of the applied GA_3. Furthermore, GA_3 was more active in the meristematic tissue and it decreased with age.

The data in Table 3 also indicate that the growth rate was increased up till the third harvest date when it reached its highest level; then dropped on the fourth harvest date. Such pattern suggests that maturity is regulated by genetic factors which might influence germination

Table 3: Effect of growth regulators and harvest dates on the growth rate of KL- KL-96.

Harvests	No growth regulator	1 mg/L 2 IP	1 mg/L 2 IP + 2 mg/L GA_3	2 mg/L GA_3	Means
First harvest	44.2 B*	40.0 B	51.0 B	11.1 A	36.57 a
Second harvest	45.0 B	43.9 B	43.6 B	57.1 B	47.40 a
Third harvest	66.1 B	80.6 B	85.6 B	88.5 B	80.20 b
Fourth harvest	31.3 A	61.3 B	56.5 B	69.1 B	54.55 a
Means	46.65	56.45	59.175	56.45	

* Means indicated by the same capital letter in the same row and by the small letter in the column are not significantly different.

LSD at 0.05 level = 22.55

The trend of the percentage increase in embryo axis showed that population KL-KL-96 always induced less growth rate (vigor) than KL-DM-96 (Table 4). This is true in case of growth regulator treatments as well as with the harvest dates. These results reflect the effect of inbreeding depression in case of KL-KL-96. Furthermore, it can be seen that the effect of growth regulators and harvest dates on growth rate showed the same pattern in both populations.

Table 4: Effect of growth regulators and the harvest date on growth of F_1 offsprings of Khalas.

Percentage increase in length of embryo axis					
Effect of growth regulators			Effect of harvest date		
Growth regulators	KL-KL-96	KL-DM-96	Harvests	KL-KL-96	KL-DM-96
None	46.6	60.8	First harvest	36.6	48.2
1 mg/L Zip	56.4	82.6	Second harvest	47.4	66.0
1 mg/L Zip + 2 mg/L GA_3	59.1	100	Third harvest	80.2	153.2
2 mg/L GA_3	56.4	95.7	Fourth harvest	54.4	71.7

AFLP analysis:

The AFLP finger printing for both parental clones was obtained with 32 primer combinations. Three primer combinations (E-AAC, M-CAG ; E-AAG, M-CAT; and E-ACG, M-CAA) showed few bands in the male parents while the few bands were observed in the female parent using the combination E-ACG, M-CAA. The total number of bands was 1647 with an average of 25.7 band per lane from which 302 bands showed polymorphism with an average of 9.4 band per primer combination. The polymorphism between the two parents ranged FROM 4 to 55 % depending on the primer combination (Table 5). The total number of bands and the polymorphic bands were found to be genotype and primer combination dependent (Pakniyat *et al.*, 1997). The reason for generating only a few bands in the three primer combinations is not clear. For that reason it is not recommended to use these primer combinations in the segregation analysis.

TAble 5. Different primer combinations and the percentage of the polymorphism between Um-Assla and KL-96.

	M-CAA	M-CAC	M-CAG	M-CAT	M-CTA	M-CTC
E- AAC	N.T*	48%	Few bands	13%	55%	N.T.
E –AAG	N.T.	30%	4%	12%	Few bands	26%
E- ACA	N.T.	26%	16%	18%	N.T.	N.T.
E –ACC	27%	11%	N.T.	8%	16%	14%
E- ACG	Few bands	20%	19%	12%	10%	N.T.
E –ACT	12%	11%	29%	14%	32%	12%
E- AGC	N.T.	20%	14%	8%	13%	N.T.
E –AGG	N.T.	33%	17%	15%	N.T.	N.T.

* N.T. = not tested.

The primer's pair E-AAC, M-CAC was used to study the segregation pattern in ten progeny plants. Fifteen bands out of 31 were polymorphic. These bands segregate as shown in Table 6.

Table 6. The segregation pattern of the AFLP generating bands in ten F_1 offspring and their parents.

Case	Parent 1	Parent 2	Progeny
1	+	+	present in all plants
2	+	--	present in all plants
3	+	--	present in some plants and absent in others
4	+	+	present in some plants and absent in others

+ Band is present

-- Band is absent

CONCLUSION

This study showed the possibility of using the AFLP technique to study the date palm genome. The map can be constructed based on the pattern of the segregation of AFLP generated bands. The bands in 1 and 2 (Table 6) can not be localized because no segregation was observed. In this case, either one or both parents are most probably homozygous in these bands. The bands showed segregation in 3 and 4 because they are heterozygous bands. The expected ratio of segregation is 1:1 or 3:1 in these two cases, respectively. In case 3, the band can be mapped to the first parent, while in case 4 it can be mapped to both parents. This last case can be used to construct a joint map. Linkage groups can be constructed based on the co-segregation of different bands. These will be used to localize the agronomic traits of interest. The AFLP technique was successfully used in localization of resistance genes in economical crops like potato (Li *et al.*, 1998) as well as measuring the variation in wild barley germplasm (Pakniyat *et al*, 1997).

Cloning of DNA fragments generated by the AFLP technique can be achieved (Cho *et al.*, 1996). In our laboratory we isolated a DNA fragment, which might be used to identify the male palms at seedling stage (data not shown). This information will be published once the identification of the male palms is confirmed.

Comparison of the data collected so far with the information that will be obtained after flowering of the F_1 progenies will help to improve the date quality and uniformity in maturity time. Localization of qualitative or quantitative traits on the genetic map can enhance breeding programs to improve the date palm. Selection of the desirable palms (male or female) can be carried out based on molecular markers. A lot of information still needs to be collected and the genome of the date palm need to be studied in more details. This will facilitate the improvement of dates' quality and the development of date palms with better adaptability to the environmental conditions. Studying the genomes of important organisms was done in different parts of the world, such as the human genome project, the rice genome project the *Arabidopsis* genome project, etc. Starting a genome project of the date palm will be the ideal method to improve it in the next century. Some of the main objectives of such project would be:

1. Accurate identification and classification of cultivars with neutral markers (molecular probes) which are not influenced by the environmental conditions or physiological state.

2. Establishment of long term breeding programs in which the selection is carried out based on molecular markers and the recognition of the best heterotic combinations.

3. Selection of male palms with desirable characters.

4. Determination of genotypes that can be easily propagated through tissue culture techniques.

5. Studying the genetic transformation of date palms and inducing the resistance to pests.

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IDENTIFICATION AND GENETIC DIVERSITY ANALYSIS OF DATE PALM (*PHOENIX DACTYLIFERA L.*) VARIETIES FROM MOROCCO USING RAPD MARKERS

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ABSTRACT

Genetic variation among 43 date palm (*Phoenix dactylifera* L.) accessions, including 37 accessions from Morocco and 6 cultivars from Iraq and Tunisia, was studied using Random Amplified Polymorphic DNA (RAPD) markers. The pre-screening of 123 primers on four genotypes allowed selection of 19 primers which revealed polymorphism and gave reproducible results. All 43 analysed genotypes were distinguishable by their band patterns. RAPD technology therefore appears very effective for identifying accessions of date palm. RAPD-based genetic distance was used to determine the relationships between the accessions. The grouping-association identified by cluster analysis was rather weak. However, morphologically similar varieties clustered together. The lack of evident organisation observed among the date palm varieties grown in Morocco could be related to the mode of introduction and maintenance of date-palm germplasm.

Additional Index words: Cultivars, Date palm, Genetic diversity, Morocco, RAPD markers.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the earliest cultivated tree crops (Wrigley, 1995). It is only found as a cultivated plant in abandoned gardens, or at desert water-holes where it has grown from seed discarded by travellers. It is believed to be a native of the Arabian Gulf region, possibly southern Iraq. In very early times, the date palm was introduced by man in northern India, North Africa and southern Spain it plays a major role in arid zones. In the oases of Morocco, for instance, date palm constitutes by far the main income-generating activity.

Despite its outstanding agronomic and socio-economic significance, attempts to improve knowledge and use of date palm biodiversity have been limited and are becoming an urgent priority. In particular in North Africa; date-palm plantations are there currently in danger of being destroyed due to a severe wilt, caused by *Fusarium oxysporum* f. *sp. Albedinis,* called "Bayoud" (Pereau-Leroy, 1958; Brac de la Perrière and Benkhalifa, 1995). Tolerant or resistant cultivars have already been identified but, unfortunately, they all give poor date quality (Louvet and Toutain, 1973; Saaidi *et al*. 1981). The evaluation of the field resistance of 6 Irakian and 6 Tunisian cultivars showed that none of them is resistant to the Bayoud disease (Sedra, 1992, 1995). However, among more than 1000 unique genotypes called 'Khalts' which are tested in the field, tens of them showed resistance and had a good fruit quality (Djerbi *et al*., 1986; Sedra 1992, 1995; Sedra *et al*., 1996). Characterisation and analysis of the available genetic diversity therefore constitute an indispensable step with regard to the development of breeding strategy.

The date palm is a dioecious perennial monocotyledon (i.e. cross-fertilisation obligatory) with long generation times (a period of 4 to 5 years is necessary to reach the first flowering). It has traditionally been vegetatively propagated from offshoots produced by elite individual trees. In Morocco, more than 220 varieties, clonally propagated, have been enumerated (Toutain *et al*., 1971). All the commercial varieties are exclusively female and there is no method yet of producing male palms of these varieties. In addition to the commercial varieties, plantations include trees called "khalt", which recover from seeds and present a large polymorphism in relation to the high heterozygosity of both female and male parents.

Correct identification of palms is usually not possible until fruit are produced. In addition the characterisation of cultivars and evaluation of genetic diversity require a large set of phenotypic data that are often difficult to assess and sometimes variable due to environmental influences (Sedra *et al*., 1993, 1996). Isoenzyme markers have proved of some use in cultivar identification (Baaziz and Saaidi, 1988; Bennaceur *et al*., 1991; Fakir *et al*., 1992; Bendiab *et al*., 1993). However, they are limited by the number of informative markers and give no direct assessment of the genomic variation. Restriction fragment length polymorphisms (RFLPs) have been evaluated for date palm clone identification (Corniquel and Mercier, 1994), but the technique is laborious and not suited to studies of a large number of samples. Randomly amplified polymorphic DNA (RAPD) markers (Williams *et al*., 1990; Welsh and McClelland, 1990) are of particular interest. DNA profiles based on arbitrary primed PCR are both time- and cost-effective.

In the present study, we tested the reliability of the RAPD-PCR system as a tool for the identification of date palm cultivars. Furthermore, we sought an indication of the level of genetic variation and genetic relationships within the date palm cultivars grown in Morocco.

MATERIALS AND METHODS

Plant materials

The plant material consisted of 31 commercial varieties, 10 "khalts" from different plantations selected for their date quality (Sedra, 1992, 1995) and 2 male cultivars. The commercial varieties comprised 3 cultivars from Tunisia, 3 cultivars from Iraq and 25 Moroccan cultivars. The aim was to select the most common Moroccan varieties representing the main plantation area of Morocco (Toutain *et al.*, 1971). The analysed varieties present great agro-morphological diversity (Sedra *et al.*, 1993, 1996). Further information on the materials is given in Table 1. All plant material was obtained from the field-collection of INRA-Morocco in Zagora.

DNA extraction and amplification

Genomic DNA of each genotype was extracted from 4 g of lyophilised leaflets. The leaves were first ground into fine powder. DNA was extracted in 200 ml of extraction buffer (350 mM sorbitol, 100 mM Tris-HCl pH 8, 5 mM EDTA pH 8, 0.5% sodium bisulphate) and the solution was filtered through a muslin cloth. The extract was centrifuged at 3000g for 20 minutes, and the supernatant discarded. The precipitate was incubated in 30 ml of lysis buffer (1.5 M NaCl, 100 mM Tris-HCl pH 8, 20 mM EDTA pH 8, 4% mixed alkyl-trimethylammonium bromide) for 4 hours at 65°C with occasional mixing. After cooling for about 5 minutes at room temperature, the extract was adjusted to 50 ml by adding chloroform/isoamyl alcohol (24/1 vv). The mixture was then homogenised by gentle inversion before being centrifuged at 3000g for 10 minutes. The aqueous supernatant was recovered and the chloroform/isoamyl alcohol extraction procedure repeated. The resulting aqueous fraction was incubated with 100 µl of 10 mg/ml RNase (Boehringer Mannheim) for 30 minutes at 37 °C before precipitating the DNA with an equal volume of isopropanol. The precipitated DNA was recovered in 1 ml of 70% (v/v) ethanol, dried and dissolved in 300 µl of TE buffer (10 mM Tris-HCl, 1 mM EDTA pH 8). Depending on the leaf samples, yield in DNA varied from 40 to 400 µg using this protocol.

A total of 123 random decamer primers (Operon Technologies, CA, USA) were used for PCR in reaction conditions similar to those described by Lashermes *et al.* (1993). The RAPD products were fractionated according to size on agarose gel (1.8% w/w) subjected to electrophoresis (10V/cm for 4½ hours) in 1X TBE buffer. The DNA fragments were uniformly stained in a solution of ethidium bromide (10 µg/ml) for 15 minutes. DNA was visualised on a UV transilluminator and photographed using Polaroid film.

Data analysis

Data was recorded as presence (1) or absence (0) of the amplified products. Genetic distances (GD) between genotypes were estimated as follows: GDxy = (Nx +Ny)/(Nx +Ny +Nxy); where Nx is the number of bands in line x and not in line y, Ny is the number of bands in line y and not in line x, and Nxy is the number of bands in lines x and y. A distance matrix between the 43 accessions was constructed. Cluster analysis by the unweighted pair group method using arithmetic averages (UPGMA) was performed with the TREECON (version 1.1) software package (Van der Peer and De Wachter, 1993). In addition, a correspondence analysis (Benzecri, 1973) was performed using an NDMS (ORSTOM, France) statistical software package. Two-dimensional graphs allow the projection of individuals. A second clustering analysis using the "Ward aggregation method" was performed based on the 4 main factor scores.

RESULTS AND DISCUSSION

Initially, the RAPD technology was applied to four genotypes (ADM, AIB, BSTN, and ZAHD) representing different geographical origins. The number of amplification bands per primer varied between 0 and 13, with a mean of 5 major bands per primers. Of the 123 primers tested, 19 were selected for further analysis based on the intensity, size and number of amplified products (Fig. 1, Table 2). To ensure reproducibility and genetic pertinence of RAPD marker data, the primers generating no, weak or complex amplification band patterns were discarded.

Analysis of the 19 selected primers among the 43 accessions included in this study generated 56 bands, 37 of which were polymorphic. There were 1.9 polymorphic bands per primer on average. Examples of polymorphism are shown in Fig. 2. All of the 43 accessions were distinguishable by their band patterns. In fact, among the studied varieties, clones SH and males palm were identified by using these 37 polymorphic markers. The Table 3 showed a example of some interesting varieties and some selected clones which were identified by using these molecular markers (Sedra, 1998). RAPD technology appears very effective for identifying accessions of date palm, although the overall exhibited polymorphism is rather low in comparison with results reported for other cultivated species (Hu and Quiros, 1991; Mossler *et al.*, 1992; Yang and Quiros, 1993; Koller *et al.*, 1993; Wolff and Van Run, 1993). RAPD-markers should therefore be of high value for date-palm germplasm characterisation and genetic maintenance. Previous molecular markers studies (Aît Chitt *et al.*, 1995; Corniquel and Mercier, 1994) involved a restricted set of date palm varieties and were less rewarding.

The 37 RAPDs were used to determine the relationships between the accessions. A dendrogram constructed by cluster analysis using RAPD-based genetic distance is presented in Fig. 3. The grouping-association identified by classification was rather weak. However, morphologically similar varieties such as Boukhanni (BKN) and Bouzeggar (BZG), as well as Boustammi noire (BSTN) and Tademainte (TDMT), clustered together. In addition, accessions originating from seedlings (khalt) appeared to be related to the parental varieties. For instance, SH7 was very similar to the variety Iklane (IKL), which is grown in the date-plantation (Drâa) where SH7 was selected. The same observation was done between the clone SH1 and Boufegous (BFG) and between the clone SH4 and Aguelid (AGL). Cultivars from Tunisia and Iraq did not exhibit a separation from the Moroccan germplasm. In fact, the similarity was relatively observed between Deglet Nour (DN) and Boufegous (BFG); Ftimi (FTM) and Houa (HOA); Besser Lahlou (BSRL) and Iklane (IKL); Hallaoui (HALW) and Bouslkhene (BSL); and Zahdi (ZAHD) and Jihel (JHL). Furthermore, the cultivars resistant to the "Bayoud" appeared in three different main groups. The first group contains BSTN, TDMT, BKN, IKL and male palm NP3. The culivars BSTB and SLY which are from the same date plantation formed the second group and the third group is composed by the alone cultivar Boufegous ou Moussa (BFGM).

Results from the correspondence analysis are summarised in Fig. 4. Major groups cannot be easily identified. However, close relationships between cultivars were observed as in the first analysis. It is notable that most of the cultivars from Tunisia or Iraq were associated with accessions already grown in Morocco. The organisation deduced from the RAPD-markers analysis did not appear to be related to the available date-characteristics of varieties. Date-appearance is given as an example in Fig. 4.

The relatively low polymorphism and the lack of evident organisation observed among the date palm varieties grown in Morocco could be related to the mode of introduction and maintenance of germplasm. Foundation germplasm is somewhat limited. The fact that the cultivars from Tunisia and Iraq did not markedly diverge from the genetic diversity present in Morocco suggests a narrow genetic diversity of populations from which the present varieties have been derived and maintained over several centuries. Exchange of cultivars between plantations and periodic development of new recombinant cultivars through sexual reproduction and seedling selection may also have played a role. In addition, the selection applied by farmers concerns mainly end-use quality-related genes which may represent only a small fraction of the date palm genome. Nature of date palm germplasm observed in Morocco diverged therefore considerably from those reported for other traditional perennial cultivated species such as the olive tree (Ouazzani *et al.*, 1996).

Observation in this study of cultivars showing resistance to Bayoud in different genetic groups may indicate the presence of several genetic resistance sources. Combination of such potentially different sources of resistance could therefore be of interest in the framework of breeding programmes. Moreover, the evaluation of "khalt" genotypes clearly shows that it is possible to develop cultivars combining both resistance to Bayoud and date-quality. According to the genetic distance (Table 4) and the phenotypic characteristics of the cultivars and male palms, it would be possible to choose similar or relatively far parents for crossing programme in order to foresee similarity or variability in progeny populations. For examples, we cite the crosses between MJH/NP3 or NP4, JHL or BSK/NP3, BSRL/NP3, and BARH or ZAHD/NP4,.etc...

Furthermore, in combination with agro-morphological criteria, RAPD assay could allow the establishment of a catalogue of cultivars grown world-wide. Other applications could include fingerprinting of date palm genotype, identification of duplicate accessions, and establishment of a core collection.

ACKNOWLEDGEMENTS

This work was supported by both the Date Palm Research & Development Network (ACSAD, Syria) through the breeding action (INRA- Marrakech, Morocco) and the French-Moroccan Co-operation Program (PRC n°95/15). Thanks are due to all staff of the ORSTOM Genetic Laboratory (LRGAPT-Montpellier), of (LPGLM) Laboratory INRA-Marrakech and of the INRA-Zagora experimental station. The authors are indebted to Dr M. Noirot for skilful assistance in statistical analysis.

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Table 1. Name, origin, and main characteristics of date palm genotypes studied.

Code	Name	Geographic Distributio	Date characteristics Appearan	Colour	Consisten	Maturity	Resistance "Bayoud"**
BSTN	Boustammi noire	A, D, F, G	Poor	Black	Soft	Late	R
BSTB	Boustammi blanche	D, G	Poor	Brown	Soft	Season	R
TDM	Tademainte	A, F, G	Medium	Black	Semi-Dry	Season	R
IKL	Iklane	A, D, F, G	Poor	Black	Soft	Very	R
SLY	Saîrlayalate	D	Medium	Pale Brown	Semi-Dry	Late	R
BFG	Boufeggouss/Moussa	D	Poor	Black	Soft	Early	R
HFS	Hafs	A, B, E	Poor	Black	Soft	Season	S
BSL	Bouslikhéne	B, F	Poor	Pale Brown	Semi-Dry	Early	MR
BZG	Bouzeggar	A, I, J	Poor	Black	Semi-Soft	Very	MR
AIB	Aissa-Iyoub	E	Good	Pale Brown	Semi-Dry	Late	S
BHZ	Belhazit	B	Medium	Pale Brown	Semi-Soft	Season	S
AZO	Azigzao	B, G	Poor	Pale Brown	Semi-Dry	Early	MR
BIT	Bouittob	D, G	Medium	Pale Brown	Dry	Late	S
ADM	Ademou	B	Good	Pale Brown	Dry	Season	S
BIJ	Bouijou	K	Medium	Pale Brown	Dry	Season	S
OTK	Otokdime	H	Medium	Pale Brown	Dry	Late	MR
AGL	Aguélid	A	Poor	Pale Brown	Semi-Soft	Very	MR
HOA	Houa	B	Medium	Pale Brown	Semi-Dry	Season	S
AHD	Ahardane	A, D, E, F,	Medium	Brown	Semi-Soft	Very	HS
BKN	Boukhanni	A	Medium	Brown	Semi-Soft	Early	R
MJH	Mejhoul	B, C	Excellent	Brown	Semi-Soft	Very	HS
BFG	Boufeggouss	All regions	Good	Brown	Soft	Season	HS
JHL	Jihel	A, D, F, G	Good	Pale Brown	Dry	Very	HS
BSK	Bouskri	A, D, F, H	Medium	Brown	Dry	Late	HS
BRR	Bourar	A	Good	Brown	Semi-Dry	Late	S
DN	Deglet Nour	Tunisia	Excellent	Pale Brown	Semi-Soft	Season	HS
FTM	Ftimi	Tunisia	Medium	Pale Brown	Semi-Dry	Late	S
BSRL	Besser Lahlou	Tunisia	Medium	Pale Brown	Semi-Soft	Season	S
BAR	Barhi	Iraq	Good	Pale Brown	Semi-Soft	Early	HS
ZAH	Zahdi	Iraq	Good	Pale Brown	Semi-Soft	Season	HS
HAL	Hallaoui	Iraq	Good	Pale Brown	Semi-Soft	Season	HS
SH-1	SH-1001	A	Good	Pale Brown	Semi-Soft	Early	R
SH-2	SH-1002	C	Excellent	Pale Brown	Semi-Dry	Early	R
SH-3	SH-1003	A	Very Good	Pale Brown	Semi-Dry	Very	R?
SH-4	SH-1004	A	Excellent	Pale Brown	Semi-Soft	Early	R?
SH-5	SH-1005	A	Very Good	Pale Brown	Semi-Soft	Season	R?

SH-6	SH-1006	A	Very Good	Pale Brown	Semi-Soft	Early	R?
SH-7	SH-1007	A	Very Good	Pale Brown	Semi-Soft	Season	R?
SH-8	SH-1008	A	Very Good	Pale Brown	Semi-Soft	Season	S
SH-9	SH-1009	A	Very Good	Pale Brown	Semi-Soft	Season	S
SH-10	SH-1010	A	Very Good	Pale Brown	Semi-Soft	Season	R?
NP3	NP3 (male palm)	A	-	-	-	-	R?
NP4	NP4 (male palm)	A	-	-	-	-	R

* Regions of Morocco: A=Drâa, B=Tafilalet, C=Ziz, D=Bani, E=Oriental, F=Saghro, G=Anti-Atlas, H=Todra, I=Ferkla, J=Ghéris, K=Guir.

** Resistance phenotypes: HS= Highly Susceptible, S=Susceptible, MR=Medium Resistant, R?=Presumed Resistant, R=Resistant.

Table 2. Nucleotide sequences of selected primers with the numbers of amplified products and polymorphic fragments.

Primers	Nucleotide sequences	Amplified products	Polymorphic fragments
OP-D3	5'-GTCGCCGTCA-3'	4	1
OP-D4	5'-TCTGGTGAGG-3'	2	1
OP-D10	5'-GGTCTACACC-3'	2	1
OP-D12	5'-CACCGTATCC-3'	5	3
OP-D15	5'-CATCCGTGCT-3'	2	2
OP-D16	5'-AGGGCGTAAG-3'	3	3
OP-D19	5'-CTGGGGACTT-3'	2	1
OP-J4	5'-CCGAACACGG-3'	2	1
OP-J5	5'-CTCCATGGGG-3'	3	3
OP-J13	5'-CCACACTACC-3'	3	3
OP-J14	5'-CACCCGGATG-3'	4	2
OP-J18	5'-TGGTCGCAGA-3'	2	1
OP-J19	5'-GGACACCACT-3'	4	3
OP-L6	5'-GAGGGAAGAG-3'	5	2
OP-M5	5'-GGGAACGTGT-3'	2	1
OP-M11	5'-GTCCACTGTG-3'	6	4
OP-N1	5'-CTCACGTTGG-3'	2	2
OP-N12	5'-CACAGACACC-3'	1	1
OP-X4	5'-CCGCTACCGA-3'	2	2
	Total	56	37

Table 3. Examples of identification of a sample of 24 genotypes of date palm using 37 RAPD markers

Cultivars and clones	37 RAPD markers
from Morocco	
MJH	1101010100101101011110100010100000010
BFG	0000010100101111011011111110110010010
JHL	1000100100111101010010100110110000010
ADM	1100010000101011111010001110100100001
AGL	1000000100101001111010100110100010010
SLY	1100010100101001110010111100110000010
BSTN	1100010111101011011011100010100001010
BKN	1100010101101011010011100100100001010
INRA 3014	1000010101001011110010100010100000000
INRA 3003	1000010000000000101000010110011000010
INRA3013	1000010000000000101000010110011000010
INRA 3010	1000010000101101011010101110100000010
INRA 1445	1100000000001111011011100110110001000
INRA 1394	1101011101100111010011111010010001010
INRA 1443	1000010111001011011011100110110000010
INRA 3415	1000010110101111010010100100100001100
male NP3	1000010100111111011110100110100000001
male NP4	1010011001001011111111100100100001000
from Tunisia	
BSRL	1000010000111011110010110110100000011
DN	1000100100001101011011101010110000000
FTM	1001011000110011011110111110100000010
from Iraq	
ZAHD	1100000100111001011010100010110000010
HALW	1000100100000000111001010001010000010
BARH	1000010100000101100000010001010000000

presence (1) or absence (0) of marker.

Table 4. Example of genetic distances esimated between some cultivars and two males palm.

females palm	origin	male palm NP3	male palm NP4
MJH	Morocco	33.3	60.0
JHL	Morocco	38.1	69.2
BIT	Morocco	40.9	69.2
BRR	Morocco	45.8	63.0
BFG	Morocco	50.0	56.0
AIB	Morocco	52.2	74.1
BIJ	Morocco	54.5	72.0
BSL	Morocco	59.1	70.8
ZAHD	Iraq	42.9	68.0
BARH	Iraq	57.9	71.4
DN	Tunisia	50.0	62.5

Fig. 1. Example of 6 primers selected for generating DNA polymorphisms detected between 3 accessions of date palm. Ethidium bromide-stained agarose gel of amplification fragments produced with these primers. Lane 10 contains fragments of molecular weight markers.

Fig. 2. Examples of DNA polymorphisms detected between accessions of date palm. Ethidium bromide-stained agarose gel of amplification fragments produced with primers OP-D12 (A) and OP-D19 (B). Lane 11 contains fragments of molecular weight markers.

Fig. 3. Dendrogram of the accessions listed in table 1 generated by group average clustering analysis (UPGMA) using RAPD-based genetic distance. The cultivars resistant to « Bayoud » are indicated by *.

Fig. 4. Representations of the 41 female palm accessions on the plane 1-2 of the correspondence analysis. A: The groups deduced from the clustering analysis of factor scores are indicated; B: Each accession is represented by its appearance-value (1=poor, 2=medium, 3=good, 4=very good, 5=excellent), the « Bayoud » - resistant varieties are framed, * indicates the « khalts » presumed resistant.

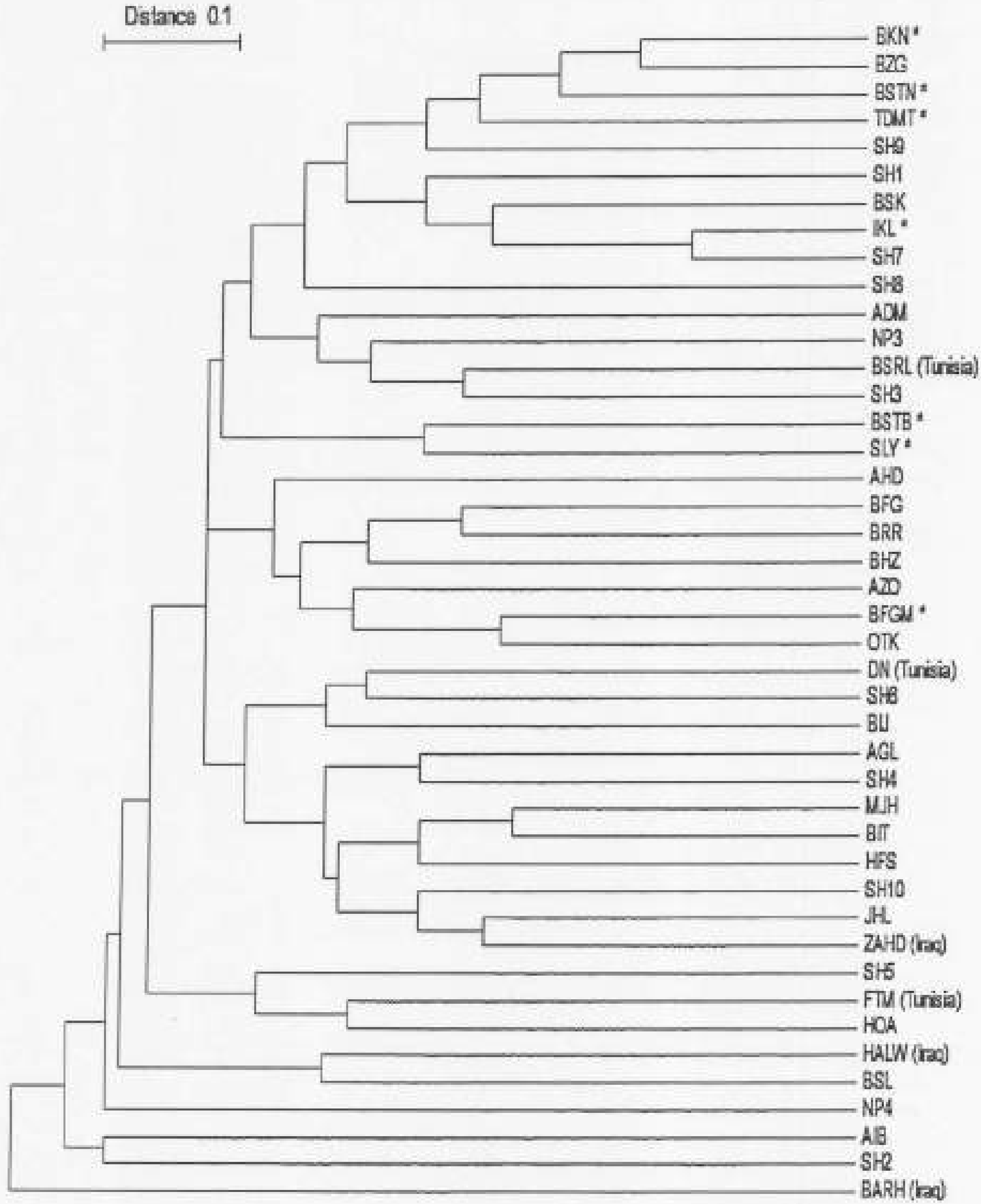
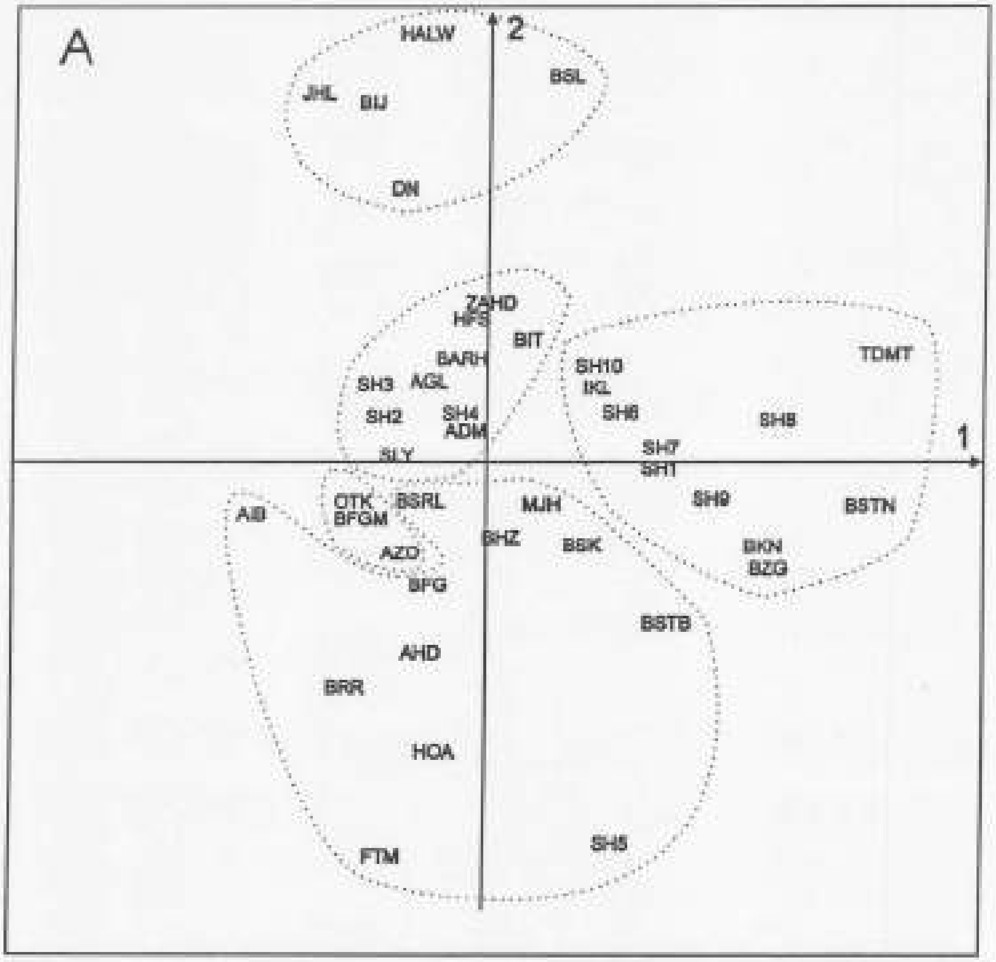


Fig. 3. Dendrogram of the accessions listed in table 1 generated by group average clustering analysis (UPGMA) using RAPD-based genetic distance. The cultivars resistant to « Bayoud » are indicated by *.


A
2
1
HALW
JHL
BIJ
BSL
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BIT
BARH
SH3
AGL
SH2
SH4
ADM
SLY
SH10
IKL
SH6
TDMT
SH8
SH7
SH1
OTK
BSRL
BFGM
MJH
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BRR
HOA
FTM
SH5

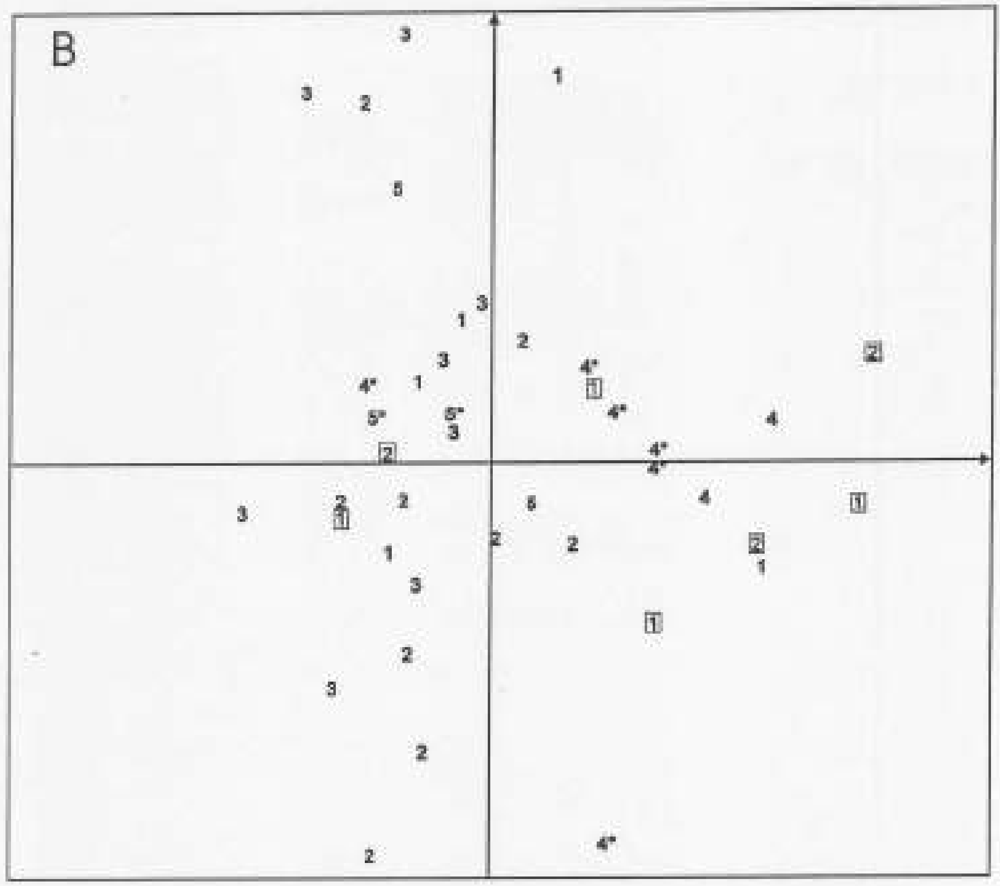


Fig. 4. Representations of the 41 female palm accessions on the plane 1-2 of the correspondence analysis. A: The groups deduced from the clustering analysis of factor scores are indicated; B: Each accession is represented by its appearance-value (1=poor, 2=medium, 3=good, 4=very good, 5=excellent), the « Bayoud » -resistant varieties are framed, * indicates the « khalts » presumed resistant.

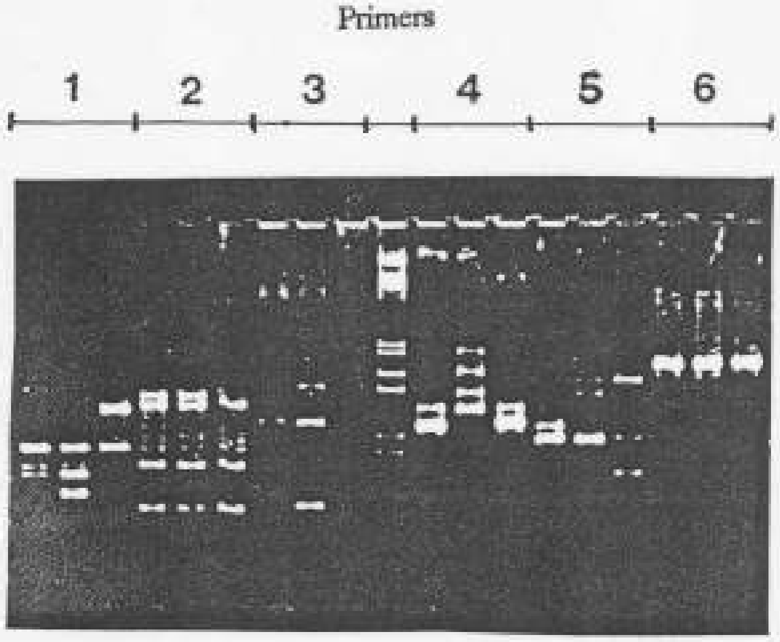


Fig. 1. Example of 6 primers selected for generating DNA polymorphisms detected between 3 accessions of date palm. Ethidium bromide-stained agarose gel of amplification fragments produced with these primers. Lane 11 contains fragments of molecular weight markers.

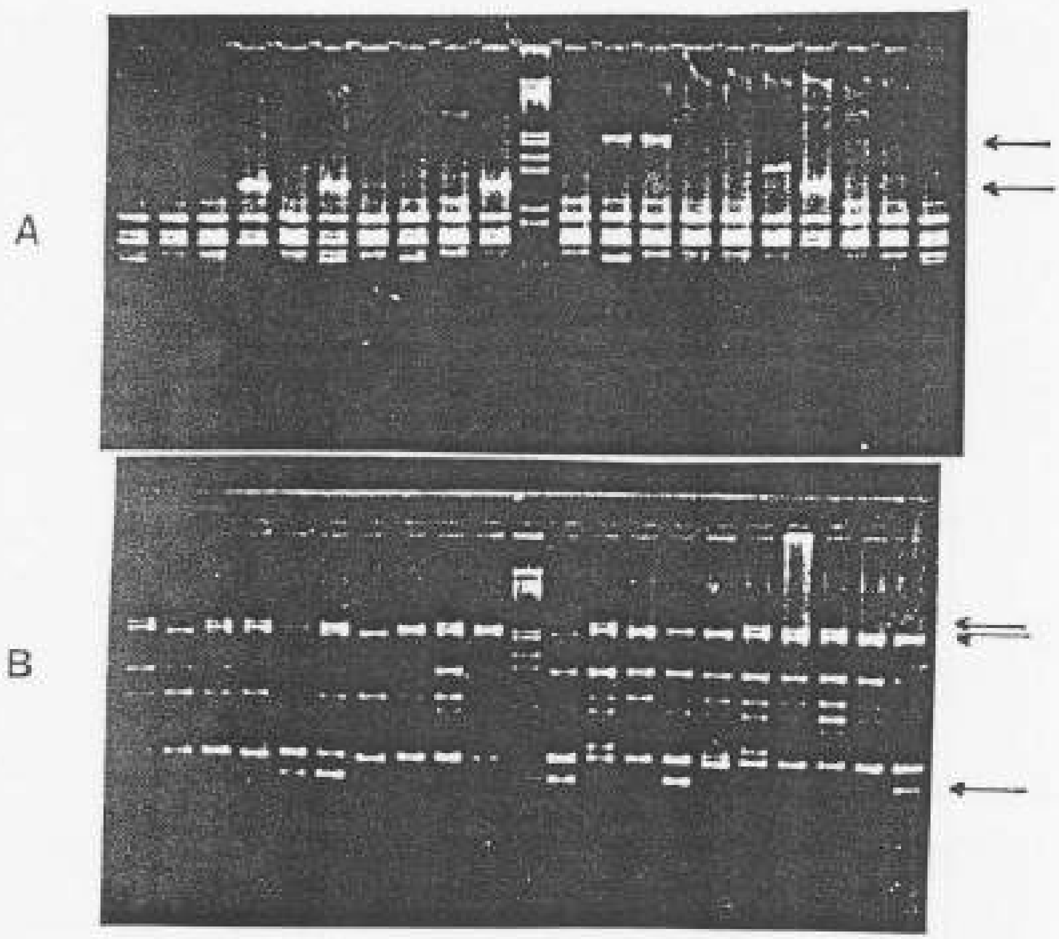
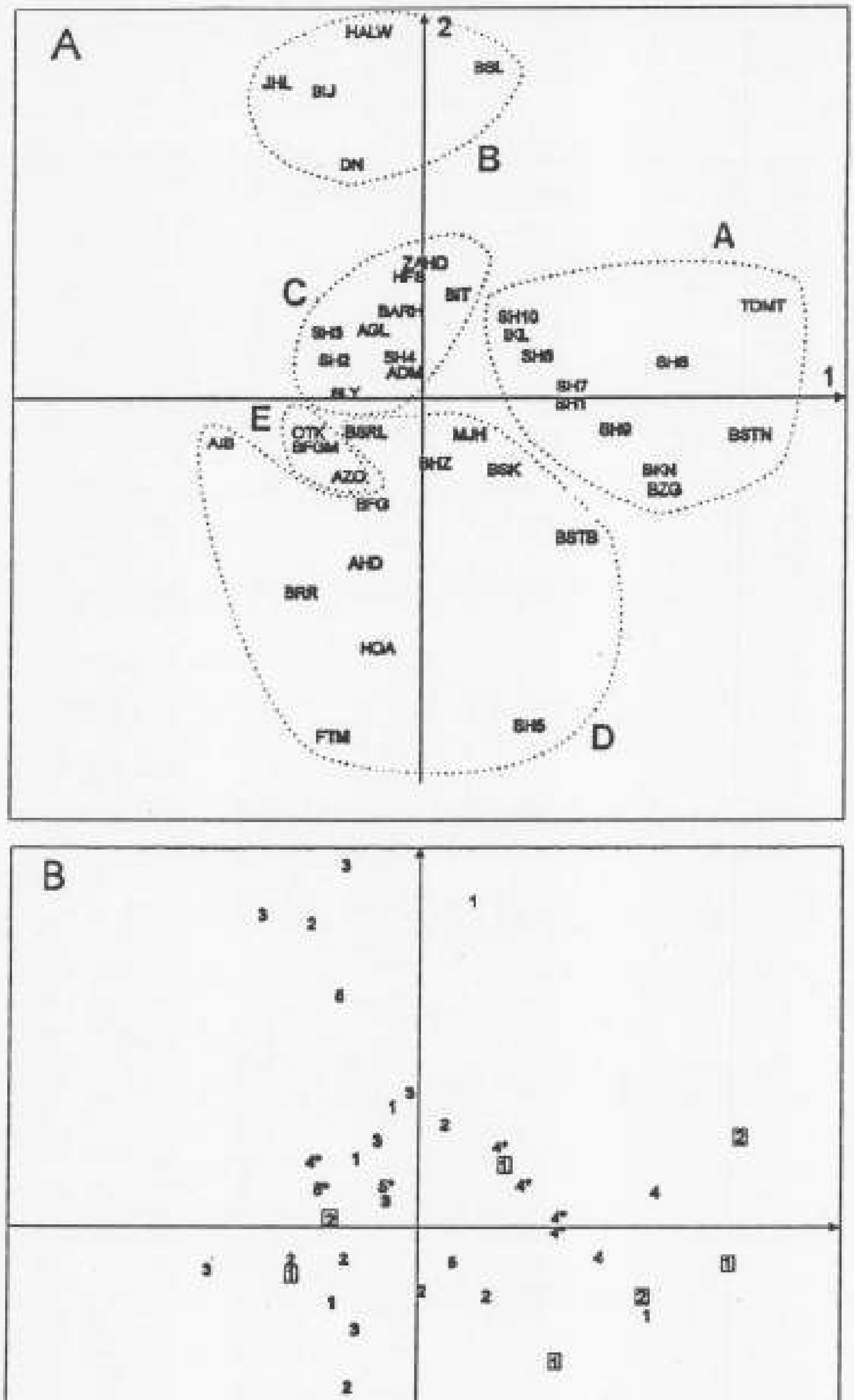


Fig. 2. Examples of DNA polymorphisms detected between accessions of date palm. Ethidium bromide-stained agarose gel of amplification fragments produced with primers OP-D12 (A) and OP-D19 (B). Lane 11 contains fragments of molecular weight markers.



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THE REPRODUCIBILITY OF RAPD PROFILES: EFFECT OF PCR COMPONENTS ON RAPD ANALYSIS OF DATE PALM DNA.

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ABSTRACT

Conditions for regenerating random amplified polymorphic DNA (RAPD) markers using the polymerase chain reaction (PCR) were optimized for date palm DNA. The importance of the optimization of this technique to obtain reproducible RAPD patterns and it's applicability is discussed. Using date palm DNA it was possible to identify adequate conditions for reproducible RAPD amplifications. The standard reaction developed included: 25-30 ng of DNA extracted using a CTAB-based protocol, 3 mM $MgCl_2$, 0.4 µM primer, 200 µM of each dATP, dGTP, dCTP and dTTP and with 0.5 U of PrimeZyme DNA polymerase per 25 µl PCR reaction.

ADDITIONAL INDEX WORDS: *Phoenix dactylifera,* Optimization.

INTRODUCTION

RAPDs have been successfully used in conventional DNA fingerprinting in plants (Caetano-Anollés *et al.*, 1991). However a commonly experienced problem with RAPD analysis, is its poor reproducibility (e.g. Devos and Gale, 1992). Since the final product is derived from exponential amplification of the template DNA, minor differences in amplification efficiencies can result in large differences in the overall product pattern and yield. It is therefore essential to optimize the PCR to obtain reproducible and interpretable results. This is particularly important when RAPD is used as a diagnostic tool.

The PCR conditions for RAPD analysis can be optimized by varying the many components, namely, type and concentration of thermostable polymerase, deoxynucleotide triphosphates, Mg^{2+} ions, primer and DNA template concentration, and other reaction factors such as primer annealing, primer extension, denaturation time and temperature. All these factors can influence a PCR reaction, and this is exacerbated by the fact that not all processes and mechanisms involved in such reactions are as yet understood fully (Wolff *et al.*, 1993).

Here we report on investigations into several components of the PCR reactions used for generating RAPD profiles from genomic DNA of date palm (*Phoenix dactylifera* L.) with a view to developing a reliable fingerprinting method for variety identification especially for evaluating plants at juvenile stages of growth.

MATERIALS AND METHODS

Plant materials

Date palm leaves used for DNA extraction were collected from an adult tree (approximately 25 years old) of "Ahrdane" variety (accession Number 102) grown in the INRA (Institut National de la Recherche Agronomique) experimental station of Zagora, Morocco.

Date palm DNAs and PCR materials

Date palm DNA was extracted from mature leaves using a CTAB based procedure described earlier by Aitchitt *et al.* (1993). The integrity and concentration of the DNA samples were determined by agarose gel electrophoresis (on a 0.6% agarose gel in TAE buffer; 1 x TAE = 40 mM Tris, 40 mM glacial acetic acid, 1 mM EDTA) and ethidium bromide fluorescence using λ DNA as size and concentration markers. The DNA concentrations were then verified by UV spectrophotometry.

PCR amplifications were carried out on a Techne PHC-3 dry bloc thermal cycler in heat tolerant HiTemp polycarbonate plates (Techne, Cambridge, UK). The standard 25 µl PCR reaction mixture consisted of 50 ng of template DNA, 2.5 mM $MgCl_2$ 1 U thermostable DNA polymerase, 200 µM dNTPs (of each dATP, dCTP, dGTP and dTTP) with 0.4 µM primer in 1x reaction buffer supplied with the respective polymerases.

The different polymerases tested included *Taq* polymerase from *Thermus aquaticus* (Promega, NBS), "Vent" polymerase from *Thermus litoralis* (New England Biolabs), *Tfl* polymerase from *Thermus flavus* (Promega) and "PrimeZyme" from *Thermus brockianus* (Biometra)

The random 10-mer primers were purchased from Operon Technologies (Alameda, California USA). A master mix of all the common components was prepared and only the varying components were adjusted individually so that any experimental error would be evenly distributed throughout all treatments. All the reactions were carried out in duplicates, triplicates or repeated to estimate experimental error. The reactions were assembled on ice and overlaid with approximately 40 µl of mineral oil to prevent evaporation. The standard PCR conditions used for testing the different parameters consisted of a preliminary 4 min denaturation at 95° C followed by 35 cycles of 1 min at 94° C, 1 min at 35° C and 2 min at 72°C or 74° C (depending on the enzyme), using the fastest possible transition between each temperature. The amplification finished with an incubation at 72° C for 10 min, followed by a 4° C soak until recovery.

Agarose gel electrophoresis

Amplification products were separated by electrophoresis on 2.0% agarose gels in 1x TAE buffer at 30 V for 16 h. The gels were stained with ethidium bromide (0.5 µg/ml for 20 min with shaking) destained in water (20 min) and visualised by UV transillumination. The gels were photographed using the Polaroid MP4 camera system and 665 film (with negative) for further interpretation and analysis.

RESULTS AND DISCUSSION

The alterations in the different parameters tested had varying degrees of influence on the RAPD patterns and its reproducibility. The relative importance and effects of these parameters on RAPD amplification are presented and discussed below.

DNA concentrations

An efficient and robust protocol for RAPD analysis should be reasonably resistant to variations in template concentrations. For most species of plants, good results have been achieved using 50 to 100 ng in 50 µl reaction mixtures (Caetano-Annoles *et al.*, 1991).

In our experiments identical profiles were obtained over a range of concentrations of template DNA from 2.5 ng to 25 ng in 25 µl reaction. However, when the template DNA concentration was raised to 50 ng to 100 ng per reaction extra low molecular weight bands appeared, although the relative intensity of the other products was not affected. In contrast to some other studies (Williams *et al.*, 1990), experiments with date palm DNA showed that the limits to template DNA were not narrow and that the patterns obtained were relatively constant even over a 40-fold difference in concentrations (Fig. 1). Similar observations have been reported for chrysanthemum DNA where amplification was relatively constant between 1 and 500 ng template DNA (Wolff *et al.*, 1993). These results suggested that DNA quantification might not be critical or even necessary when a standard DNA extraction and purification procedure is used with set amounts of fresh weight tissues. This is particularly important when large numbers of samples have to be analysed. The fact that small quantities of DNA are sufficient for PCR amplification and that polysaccharides, which are common contaminants in DNA preparations, are unlikely to affect the PCR reactions (Demeke and Adams, 1992), indicates that RAPD analysis can be performed effectively using a more crude DNA preparation. Such "minipreps" methods have been developed and reported as suitable for RAPD analysis for other species such as rice and maize (Oard and Dronavalli, 1992), *Brassica napus* (Deragon and Landry, 1992), *Brassica oleracea* (Kresovich *et al.*, 1992). A "miniprep" method was developed for date palm during the current study that proved suitable for RAPD analysis. This extraction procedure was possible only when the tissue used was soft *in vitro* produced material (results not shown). It will be useful to develop such a miniprep approach on mature date palm tissues which are fibrous and rich in polyphenolics. This will enable the screening of large number of samples from adult palms.

$MgCl_2$ concentrations

Magnesium is an essential component of PCR reactions and affects the quality of RAPD profiles obtained (Munthaly *et al.*, 1992). It is known to affect primer annealing and template denaturation, enzyme activity and fidelity and the formation of primer-dimer artefacts (Saiki, 1988). Generally, increasing amounts of Mg^{2+} will result in the accumulation of non-specific amplification products, although insufficient Mg^{2+} will reduce the yield (Williams *et al.*, 1993). The use of > 1 mM $MgCl_2$ has been reported to be generally necessary for good levels of DNA amplification in bacterial and plant DNAs (Bassam *et al.*, 1992). Typically $MgCl_2$ concentrations range from 1-8 mM in most RAPD analyses reported in the literature. Concentrations as high as 5 mM have been used successfully in RAPD analyses of plant species such as poplar (Castiglione *et al.*, 1993). In the present study, amplification products were detected when $MgCl_2$ concentrations ranged from 0.5 to 6 mM. For example Figure 2 shows the result for one primer (OPI11) where the number of detectable products increased from two (600 bp and 2 kb) at 1 mM to at least six (from 300 bp to 2 kb) at 2.5 mM. From 4 to 7 mM, amplification of the larger fragments decreased. Profiles obtained using 2.5 to 3.5 mM $MgCl_2$ were similar. Concentrations of 6 to 7mM of $MgCl_2$ amplified only small molecular weight products (Fig. 2). $MgCl_2$ concentration was therefore important for the RAPD pattern obtained, but had only a minor influence on the yield of amplified DNA. Similar observations have been reported in RAPD studies on other plants (e.g. chrysanthemum, Wolff *et al.*, 1993).

Thermostable polymerases and enzyme concentration

Since the initial use of a thermostable polymerase for PCR amplification (Mullis and Faloona, 1987), a large number of variants of *Taq* (e.g. ampliTaq) and thermostable polymerases from other organisms (e.g. *Thermus brockianus*, *Thermus flavus*, *Thermus litoralis*, *Thermus thermophilus*, *Thermococcus litoralis*, *Thermotoga maritima*) have been isolated and shown to be suitable for PCR amplification of DNA. These enzymes have varying conditions for optimal performance and amplification. The choice can also depend on the requirments of the PCR experiment especially with respect to specificity, efficiency or fidelity (reviewed by Cha and Thilly, 1993).

The major factors that governed our choice of enzymes were their availability, potential efficiency and cost. The results obtained in the current study indicated that all of the enzymes described in Materials and Methods amplified date palm DNA but at different concentrations (results not shown). In the current study, 0.4 U of PrimeZyme (Biometra) in a 25 µl reaction was sufficient for good amplification. None of the other enzymes amplified at less than 1.5 U per 25 µl reaction (data not shown). For the primer OPI11 an increasing number of bands were observed with increasing enzyme concentration and these bands were more distinct at concentration above 2U in 25 µl (Fig. 3). Devos and Gale (1992) reported a similar observation and suggested that such extra bands were due to a non-specific amplification. Based on our results, we opted to use PrimeZyme as the enzyme of choice in our standard RAPD protocol. It must be pointed out that the efficiency of the same polymerase can vary significantly depending on the nature of the target sequence, the primer sequences, and the reaction conditions (Eckert and Kunkel, 1991). Therefore, the efficiency of PrimeZyme reported here might not necessarily reflect the efficiency of a different PCR that is carried out under different conditions.

Deoxynucleotide (dNTP) concentrations

The dNTP concentrations have often been reported as having little influence on the patterns of DNA amplified. 100 to 200 µM of each of the four nucleotides have been quoted as being optimal for most reactions used in RAPD analyses (Williams *et al.*, 1990, Caetano-Anollés *et al.*, 1991).

Figure 4 shows results with primer OPE20, where amplification products were obtained using concentrations of 50 to 250 µM dNTP. However, the profiles and intensities of the products obtained were significantly affected. At 50 µM, only relatively small products (< 1.6 Kb) were amplified and the intensities of the bands were poor. Similar results have been reported by Williams *et al.* (1993) where concentrations < 100 µM produced relatively fainter bands. With date palm DNA extra bands of high molecular weight (>1.6 Kb) were amplified with increasing concentrations of dNTPs. This also resulted in the concurrent loss of some of the low molecular weight bands (between 300 bp and 1 Kb) and some of the weak amplification products. The intensity of the higher molecular weight bands was significantly greater at the highest concentrations (250 µM). Based on the quality of the amplification products (size, numbers, intensity), it would be tempting to use 250 µM dNTPs or more. However, it is known that dNTPs chelate magnesium and thereby change the effective optimal Mg^{2+} concentrations. Moreover high concentrations of dNTPs increase the error rate of the polymerase; for instance, millimolar quantities were found to actually inhibit *Taq* DNA polymerase (Gelfand, 1989). It is not clear if the observations in our experiments were a result of interactions between dNTPs and $MgCl_2$ resulting in a lower amount of available Mg^{2+} and its effect on primer annealing.

Cycling parameters

The different PCR parameters, namely temperatures, durations and 'ramping' of denaturation, annealing and extension steps, as well as the number of amplification cycles can be altered to obtain optimal RAPD banding patterns. The thermocycling conditions described in Materials and Methods and found to be adequate for RAPD analysis of date palm DNA were arrived at either empirically or based on product specifications provided by the suppliers.

The first 4 min at 95 °C besides denaturing the DNA can also inactivate any proteases that could still be in the DNA solution and would influence primer extension reactions with PrimeZyme. This step does not affect the enzyme activity because, PrimeZyme is highly thermostable (the half life at 96°C is 2.5 hours). The extension temperature of 72°C was as recommended by the manufacturer for optimal activity of PrimeZyme. At this temperature, 2 min was sufficient for extension of products up to 4 Kb. The annealing temperature set at 35°C was as recommended by Operon Technologies. Annealing temperatures reported in the literature for arbitrary short primers range from 34 to 36°C but can clearly be defined with more precision depending on the melting temperature of each primer. Methods have been developed to calculate the optimum annealing temperatures in a PCR reaction (Rychlik *et al.*, 1990). However these formulae are inaccurate for the short primers (c. 10 bases) used in RAPD assay. Optimal annealing temperature for RAPD must consequently be determined empirically. In the present study as little as 30 cycles of amplification were sufficient to obtain amounts of DNA which could be detected by agarose gel electrophoresis. The 35 cycles which were used in the standard amplification protocol were chosen to minimize unspecific amplification products. Sampling of PCR products has been recommended to be carried out during the exponential phase (Cha and Thilly, 1993). This exponential phase of the reaction is defined as the period during which the products accumulate in an exponential manner, beyond which amplification often results in the production of unspecific bands. The undesirable effects of over-amplification are presumably attributable to the fact that as the number of cycles increases and more products are generated, some components of the PCR could become limiting.

Conclusion

The reproducibility of RAPD amplification is known to be highly influenced by experimental conditions (Devos and Gale, 1992; Wolff *et al.*, 1993), but there is usually a "window" through which reproducible results can be obtained (Bassam *et al.*, 1992; Williams *et al.*, 1993). Using date palm DNA prepared using an earlier procedure, it was possible to identify such a "window" for reproducible RAPD amplifications. The standard reaction developed included: 25-30 ng of DNA extracted using a CTAB-based protocol, 3 mM $MgCl_2$, 0.4 µM primer, 200 µM of each dATP, dGTP, dCTP and dTTP and with 0.5 U of PrimeZyme DNA polymerase per 25 µl PCR reaction. This powerful approach to detect polymorphism will provide a rapid molecular tool for various applications related to the molecular genetics studies of the date palm.

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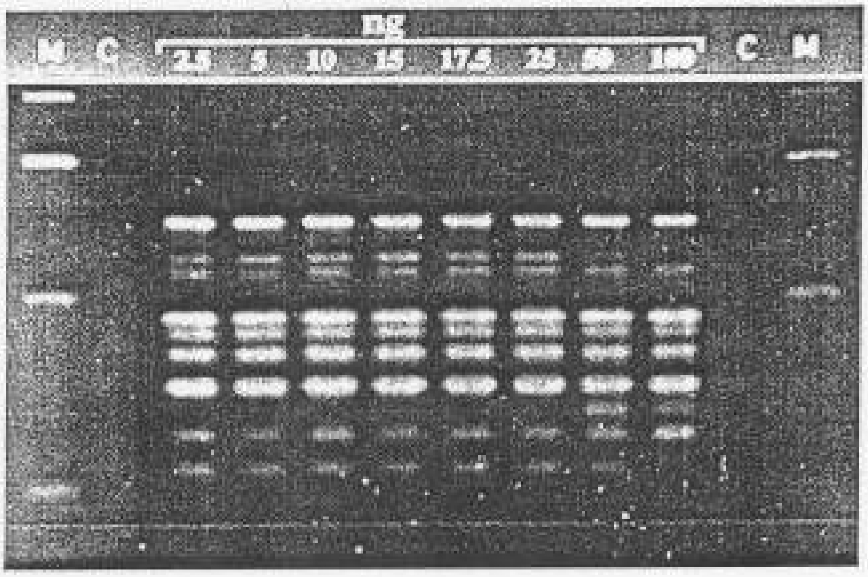

Figure 1. Effect of template DNA concentration on RAPD patterns.

Increasing amounts of date palm DNA (CV Ahrdane) were amplified with primer OPI11 (5'ACATGCCGTG).

Lane C is a control with all the reaction components except template genomic DNA. Lane M is a 1-kb ladder size marker (BRL).

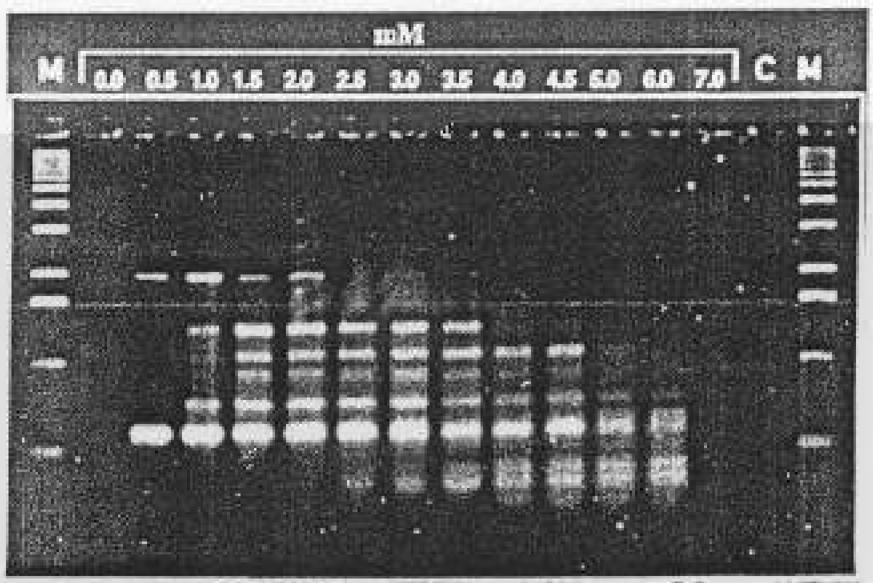

Figure 2. Effect of magnesium chloride concentration on RAPD patterns.

30 ng of date palm DNA (cv Ahrdane) were amplified with primer OPI11 (5'ACATGCCGTG). in reactions containing varying concentrations of Mg^{2+} (0 to 7 mM).

Lane C is a control without template genomic DNA (2.5 mM $MgCl_2$). Lane M-1kb ladder size marker (BRL).

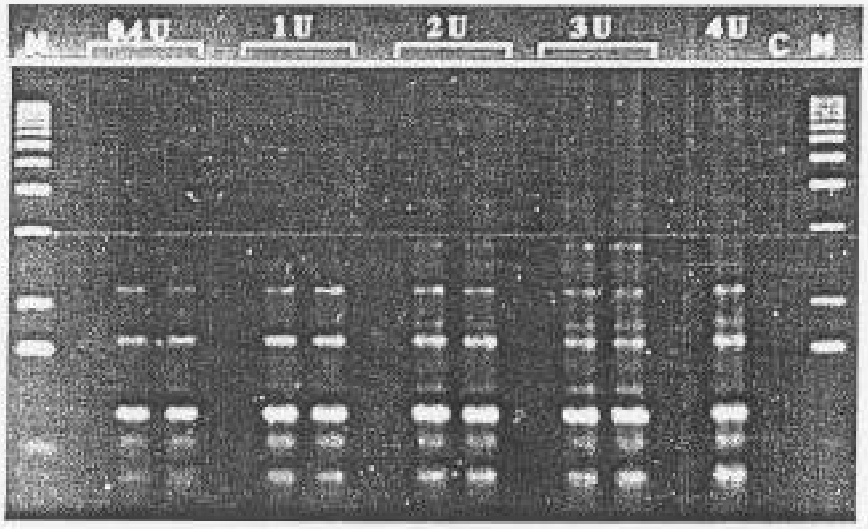

Figure 3. Effect of PrimeZyme concentration on RAPD patterns.
30 ng of date palm DNA (cv Ahrdane) was amplified using primer OPI11 (5'ACATGCCGTG) and the standard conditions described in Materials and Methods. PrimeZyme polymerase (Biometra) was used at 0.4, 1, 2, 3, and 4 unit per 25µl reaction.
Each reaction was duplicated to estimate experimental error (except for 4U).
Lane C1 and C2 are controls containing all the reaction components except either template genomic DNA (C1) or the enzyme (C2). Lane M-1kb ladder size marker (BRL).

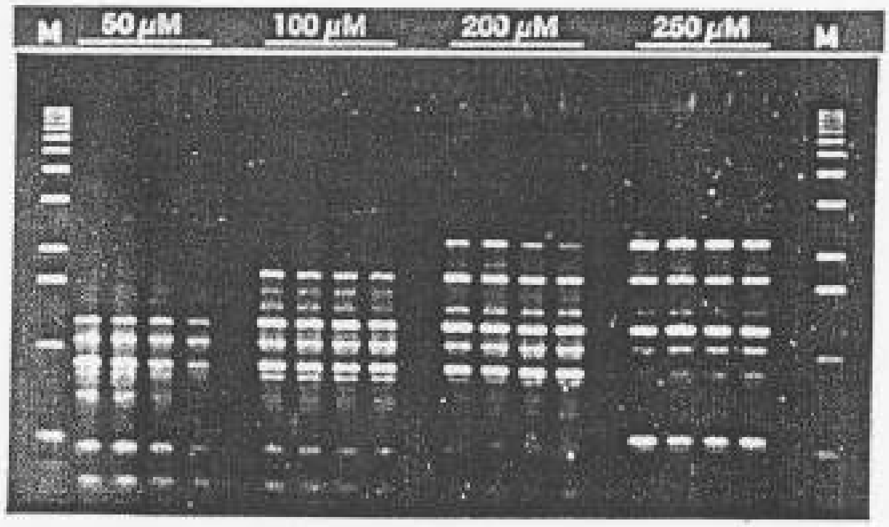

Figure 4. Effect of dNTP concentration on RAPD patterns.
30 ng of date palm DNA (cv Ahrdane) was amplified using the standard conditions described in Materials and Methods and four concentrations of dNTPs (50, 100, 200 and 250 µM). Lane M-1kb ladder size marker (BRL).

GROWTH OF DATE PALM CALLUS AS AFFECTED BY AMINO ACIDS AS ORGANIC NITROGEN SOURCE

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ABSTRACT

MS-medium that contained kinetin 0.5 mg/L with 2 mg/L 2,4-D was the best combination of growth regulators in callus production of date palms. The effect of methionine, tryptophane, alanine, glutamic acid and casein hydrolysate on growth and production of callus were tested. All amino acids treatments steadily decreased both fresh and dry weights of calli compared with control. Also, it was noticed that methionine and tryptophane treatment gave the lowest values of both fresh and dry weights. However, alanine and glutamic acid added to the nutrient medium decreased the growth of callus compared with other amino acids. Fresh and dry weights of callus derived from leaf primordia of terminal buds stem tissue were determined as affected by casein hydrolysate which supplemented to culture medium. Casein hydrolysate concentrations were added to the medium at 0.5, 1.0, 1.5 or 2.0 g/L. The obtained results revealed that, with all treatments, the fresh and dry weights were gradually increased with casein hydrolysate concentration increased and reached their maximum with 2.0 g/L casein hydrolysate.

"Additional Index Words": Tissue culture, *Phoenix dactylifera* L., casein hydrolysate, glutamic acid, phenylalanine, tryptophane, ornithine, methionine, arginine, alanine.

INTRODUCTION

Cultured cells are normally capable of synthesizing all of required amino acids yet, the addition of amino acid or amino acids mixture may be used to stimulate cell growth and facilitate plant regeneration (Mohamed, 1996). L-glutamine can serve as the sole source of nitrogen which can be taken more rapidly than inorganic nitrogen (Thom et al., 1980). Hussein et al. (1994) studied the effect of some amino acids on the growth of *Datura* *stramoinium* cultured on MS-medium with 1 mg/L of both 2,4-D and kinetin and subcultured on fresh medium containing some amino acids. They found that, the fresh and dry weight of calli was reduced. Kamada and Harada (1979) reported that, at the addition of individual amino acids to carrot callus culture, alanine stimulated somatic embryogensis followed by glutamine, asparagine, aspartic acid, arginine and proline. Abou El-Nil (1989) indicated that amino acids stimulated callus growth and ranked, as follows: glutamine, asparagine, arginine, serine, glycin and alanine. Glutamine caused doubling callus growth compared to control.

The effect of casein hydrolysate (amino acids mixture) as a sole nitrogen sources on callus growth was reported by Heimer and Filner (1970) on tobacco callus. Zenk et al., (1975) found that, when cultured medium was supplemented with casein hydrolysate at level greater that 4 g/L, callus growth was stimulated in *Morinda citrifolia*. Casein hydrolysate was used as a sole nitrogen source for beans (Crocomo et al., 1976), carrot (Wetherell and Dougall, 1976) and fenugreek (Singh et al., 1981). Cardi and Monti (1993) found that, the addition of casein hydrolysate at 2 g/L is important for callus production from pea. Also, in a study on kidney bean and pea callus, Saker (1995) reported that, the addition of 2 g/L casein hydrolysate to culture medium enhanced callus growth.

This study was carried out to determine the activity of some amino acids and casein hydrolysate in date palm tissue culture.

MATERIALS AND METHODS

Culture media:

The composition and concentration of the medium used in this work were according to Murashige and Skoog (1962) Media were autoclaved at 121 °C and 1.2 Kg/cm^2 for 20 min. The water used for preparation of the media was double distilled and sterile. The medium was solidified with 0.7% agar, pH was adjusted to 5.8 before autoclaving. The prepared media were poured into heat sterilized 100 ml glass containers. Each contained about 25 ml solidified medium.

Callus Initiation and Maintenance:

Callus cultures from date palm (*Phoenix dactylifera* L.) from leaf primordia of terminal buds stem tissue was initiated on the MS-media.

Certain amino acids included glutamic acid, phenylalanine, tryptophane, ornithine, methionine, arginine and alanine were used.

Subculturing was carried out after 4 weeks by cutting the callus into small pieces each about 200 mg and transferring them to fresh nutrient MS-basal medium supplemented with 2 mg/L 2,4-D, 0.5 mg/L kinetin and 10 mM of each amino acid individually.

To study the effect of casein hydrolysate on date palm callus, callus tissue was transferred to fresh MS-medium, supplemented with 2 mg/L 2,4-D, 0.5 mg/L kinetin and different concentrations of casein hydrolysate (0.5, 1.0, 1.5 and 2 g/L). Cultures were incubated in a 16-hours photoperiod at 24-26 °C. The growth was determined at the end of the 4 weeks incubation period (6 replicates).

The obtained data from the present study were subjected to statistical analysis performed using standard deviation (S.D) according to the method described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of amino acids on Callus Growth:

The influence of amino acids supplemented to the culture medium on growth of initiated callus tissues of date palm were studied. Calli stock grown onto MS-medium contained 2 mg/L 2,4-D and 0.5 mg/L kinetin supplemented with 10 mM/L of different amino acids. From Table (1), it could be noticed that, the fresh weight and growth rate of callus tissues were decreased as affected by amino acids supplemented to culture medium compared with control. Filner (1966) reported that the growth of tobacco callus in culture was inhibited by a wide variety of amino acids added singly to the nitrate medium on which the cells were grown, and that the inhibition could be attributed to repression of the nitrate reductase activity in the cells. Also, Fukunaga and King (1982) reported that, some single amino compounds inhibited the growth of datura cells at points in metabolism other than nitrate assimilation and that in no case could growth and nitrate reductase activity inhibition be causally unequivocally.

Table (1): Effect of amino acids on the fresh weight (gm/inoculum) and growth rate (mg/day) of the callus tissue of date palm cultured 4 weeks.

Amino acids 10 mM/L	Callus fresh weight ± SD gm/inoculum	%	Callus growth rate mg/day	%
Control	2.630 ±0.110	100	87.667	100
Glutamic acid	1.818 ±0.071	69	60.600	69
Methionine	1.757 ±0.072	66	58.567	66
Tryptophane	1.403 ±0.069	53	46.767	53
Phenylalanine	1.800 ±0.072	68	60.000	68
Ornithine	2.104 ±0.094	80	70.133	80
Arginine	2.103 ±0.090	80	60.267	69
Alanine	2.041 ±0.089	78	68.033	78

Each value was the average of 6 replicates, % at control

Comparing the effect of amino acids supplementations on the growth, it could be noticed that tryptophane methionine and treatments gave the lowest values of both fresh and growth rate. However, arginine, alanine, asparagine and glutamic acid gave the highest values of both fresh and growth rate. In accordance, Filner (1966) showed that, alanine, asparagine, glutamic acid and arginine did not inhibit the growth when they were added to tobacco cells growing with nitrate as a sole nitrogen source. On the other hand, Mohamed (1996) reported that, glutamic acid, methionine, tryptophane, phenylalanine and arginine inhibited the growth of callus tissue cultures of fenugreek. In contrast, Abou El-Nil (1989) reported that, growth of date palm callus tissue was stimulated by adding of amino acids specifically glutamine. This stimulation suggested that organic nitrogen was a growth-limiting factor in date palm cultures.

Effect of casein hydrolysate on Callus Growth:

The effects of different supplementations of casein hydrolysate on the growth of date palm callus was determined (Table 2). Fresh weight and growth rate of calli gave increasing values during cultivation period. It is found that, when casein hydrolysate concentration increased in the medium, the growth of the tissue as fresh weight and growth rate were increased. Similar results for the positive effects of casein hydrolysate on callus growth were reported by Crocomo et al., (1976), and Mok and Mok (1985) on kidney bean, Murashige and Skoog (1962) on tobacco and Singh et al., (1981) and Mohamed (1996) on fenugreek.

Table (2): Effect of different concentrations of casein hydrolysate on fresh weight (gm/inoculum) and growth rate (mg/day) of the callus tissue of date palm cultured 4 weeks.

Hydrolysate Conc. gm/L	Callus fresh weight ± SD gm/inoculum	%	Callus growth rate mg/day	%
Control	1.523 ± 0.104	100	50.767	100
0.5	1.618 ± 0.110	106	53.933	106
1.0	1.618 ± 0.142	164	83.133	164
1.5	2.625 ± 0.137	172	87.500	172
2.0	2.741 ± 0.141	180	91.367	180

Each value was the average of 6 replicates, % at control

The present data clearly indicated that, all concentrations of casein treatment steadily increase both fresh weight and growth rate of calli compared with control. Two g/L casein hydrolysate treatment gave the highest value of both fresh weight and growth rate. On the other hand, Matsumoto et al., (1976) showed that, the requirement of amino acids for plant tissue culture could be estimated by adding different amounts of protein hydrolysate. The enhancement of growth or morphogenesis could be explored further by using a mixture of amino acids. They provide plant cells with an immediately available source of nitrogen which generally can be taken up by the cells more rapidly than inorganic nitrogen (Thom et al., 1980).

ACKNOWLEDGMENT:

The authors would like to thank Prof. Dr. Abel-Rehim F.A., Dept. of Biochem., Fac. of Agric., Cairo Univ., Giza Egypt, for his help during this work.

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IMPACT OF THE ENTOMOPHAGOUS FAUNA ON THE *PARLATORIA BLANCHARDII TARG* POPULATION IN THE BISKRA REGION

PART 1

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ABSTRACT

Date palm tree is facing many problems and constraints such as water stress, excess of salinity, deseases, pests, etc. Among the most important pests *Parlatoria blanchardii,* commonly known as the white cochineal, is spread in Biskra region. The objectives of this study were to measure its spread, to identify its natural predators, and to measure their impact on this pest.

Iperti's scale was used to measure overrun of *P. blanchardii* on date palms. Most predators of this pest living in the study area were identified and their impact measured. Results show that spread of *P. blanchardii* is not uniform all over the study area. More over a close relationship was found between it's spread and those of predators such as, *Cybocephalus Palmanum* and *Pharoscymus semiglobusus.*

INTRODUCTION

Date palm tree is facing many problems and constraints that have without any doubt negative impacts on its normal growth and production.

Problems such as water stress, excess of salinity, and lack of drainage are making up an ideal biotope for a spreading and an increase of many deseases and pests. Among the latest. *P. blanchardii* commonly known as the white cochineal seems to be one of the most widespread pest in the Biskra region.

Factors such as lack of treatment, inefficiency, and high cost of chemical products, reproduction speed of *P. blanchardii,* that is four generations per year (Toutain, 1972) seem to be the main causes of the infestation of the study area.

However, it is widely accepted that *P. blanchardii* population can be decreased by the impact of some predators. Balachowsky (1936) reported that *P. blanchardii* has been jugulated by two main predators: *C. palmarum* and *Pharoscymus anchorago*. Iperti et al. (1970), showed the impact of some natural predators mainly *Chilochorus bipustulatus* on *P. blanchardii.*

Informations outlined in most references demonstrate that if the white cochineal is living with its natural predators, it should be easy to control its population growth and damages caused on palm trees could be maintained at an acceptable level.

To reach such objective it is necessary to:

(1) Monitor the extent of the damage caused by *P. blanchardii* on the palm trees of the Biskra region,

(2) Draw a map of the infested area.

(3) Have an exhaustive list of all entomophagous fauna in the study area.

(4) Study the relationship between *P. blanchardii* and its predators.

(5) Deterime and the real impact of the entomophagous fauna as a natural predator of *P. blanchardii.*

This research work has been divided in two parts and started on the 5^{th} April, 1997. The first part deals mostly with an understanding of the extend of the infestation the relationship between *P. blanchardii* and its predators.

MATERIALS AND METHODS:

Seventeen 917) districts among the 33 that make up the Biskra region (Wilaya) were selected for this study. These are the most representative districts in terms of palm trees populations (table 1).

Usnig the iperti scale, a map showing the degree of infestation was drawn.

In each of the seventeen selected districts, five oasis were choosen for this study, usnig criteria such as:

- the most infested oasis (visually estimated),
- homogeneity of the palm trees population in the selected oasis (same variety).

In each oasis, five palm trees were taken at random. From each palm tree, 12 palm leafs were cut and taken back to the laboratory, these were selected according to their orientation i.e. (N.E.S.W.). Three cuttings measuring 30 to 40 cm^2 per palm leaf were used for counting. All leaving individuals on one cm^2 were taken into account. Umpty folicules were disreagarded. Twenty five thousand countings were carried out in this analysis.

All entomophagous species found in one leaf taken at random from one palm tree in the studied oasis were recorded, identified and used in the analysis for the relationshop between the predatory fauna and the white cochineal.

Table 1 : Total Palm trees population in the Biskra region.
(unpublished data)

DISTRICTS	TOTAL PALM TREES	SELECTED DISTRICTS(*)
01 Biskra	140 995	
02 El Hadjeb	116 739	*
03 El Outaya	9 886	
04 El Kantara	16 500	*
05 Ain Zaatout	4 000	
06 Djemorah	10 230	
07 Branis	20 875	
08 Sidi Okba	213 100	*
09 Ain Naga(Ain Deba)	32 777	*
10 El Haouch	72 302	*
11 Chetma	72 800	*
12 Mchouneche	83 000	
13 Zeribet El Oued	7 690	
14 M'ziraa	10 800	
15 El Feidh	20 950	
16 Khangat S. Nadji	21 700	
17 Tolga (Magtoufa)	209 000	*
18 Bordj B. Azzouz	124 749	
19 Lichana	74 900	*
20 Bouchagroune	61 000	*
21 Foughala	104 600	
22 Laghrous	85 600	*
23 Ourlal (Saada)	110 168	*
24 Mekhadma	96 848	*
25 Lioua	155 520	*
26 Mlili	109 351	*
27 Oumache	106 011	*
28 Ouled Djellal	166 500	*
29 Doucen	52 300	
30 Chaiba	1 860	
31 Sidi Khaled	82 000	*
32 Besbes	00000	
33 Ras El Miad	00000	
T O T A L	**2 394 748**	

RESULTS AND DISCUSSIONS

Levels of infestation in the study area

Levels of infestation of palm trees by *Parlatoria Blanchardii* in the study area are shown in table 2. Three main levels were observed according to the iperti scale (1987):

- High level : 2 - Six districts
- Medium level : 1 - Five districts
- Low level : 0.5 - Six districts

in each leaf it was found that living individuals of white cochineal varied from 5 individuals to more than 100 per cm.

Table 2: Mean levels of infestation by *Parlatoria Blanchardii* in the 17 districts of the study area.

DISTRICTS	WHITE COCHINEAL / CM^2	LEVELS OF INFRSTATION (*)
01 Sidi Okba	101	2
02 Ourlal (Saada)	128	2
03 El Haouch	117	2
04 Oumache	112	2
05 Ain Naga (Ain Deba)	125	2
06 Chetma	126	2
07 Bouchagroune	58	1
08 El Hadjeb	51	1
09 Lichana	47	1
10 Laghrous	38	1
11 Tolga (Magtoufa)	59	1
12 Ouled Djellal	12	0.5
13 Sidi Khaled	13	0.5
14 Lioua	5	0.5
15 Mekhadma	15	0.5
16 Mlili	8	0.5
17 El Kantara	10	0.5

(*) Iperti scale

Highest levels of infestation were observed either in the oasis with the most important density of palm trees, i.e. the highest number of palm trees per hectare (table 3) or in those with the oldest palm trees that could be found in the Biskra region (Figure 1). Our observations revealed also that shaded oasis with high levels of moisture seem to have favoured an increase of the white cochineal population. Munier (1973) reported that *Parlatoria Blanchardii* prefers shaded sites whith high hygrometrie levels.

Table 3 : Number of palm trees per hectare in the Biskra region (BNEDER, 1992)

DISTRICTS	NUMBER OF PALM TREES/ HA	SELECTED DISTRICTS(*)
01 Biskra	131	
02 El Hadjeb	111	*
03 El Outaya	130	
04 El Kantara	120	*
05 In Zaatout	118	
06 Djemorah	59	
07 Branis	130	
08 Sidi Okba	122	*
09 Ain Naga (Ain Deba)	61	*
10 El Haouch	90	*
11 Chetma	140	*
12 M'Chouneche	128	
13 Zeribet El Oued	100	
14 Mziraa	140	
15 El Feidh	128	
16 Khangat Sidi Nadji	128	
17 Tolga (Magtoufa)	123	*
18 Bordj Ben Azzouz	134	
19 Lichana	92	*
20 Bouchagroune	119	*
21 Foughala	123	
22 Laghrous	120	*
23 Ourlal (Saada)	120	*
24 Mekhadma	117	*
25 Lioua	117	*
26 Mlili	138	*
27 Oumache	101	*
28 Ouled Djellal	63	*
29 Doucen	102	
30 Chaiba	20	
31 Sidi Khaled	63	*
32 Besbes	0	
33 Ras El Miad	0	

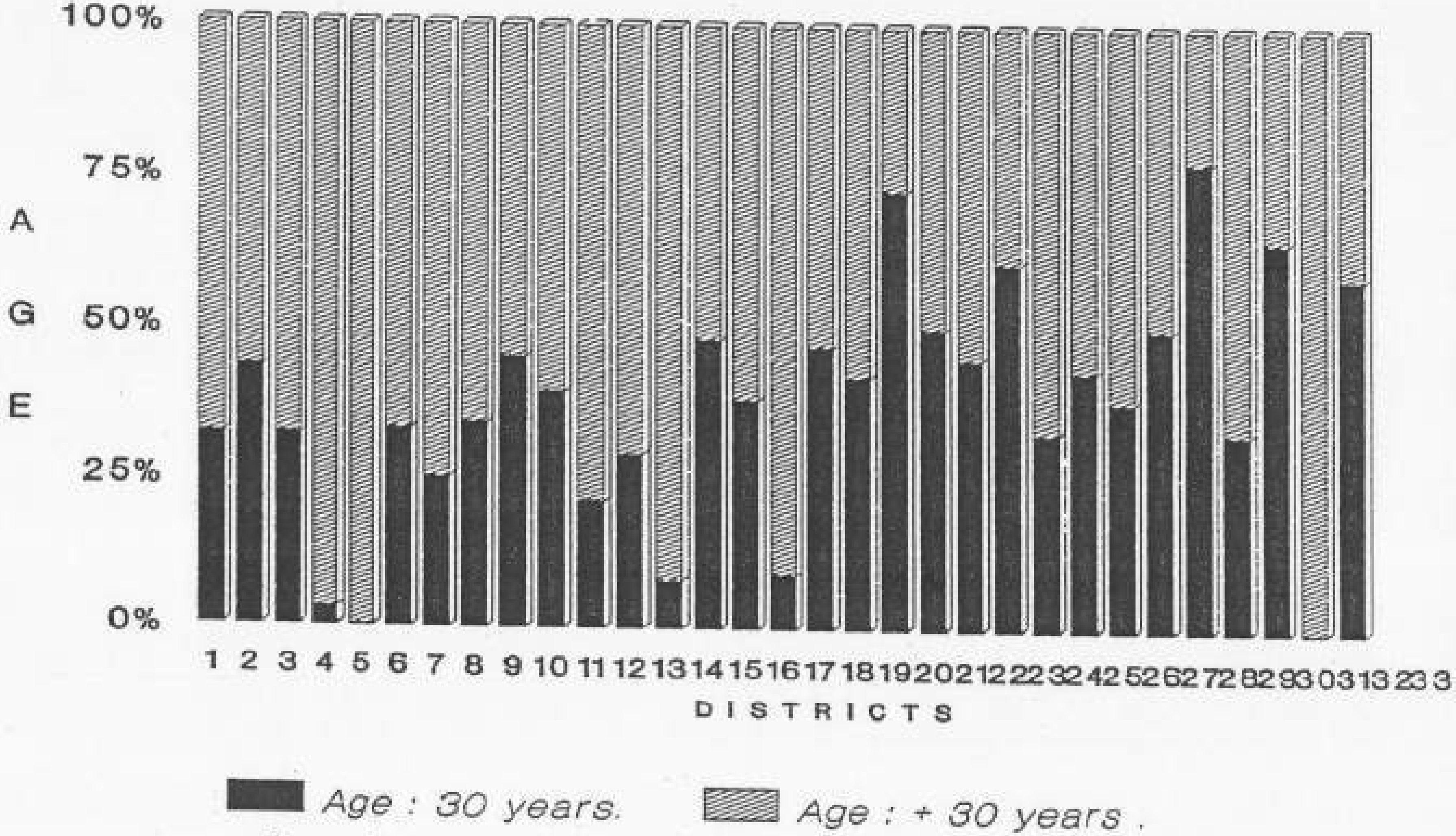

Figure 1: % Age structure of palm trees in the Biskra region
(Numbers 1 to 33 indicate the 33 districts : see table 1)

INFESTATION MAP

Results outlined above in table 2 were used to draw the infestation map of Biskra region (Figure 2). This map shows very clearly that the pattern of the infestation decreased from east to west. The most infested oasis were located in the south east districts. Beyond the fact that in these districts the oldest and less productive palm trees could be found, highest levels of air moisture are recorded throughout the year in this area.

Further more, we noticed that the most infested oasis were inveaded by many speciees of weeds. It has been supposed that these weeds could host the white cochineal. Bodenheimer (1944), reported that beyond the palm tree, many others plants could host *Parlatoria Blanchardii.*

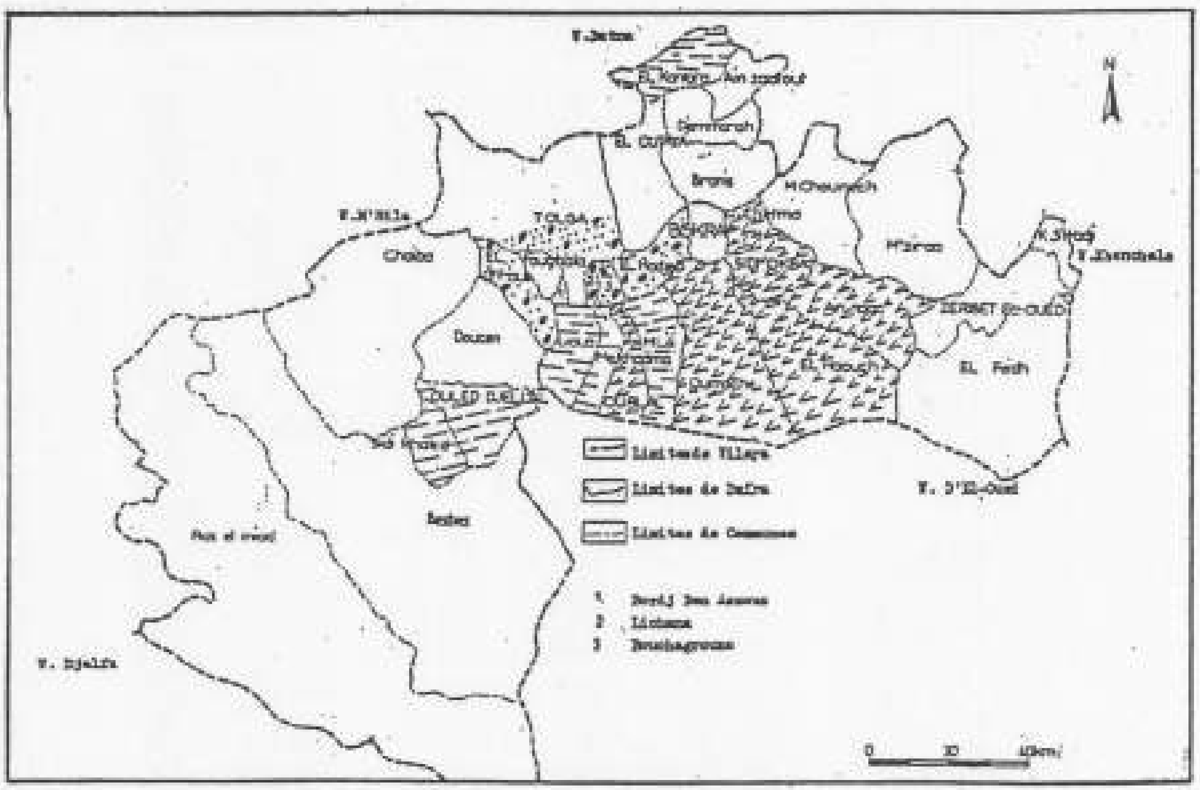

Figure 2 : Infestation map by P. blanchardii
level 2 ∠∠, level 1 ∗..∗, level.5 —

ENTOMOPHAGOUS FAUNA AND ITS IMPACT ON *PARLATORIA BLANCHARDII*

The entomophagous fauna

Throughout our prospections in the 17 surveyed districts, some acaridan and insects suspected for their predatory action against *Parlatoria Blanchardii* were recorded. These were taken back to the laboratory sorted out and identified under a binocular dissecting microscope. Species identified were: *Chrisopa vulgaris, cybocephalus palmarum, Pharoscymus semiglobusus, Pharoscymus ovoidus* and *Hemisarcopes malus.*

Among all these species only adult individuals of *Cybocephalus palmanum* and *Pharoscymus semiglobusus* were taken into account for the analysis (table 4).

Many authors such as Balachowsky (1926), iperti and al (1970), Laudenho and Fround (1970), reported these species for their predatory activity against *Parlatoria Blanchardii.*

Impact of the main predators on Paratoria Blanchardii

As outlined before only adult individuals of *Cybocephalus palmanum* and *Pharoscymus semiglobusus* were taken into account for the understanding of the relationship between the entomophagous fauna and *Parlatoria Blanchardii.* A regression analysis was performed using data shown in tables 2 and 4 respectively for *Parlatoria Blanchardii* and the predatory fauna. Results showed that there is a close correlation between the two populations (Figure 3) with $r^2 = 0.85$.

CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

Of many solutions that have been put forward to control and / or eradicate *Parlatoria Blanchardii,* it is obvious that the most indicated seems to be the biological mean.

Balachowski (1929), Hoceini (1977) reported that the white cochineal population could be easily controlled by natural predators. However, it is also clearly stated that the choice of one or another of the many predators of *Parlatoria Blanchardii* targ has to be very accurate. Iperti and al (1970) showed that of the four entomophagous species

Table 4 : Recorded adult individuals of ***Cybocephalus palmarum*** and ***Pharoscymus semiglobusus*** in one leaf taken from one palm tree in each of the surveyed oasis:

SURVEYED DISTRICTS	NUMBER OF PREDATORS (*)
01 Sidi Okba	8
02 Ourlal (Saada)	7
03 El Haouch	6
04 Oumache	6
05 Ain Naga (Ain Deba)	9
06 Chetma	6
07 Bouchagroune	12
08 El Hadjeb	14
09 Lichana	13
10 Laghrous	12
11 Tolga (Magtoufa)	10
12 Ouled Djellal	15
13 Sidi Khaled	12
14 Lioua	11
15 Mekhadma	15
16 Mlili	13
17 El Kantara	14

(*) As oulined above, only adult individuals of two predatory species were taken into account .

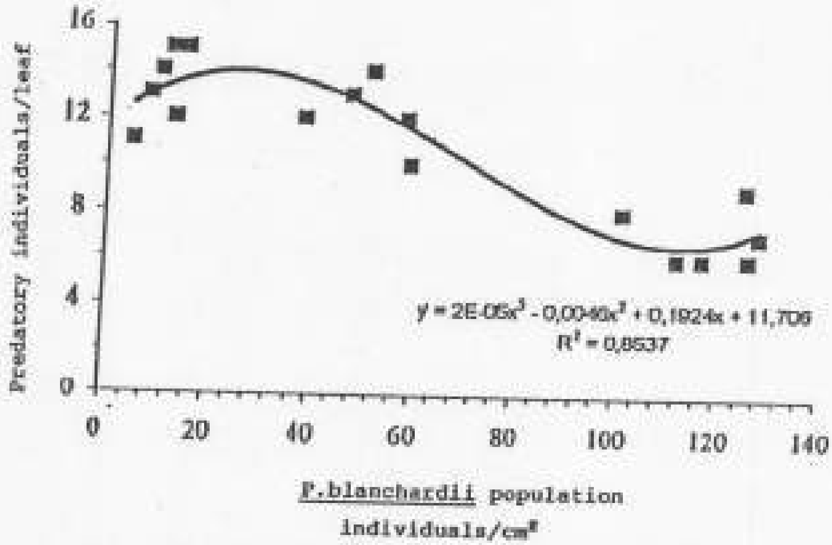

Figure 3 Regression line for the number of Predatory individuals/leaf on P.blanchardii population/cm

introduced in Mauritania, only *Chilochurus bipustulatus* iranensis gave satisfactory results.

Beyond the fact that in the biskra region, we found that a predotory fauna able to jugulate the white cochineal is already present, the study revealed also that among the entomophagous individuals found in the area, *cybocephalus palmarum* and *Pharoscymus semiglobusus* are the most efficient. Their impact on *parlatoria Blanchardii* is related to their number. The lowest level of infestation were recorded were up to 15 predators could be found in one leaf.

Part II of this work will be consacrated to know more accurately the required number of the two species that could eradicate or at least control *Parlatoria Blanchardii* in the Biskra region. Another aspect of the future work will be dealing with the possible ways to relocate some individuals of the predatory fauna in the south east of the study area.

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INSECT PESTS OF DATE PALM TREES IN NORTHERN SINAI, EGYPT

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ABSTRACT

The Insect pests attacking date palm trees at AL-Arish region, Northern Sinai, Egypt, were surveyed throughout two successive years. Survey covered existing insect species, stage(s) causing damage, frequency of occurrence, period of occurrence and attacked plant part(s). Eleven insect pests belonging to nine families from the orders Isoptera, Homoptera, Lepidoptera and Coleoptera were recorded. The most dominant and economically important pests were two scale insects (*Parlatoria blanchardii, and Phoenicococcus marlatti),* a mealy bug (*Dysmicoccus brevipes),* the lesser date moth (*Batrachedra amydraula)* and the termite *Psammotermes hypostoma*. Accidental attacks of desert locust *(Schistocerca gregaria)* were of rare occurrence especially on offshoots. Fermented or decayed damaged plant parts hosted Drosophila larvae and/or adults.

Additional Index Words: date palm, insects, survey.

INTRODUCTION

Cultivation of date palms in Egypt goes back to thousands of years. Approximately seven million fruiting palm trees are grown in Egypt in both the Nile valley and the desert. More than two hundred thousand fruiting palms grow in Sinai peninsula most of which occur in Northern Sinai particularly at AL-Arish region. Beside their high nutritive value, dates represent a main source of income for a wide sector of desert inhabitants.

Northern Sinai is, still, a relatively virgin ecosystem with almost no or very limited environmental disorder. It is quite essential, therefore, to maintain such naturally balanced system and restore its biodiversity. A basic step in that respect is to conduct continuous surveys of existing flora and fauna. As any other plant, date palms are, wherever grown, subject to infestation with a variety of insect pests. Such infestations may reflect serious damage on palms growth and, subsequently, cause considerable quality and quantity yield losses. In an effort to contribute to the knowledge

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on the insect fauna associated with date palms, (the dominant tree in Northern) Sinai, the present investigation was aimed. Insect pests attacking the different parts of date palm trees at Al-Arish region were surveyed.

Surveys of date palm insects were previously reported from Libya (Martin, 1958;EL-Haidari, 1981; and Bitaw and Ben saad, 1990), Egypt (Bodenheimer, 1923), Palestine (Ben Dov, 1985), Iraq (Buxton, 1920; and EL-Haidari *et al.* 1981), Qatar (EL- Haidari, 1981 and AL Azawi, 1986), Kuwait, Bahrain and United Arab Emirates (El- Haidari, 1981), Sultanate of Oman (Aly and Elwan, 1995), Saudi Arabia (Talhouk, 1982; and Hammad and Kadous 1989), Yemen (El-Haidari, 1981), Pakistan (Sharif and Wajih, 1982) and California, U.S.A. (Cook, 1914).

MATERIALS AND METHODS

Survey of the insect pests attacking date palm trees in Northern Sinai, Egypt, was carried out at Al-Arish region, ca. 150 Km. east of Port-Side city, throughout two successive years from March 1994 until February 1996. Several palm growing locations, scattered all over the region, were inspected for insect infestations once every month. At any selected location, 5 random trees-together with their offshoots-were carefully examined. Inspection covered all plant parts (*e. g.* roots, stem, leaflets, leaf mid-rib, spathes, female flowers and fruits). Any existing insect stage(s) or infestation symptoms were identified on-site as far as possible. In case of uncertainty, samples of the occurring stage(s) were transferred in suitable containers to the laboratory for proper identification. Laboratory identification of the specimens was made either under the stereoscopic binocular or after mounting on microscopic slides. Whenever further identification assistance was required, the specimens were referred to the appropriate taxonomist(s) at the Entomological Collection Division, Plant Protection Research Institute, ARC, MOA, Dokki, Giza, Egypt. Monthly examination of the trees further included an arbitrary evaluation of the frequency of occurrence of the surveyed insects (as rare, frequent or common). The period of occurrence of every surveyed insect pest was also approximately determined.

RESULTS AND DISCUSSION

A list of the insects recorded on date palm trees at Al-Arish region, Northern Sinai, Egypt, is given in Table 1. The upper section of this table shows that trees were subject to infestation with 11 insect pests belonging to

9 families from the orders Isoptera (1 species), Homoptera (3 species), Lepidoptera (3 species) and Coleoptera (4 species). The lower section of the same table indicates that, in addition to the above-mentioned insect pests, few nymphs and adults of desert locust *Schistocerca gregaria* (Forskal) (Acrididae: Orthoptera) occasionally visited date palms, especially young offshoots, between March and October. Larvae and adult flies of *Drosophila melanogaster* Meigen. (Drosophilidae: Diptera) were also seen during autumn (September-November) on the fermented fruits primarily attacked with other pests. Surveys of date palm tree insects in the different countries refer to the occurrence of 2 species in California, U.S.A. (Cook, 1914), 25 species in Iraq (Buxtan, 1920), 2 species in Egypt (Bodenheimer, 1923), 11 species in Bahrain, UAE, Kuwait, Qatar and Yemen (El-Haidari, 1981), 6-20 species in Saudi Arabia (Talhouk, 1982 and Hammed and Kadous, 1989), 7 major species in Pakistan (Sharif and Wajih, 1982) and 17 species in Oman (Aly and Elwan, 1995).

1- Common pests:

Information Table 1 reveals that the most common and economically important insect pests on date palm trees at Al-Arish region were the termite *Psammotermes hypostoma* (Desneux) (Rhinotermitidea: Isoptera), the parlatoria date scale *Parlatoria blanchardlii* (Targioni- Tozzetti) (Diaspididae: Homoptera), the red date scale *Phoenicococcus marlatti* Cockerell (Phoenicococcidae: Homoptera), the pineapple mealy bug *Dysmicocccus brevipes* (Cockerell) (Pseudococcidae: Homoptera) and the lesser date moth *Batrachedra amydraula* Meyrick (Momphidae: Lepidoptera).

P. hypostoma termite workers occurred on all tree parts all the year round and considerably affected the palm. Termite workers mine into the stems and frond bases of weak palms and build sand or mud- covered galleries on the outside of the stem.

All stages of the scale *P. blanchardii* occurred on the leaves, spathes and fruits from early spring until late autumn and caused noticeable damage to them. Cook (1914) reported *P. balnchardii* on date palm trees in California and Arizona, U.S.A. Bodenheimer (1923) recorded the same species on date palms at Al-Arish (Sinai), Egypt. Batra and Sohi (1976) mentioned that *P. blanchardii* is an important pest on date palm trees in India. *P. blanchardii* has also been reported on date palms from Yemen (El-

Haidari, 1981), Pakistan (Sharif and Wajih, 1982) and Saudi Arabia (Talhouk , 1982).

The different stages of *P. marlatti* were found on the leaves and aerial roots from March until December and oftenly destroyed invaded plant parts. In California and Arizona, U.S.A., *P. marlatti* is a serious pest and obstacles successful date culture (Cook, 1914). It also attacks date palms in Sinai and Transjordania (Bodenheimer, 1923). The same pest has been reported from Bahrain, Qatar and Yemen (El-Haidari, 1981) and Saudi Arabia (Hammad and Kadous, 1989).

Nymphs and adult females of the mealy bug *D. brevipes* were seen in large numbers on or among the aerial roots from April until January. Infested trees were weak and their fruit yield decreased markedly. Ben-Dov (1985) stated that *D. brevipes* is a major pest on the roots of date palm offshoots in Palestine.

Larvae and adults of the date moth *B. amydraula* attacked fruits particularly throughout the fruit growing period between April and July. Infested fruits were totally or partially destroyed, and mostly fell to the ground before full ripening. In Libya, Qatar and Saudi Arabia, the larvae of *B. amydraula* attack date fruits (Martin, 1958; El-Haidari, 1981; and Hammad and Kadous1989).

2- Frequent pests:

The insect pests of frequent occurrence (Table 1) on date palm trees at Al-Arish region were the greater date moth *Arenipses sabella* Hampson (Pyralidae: Lepidoptera), the almond or fig moth *Ephestia cautella* (Walker) (Pyralidae: Lepidoptera), the date stone beetle *Coccotrypes dactyliperda* (Fabricius) (Coleopteran: Scolytidae), *Phonapate frontalis* Fahraeus and *Phyllognathus excavatus* Forster (Scarabaeidae: Coleopter).

Larvae of *A. sabella* attacked spathes and fruits from March till October. Their damage resembles that caused by *B. amydraula*. Hussain (1974), Hammad and Kadous (1989), Bitaw and Ben Saad (1990) and Aly and Elwan (1995) coincided that *A. sabella* bores into the fronds, spathes and bunches of date palm trees in Iraq, Saudi Arabia, Libya and Oman, respectively.

E. cautella larvae and adult moths attacked ripe fruits during autumn (September-December) and induced moderate to high quality and quantity fruit yield losses. It has been reported as a major insect pest on date fruits in Libya (Martin, 1958) and Egypt (El-Saeady and Abad el salam, 1982).

C. dactyliperda larvae bored into fruit stones from the beginning of fruiting season till its end (April-December). Female beetles penetrate into unripe date fruits and lay their eggs on the seeds. Emerged larvae penetrate into the seed itself and several generations may be completed within the fruit. Such damage occurs in several countries including Egypt (Willcocks, 1914), U.S.A. (Linsley, 1945), Libya (Martin, 1958), Iraq (Thiab Al Hafidh *et al.*, 1981), Saudi Arabia (Hammad and Kadous, 1989) and Greece (Vassilaina *et al.*, 1986).

The Larvae and adult beetles of *P. frontalis* excavated into the leaf mid-ribs as well as fronds all the year round. Larvae and adults fed on or tunneled into the leaf mid-ribs and/or aerial roots in spring, summer and autumn. In Libya, the adult beetles of *P. frontalis* excavate into the mid-ribs and fruit bunches of the date palm tree (Bitaw and Ben Saad, 1990). *P. excavatus* also bores into the roots.

3- Rare pests:

In addition to the afore-mentioned 5 common and 5 frequent inset pests, date palm trees in the study region were subject to rare infestation with the larvae and adult beetles of the Bostrychid *Enneadesmus trispinosus* Oliver (Coleoptera : Bostrychidae) which infested into leaf mid-ribs and female flower fronds all the year round. *E. trispinosus* beetles bore into the mid-ribs of date palm leaves and their fruit bunches in Libya (Bitaw and Ben Saad, 1990).

4- General remarks:

In spite of the fact that, at least, 10 insect pests of variable economic importance (common and frequent species) were recorded on date palm trees at Al-Arish region no natural enemies were associated with them except for an unidentified parasite, mostly *Aphytis* sp. (Aphelinidae: Hymenoptera), parasitizing upon the parlatoria scale *P. blanchardii.*

Surveyed date palm insect pests may be classified according to feeding behaviour into 5 groups including: 3 sap suckers (*P. blanchardii, P. marlatti* and. *D. brevipes*), 4 borers (*A. sabella, E. trispinosus, P. frontalis* and *P. excavatus*), a termite (*P. hypostoma*), a foliage feeder (*S. gregaria*) and 3 fruit destroyers (*B. amydraula, C. dactyliperda* and *E. cutella*). Special attention ought to be paid to, at least, restore the current status of insect pests on date palm trees in Northern Sinai. Such attention has to concentrate on two main strategies. One is the protection from introduction of any new pests to the region particularly through prevention of offshoots coming from outside the region or the country. The second is avoiding, as much as possible, using insecticides for combating date palm insects and relying-instead-on the various available non-chemical pest control measures to maintain the still existing more or less naturally balanced agroecosystem of the region.

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Table 1: Insects recorded on date palm trees at Al-Arish region, Northern Sinai, Egypt.

No.	Species	Family	Order	Status	Frequency	Stage(s)	Attacked plant part(s)	Period of occurrence
1	*Psammotermes hypostoma* (Desneux)	Rhinotermitidae	Isoptera	P	C	W	Al	Jan.-Dec.
2	*Parlatoria blanchardii* (Tragioni-Tozzetti)	Diaspididae	Homoptera	P	C	As	Lb,Lt, Ff, Ft & Sp	Mar.-Dec.
3	*Phoenicococcus marlatti* Cockerll	Phoencococcidae	Homoptera	P	C	As	Lb,Lt,Mr&Rt	Mar.-Dec.
4	*Dysmicoccus brevipes* (Cockerell)	Pseudococcidae	Homoptera	P	C	N&A	Rt	Apr.-Jan.
5	*Batrachedra amydraula* Meyrick	Momphidae	Lepidoptera	P	C	L	Ff&Ft	Apr.-Jul.
6	*Arenipses sabella* Hampson	Pyralidae	Lepidoptera	P	F	L	Ft&Sp	Mar.-Oct.
7	*Ephestia cautella* (Walker)	Pyralidae	Lepidoptera	P	F	L&A	Ft	Sep.-Dec.
8	*Coccotrypes dactyliperda* (Fabricius)	Scolytidae	Coleoptera	P	F	L&A	Ft	Apr.-Dec.
9	*Phonapate frontalis* Fahraeus	Bostrychidae	Coleoptera	P	F	L&A	Ff&Mr	Jan.-Dec.
10	*Enneadesmus trispinosus* Olivier	Bostrychidae	Coleoptera	P	R	L&A	Ff&Mr	Jan.-Dec.
11	*Phyllognathus exeavatus* Forster	Scarabaeidae	Coleoptera	P	F	L&A	Lb&Rt	Apr.-Dec.
12	*Schistocerca gregaria* (Forskal)	Acridide	Orthoptera	V	R	N&A	Lt,Ft&Os	Mar.-Oct.
13	*Drosophila melanogaster* Meigen.	Drosophilidae	Diptera	Sy	R	L&A	Ft	Sep.-Nov.

C: common **F: frequent** **R: rare**
A: adult **As: all stages** **L: larva** **N: nymph** **W: worker**
Al: all parts **Lb: leaf base** **Lt: leaflet** **Ff: female flower** **Ft: fruit**
Mr: mid- rib **Os: offshoots** **Rt: root** **Sp: spathe** **St: stem**
P: pest **V: visitor** **Sy: saprophyte**

Preliminary Biological Studies on Some Date-Palm Insects in Syria

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ABSTRACT

Date-palm trees in Deir-Ezzor area in Syria are infested with three species of insects: the Parlatoria date scale (*Parlatoria blanchardi Targ.*), the saw-toothed grain beetle (*Orizaephilus surinamensis, L.*), and the lesser date moth (*Batrechedra amydraula Mey*). Degree of infestation was determined and it was found that the percentage of fallen fruits reached 63 % of the total number of fruits on the tree. The percentage of infested fruits reached 39 % of the total number of fallen fruits.

A laboratory study was conducted to show the effects of various temperatures on the duration of life cycle of *O. surinamensis* and on the percentage of infestation in stored fruits. Results demonstrated that the duration of life cycle of the insect varies from 25 to 50 days in a temperature that varies between 20-35 °. It was also found that the ideal temperature to the evolution of the insects is 30-35 °, and that this evolution interrupts in the pupal stage by a temperature of 15 ° and 40 °. The percentage of infestation reached 68 % in the ideal temperature, whereas it decreased by a temperature of 15° and 40 °.

INTRODUCTION

Date-palm (*Phoenix dactylifera L.*) is considered to be as one of the most important fruit tree in the Arab countries. It is believed that this tree is native in the areas surrounding the Arab gulf. The production of dates in the Arab countries accounts for 85 % of the international production. About 32.4, 53.0, 71.0, and 82.3 kg/per tree per year were reported in Yemen, Saudi Arabia, Spain and USA, and {Pakistan, respectively. A production of 12 kg/tree/year was reported from Mauritania. Many factors could be held responsible for the low level of production, among of which is infestation with insects pests.

In Syria, agricultural statistics showed that date-palm trees are cultivated in arid regions around Palmyra and in some eastern areas along the Euphrates basin (i.e., from Deir-Ezzor to Al-Bokamal), in addition to some dispersed trees in other areas of Syria.

This research was undertaken to (1) determine the most important insects that infest date palms in Deir-Ezzor area in Syria, (2) determine the insects that infest stored fruits, either local or imported, and (3) study the effects of temperature variations on some biological features of insects infesting stored fruits in order to determine the evolution of these insects to establish the ideal conditions of storing dates.

MATERIALS AND METHODS

1 - Field experiment:

This experiment was conducted to study the cultivation areas of date - palm in Deir-Ezzor. Trees (n = 140) were examined but samples were randomly taken from 14 trees. The samples consisted of 1-2 leaves, 40-50 cm long each, and taken from each side of the tree's four sides.

Fallen fruits were collected to calculate the ratio of infestation. Samples were transferred into a laboratory to be examined and to determine the nature and site of infestation on the date palm.

To measure the degree of infestation with Parlatoria date scale (*Parlatoria blanchardi* Targ), a simplified scale was followed:

1 - Very slight infestation	3 Insects on the leaflet
2 - Slight infestation	3-10 Insects on the leaflet
3 - Medium infestation	More than 10 Insects on the leaflet
4 - Severe infestation	The number of full infested leaflets is lesser than the number of non-infested leaflets on the leaf
5 - Very severe infestation	The majority of leaflets on the leaf are infested

Table (1): Simplified scale of Parlatoria infestation

2 - Laboratory experiment:

400 fruits of two different varieties were examined (200 fruits of a dry variety and 200 fruits of a semi-dry variety). The examination lead to the determination of insect species, infestation's ratio, and infestation's phase.

3- Study of effects of temperature variations on the duration of life cycle of *Orizaephilus surinamensis* L.

This experiment was conducted by putting dates free from any insect infestations in clean and sterile Petri dishes to serve as a nutritive milieu. Adult saw-toothed grain beetles were obtained from other infested dates and put together three pairs in each Petri dish. The experiment was conducted on four replicates and a fifth Petri dish was left for control.

The Petri dishes were covered with a tissue sheet and closed tightly to prevent circulation of beetles from one dish to another, and then put in an incubator for various periods and in various temperatures: 15, 20, 25, 30, 35, and 40 ° with a relative humidity of 60 ± 5 %.

Petri dishes were left in the incubators to obtain the whole generation, and were exchanged with other dishes when done. The variation of infestation's ratio with temperature's variation was also studied. The percentage of infestation was given according to the number of insects found on dates. Table 2 shows the scale of infestation used in the study.

Infestation's ratio	5 %	20 %	40 %	60 %	80 %	100 %
Number of insects	1	5	10	15	20	25

Table (2): The scale used to determine the infestation caused by *O. surinamensis*.

Results and Discussion:

1 - The foliage of date palms were infested with *P. blanchardi Targ*). Table 3 shows the mean number of insects on the examined samples and the ratio of infestation according to a scale consisted of five grades.

2 - Fallen fruits were collected, examined and found to be infested with *O. surinamensis* and the lesser date moth (*Batrachedra amydraula Mey*). Table 4 shows the number of examined fruits, the percentage of fallen fruits to the total number of fruits, and the infested / non-infested ratios.

Grades of the scale	Percentage of infestation	Mean number of insects on the leaflet	Number of samples examined
1	30 %	3	4
2	40 %	10	5
3	60 %	60	7
4	80 %	150	10
5	90 %	More than 150	7

Table (3): The mean number of insects on examined samples and the percentage of infestation by *P. blanchardi*.

	Fallen fruits	Infested fruits	Non-infested fruits
Number of examined fruits	47	30	17
Percentage	63 %	39 %	24 %

Table (4): Percentage of fallen fruits, and infested and non-infested fruits.

3 - Stored dates were infested with the following insects:

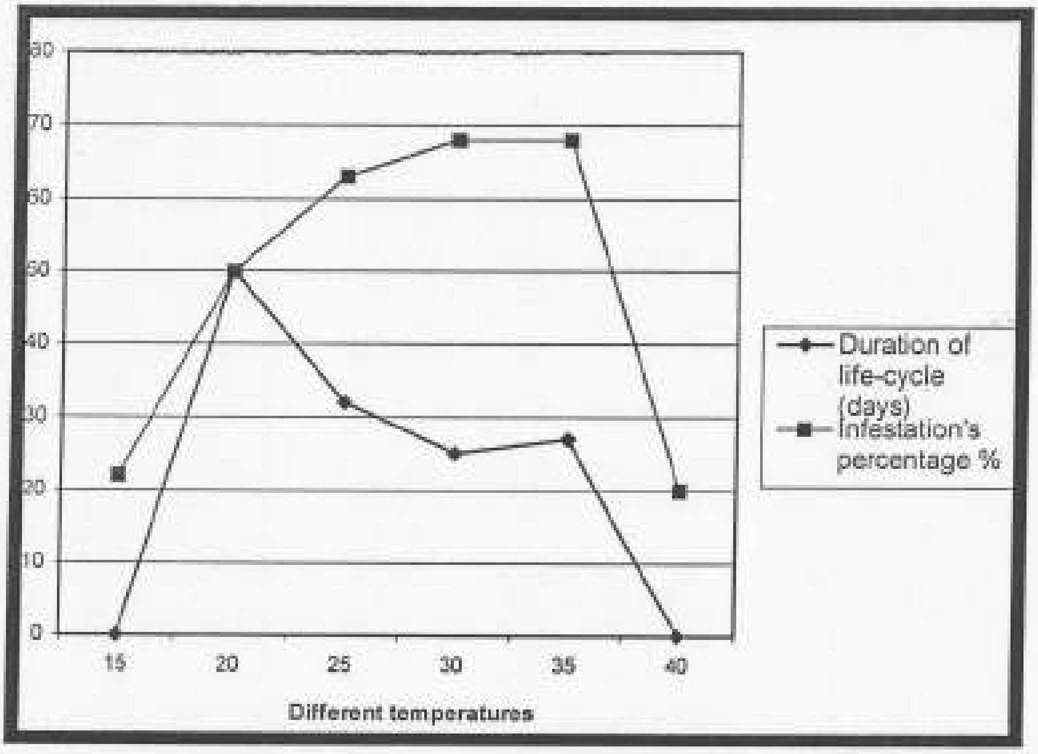
Species	Infestation's ratio	Infestation's phase
Saw-toothed grain beetle *Orizaephilus surinamensis, L.*	10 %	Adult
Khapra beetle *Trigoderm granarium , Everts*	6 %	Larva
Indian meal moth *Plodia interpunctella, Hbn*	1 %	Larva

Table (5): Ratio and phase of infestation by several species found on stored dates.

4 - The effects of variant temperatures on the duration of life cycle of the saw-toothed grain beetle and the percentage of infestation among stored dates with it were all studied. The results obtained are arranged in table 6 and are clarified in the graphic line.

Temperature ° c	Duration of life-cycle (days)	Infestation's percentage %
15	No evolution was reported	22
20	50	50
25	32	63
30	25	68
35	27	68
40	No evolution was reported	20

Table (6): The variations of the duration of life cycle of the saw-toothed grain beetle with various temperatures and the percentage of infestation on stored dates.



Graphic line that shows the duration of life cycle of the saw-toothed grain beetle according to variant temperatures and the infestation's percentage in stored dates.

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دراسة أولية بيولوجية لبعض حشرات النخيل في سوريا

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الملخص :

تم تحديد ثلاث حشرات تصيب أشجار النخيل في منطقة دير الزور في سورية، الحشرة القشرية البيضاء *Parlatoria blanchardi Targ* على سعف النخيل، والخنفساء المنشارية *Orizaephilus surinamensis L.* ودودة البلح الصغيرة (الحميرة) *Batrachedra amydraula Mey* ، وذلك على ثمار النخيل المتساقطة. ووجد أن نسبة الثمار المتساقطة تصل إلى ٦٣ % من مجموع الثمار على الشجرة ونسبة الثمار المصابة ٣٩ % من الثمار المتساقطة. وبدراسة مخبرية عن تأثير درجات الحرارة المختلفة على طول دورة حياة الخنفساء المنشارية ونسبة إصابة التمور المخزونة بها، وجد أن طول دورة حياة الحشرة يتراوح بين ٢٥ و ٥٠ يوماً على درجة حرارة بين ٢٠ - ٣٥ ° م، ووجد أن أنسب درجة حرارة لتطور الحشرة هي ٣٠ - ٣٥ ° م. ويتوقف تطور الحشرة في طور العذراء عند الدرجة ١٥ و ٤٠ ° م. وقد وجد أن نسبة الإصابة قد بلغت ٦٨ % على درجة الحرارة المثلى، بينما انخفضت نسبة الإصابة بالحشرة على درجة الحرارة ١٥ و ٤٠ ° م.

INTEGRATED PEST MANAGEMENT FOR THE CONTROL OF RED PALM WEEVIL *RHYNCHPHORUS FERRUGINEUS* OLIV IN THE UNITED ARAB EMIRATES, EASTERN REGION, AL AIN.

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ABSTRACT

Date Palm Weevil (*R. ferrugineus*) is a serious pest that may affect date production. Therefore, an Integrated pest Management (IPM) program was initiated in 1990 for its control in the Department of Agriculture and Livestock farms. Over 10,000 infested palms were injected and sprayed with one insecticide (Carbosulfan 25% EC, Primiphos ethyl 50% EC or Dimethoate 41% + Phenthoate 11% EC). Aluminium phosphide 56-57% tablets were used when necessary. Ninety eight percent of the injected palms survived. In seasons 1991/92, 1992/93, and 1993/94 insecticide injection and spraying reduced infestation to 0.7, 0.8, and 0.6%, respectively. When Endosulfan 40% + Dimethoate 18% EC was used in seasons 1994/95, 1995/96, and 1996/97, infestation was reduced to 1.3, 1.1 and 0.7%, respectively. Aggregation pheromone (4-methyle-5 nonanol (9 parts) +4-methyl-5- nonanone (1 part) gave high weevil catch in March and April. Infestation was reduced by 63.5% when pheromones were included with injection and spraying treatments, as compared to 3.58% reduction when pheromones were not included. So IPM program for the control of Red palm Weevil, using pesticide injection and spraying plus aggregation pheromones, was adopted and applied. Aluminium phosphide tablets are used when necessary.

INTRODUCTION

Red palm weevil, *Rhynchophorus ferrugineus Oliv. (RPW) (curculionidae, Coleoptera)* is a serious pest attacking different species of palm trees (e.g. date palm, Coconut palm, and royal palm). The pest has been reported in Asia, Australia, Philippines, and Thailand as early as 1962 (Mathen, 1962 & Wygner, 1962). In 1963, the weevil was reported in Iraq (Abdo Rubo, 1963). Lever (1969) advocated that the origin of RPW is Tropical Africa, although Abraham (1975) claimed that its origin is India. Later the weevil was recorded in India, SeriLanka, Indoesia, Burma, punjab, and Pakistan (Lakshmanan, 1972 & Muthuraman, 1984). In the United Arab Emirates, the pest was first reported in the Northern

Emirates in 1985. Since then the weevil spreaded almost all over the Emirates.

The larvae are the most destructive stage of the weevil as they penetrate deep in the lower part of the stem causing a lot of damage to the internal tissues. When the infestation is severe, the whole tree falls and dies.

Means of control were directed towards the larvae inside the stem using insecticide injection. Lepesme (1974) in India reported that the injection of Fenthion 0.2% and Carbaryl 1% was most effective in controlling the larvae. In 1956, Monocrotophos injection gave good results (Nirula, 1956). Mathen (1967) used Endrin 0.05% for the control of the larvae. In Latin America, Dipterex, Lannate, and Pirimicid injection were found most effective in controlling the larvae (Frohlich, 1970). Pyrethrum 1% (Lakshmanan, 1972) and Pyrethrin piperonyl-butoxide 1% (Roa 1973) injection gave good control of the larvae. Dean (1976) found that Dichloroveos 0.25%, Methyl-demeton 0.5%, Phsphamidon 0.5%, Propoxur carpoxur 0.5%, Trichlorphon 0.1%, Malathion 0.1%, and parathion 0.2% injections were most effective in controlling larvae in India. Aluminum phosphide (Phostoxin) tablets embedded around the infested area also resulted in good control of the larvae (Lepesme, 1947; Nirula, 1956 and wygner, 1962).

Recently El Ezaby (1997) of the Department of Agriculture & Livestock, Al Ain, reported that insecticides such as Carbosulfan 25% EC (Marshal), Pirimiphos ethyle 50% EC (Pirimicid), and Dimethoate 11% + Phenthoate 41% EC (Rogodial) in Laboratory tests resulted in 80-100%, 90% and 100% mortality of the adults, pupae and larvae, respecitively. Under field conditions the injection of the same insecticides in seasons 1991/92, 1992/93 and 1993/94 reduced RPW infestation to 0.6%, 0.8%, and 0.7%, respectively.

MATERIALS & METHODS

1- LABAROTORY EXPERIMENETS:

The mortality rates of the new hatching and one month old larvae, pupae, and adults were evaluated in the laboratory using Rolfan and Marshal insecticides.

1.1. Young larvae: Five larvae were fed on sugar cane tissues dipped for 30 seconds in diluted Rolfan and Marshal. Five larvae were fed in treated sugar cane tissues. In the control, five larvae were fed on sugar cane tissues soaked in water only. Four replicates of each treatment were made. Mortality was evaluated 24 hours later.

1.2. One-month old larvae: One-month old larvae were embedded inside the tissue of young date palm tree free from any infestation. The tissue was then treated with diluted Rolfan and Marshal, while the control was soaked in water only. Dead larvae were counted 7 days later and percentage kill was evaluated.

1.3. Pupae: Ten pupae of the same age-group were dipped for 30 seconds in the diluted insecticide Rolfan and Marshal, while in the control, ten pupae were dipped in pure water only. After all pupae in the control emerged, the dead pupae dipped in the insecticides were counted. Percentage kill was calculated.

1.4. Adults: Five males and five females adults of the same age-group were embedded in date palm tissue treated with diluted insecticides Rolfan and Marshal separately. Cotton soaked with nutrients for adults feeding was added. In the control, palm tissue was soaked with water only. Dead adults were counted within a period of 1-12 days.

2- FIELD EXPERIMENTS

Evaluation of insecticides Marshal, Pirimicid and Rogodial in controlling RPW in the field in seasons 1991/92, 1992/93 and 1993/94 were reported (Al Ezaby, 1997). In seasons 1994/95, 1995/96 and 1996/97 Rolfan (Dimethoate 40% + Endosulfan 18% EC) was evaluated with Marshal only.

Adults, pupae, and larvae present in the infested palm were removed with the damaged stem tissues. Holes 10-cm above the infested area were made by a chisel 1.25-cm in diameter and 30-cm long. Depth and angle of hole depends on stem size and location of infestation. Concentrated insecticides were then injected in the holes by a special glass syring. Dose of 5, 10, 15 or 20 ml of the insecticide per palm ree depends on the diameter of the stem and degree of infestation. Soil was heaped around the roots and about 10-cm. Above the stem. Then the treated area was covered with plastic sheets to trap and kill any emerging adults or larvae, and to help the development of new roots.

Table 1: Number, angle, and depth of hole per palm and dose of insecticide used.

Group	Palm diameter (m)	Dose per palm (ml)	No. of holes per palm	Hole angle (Degree)	Chisel depth (cm)
1	Less than 1	5	1	30	3-5
2	1.5	10	2	45	5-10
3	1.5-2	15	2-3	60	10-15
4	More than 2	20	3-4	60	20

2.1. Small Scale Experiments: four Centres where infestation of RPW was high were chosen. Three infested palms per farm were injected with concentrated Rolfan. Doses were 5, 10, 15 or 20 ml/plant depending on the stem size and the degree of infestation.

Efficiency of the insecticide on controlliing infestation was evaluated after 30 days on external symptoms on scale where.

A: No external infestation symptoms.

B: Dryness of up to third-leaf row.

C: Dryness of the heart of the palm tree.

D: Presence of fruits.

E: Development of new offshoots.

F: Collapse death of the palm tree.

2.2. Large Scale Survey: In the thirty Centres of the Department of Agriculture & Livestock there are 6,177 farms with a total of 1,108,723 date palm trees of different cutivars and age. During seasons 1994/95, 1995/96 and 1996/97, the number of infested farms were counted. All plam trees infested by RPW during the three seasons were injected with Marshal, Rogodial, Pirimicid or Rolfan. The percentages of infested farms and palm trees were calculated.

3. AGGREGATION PHEROMONES

Aggregation pheromones have been reported as effective tools for monitoring and trapping of RPW in the field (Lepasme, 1974; Nirula, 1956; Wygner, 1962; Mathen, 1967; Frohich 1970; Lakshmanan, 1972;

Roa, 1973; Dean, 1976; El Hideri, 1980; Gunnawardena & Bandarge, 1995b; El Garhy, 1996 and El Ezaby, 1997).

3.1. Small Scale Experiment: An aggregation pheromone obtained from Costa Rica under trade name: Lures + ferrolure or pheromone lures *Rhyunchophorus ferrugineus* with chemical name: 4-methy 1-5-nonanol (9 parts)+4-methy 1-5 nonanone (1 part)-99.9% purity + 0.1% colorant and 0.1% antioxidant, was evaluated for RPW catch in the field.

Trap consists of 10 litre plastic bucket with a cover, with four 2.5x6 cm openings for the entrance of the attracted adults. About 600 mg of the pheromone are contained in a bag 3.5x6 cm in dimension made from special plastic that allows the release of the pheromone slowly and at a constant rate. The pheromone lures are hanged from underneath of the bucket cover. Soft date fruits, treated with granular insecticide Furidan or Marshal 5G are put at lower part of the bucket as baits. The bucket is covered from the outside by rought cloth to allow the adults weevils to crawl up easily to the openings, rather than falling down from the smooth surface of the bucket.

In Al Saad West and She Bin Ammar Centres, two farms with high degree of infestation were selected where ten traps were hanged on ten infested palms per farm. The pheromone lures and baits were changed regularly. Catches were collected up to December 1996.

3.2. Large Scale Experiment: In eight Centres, ninety three farms with continuous RPW infestation were selected and in each farm five traps were hanged on the infested palms 50 cm above the ground level. Pheromone lures were changed when necessary. Catches were collected regularly over a period of twelve months.

RESULTS AND DISCUSSION

LABORATORY EXPERIMENTS

1. Larvae: Insecticide Rolfan and Marshal gave 100% kill of newly hatched larvae (Table 2) and 97% and 87.2% kill of one-month-old lavae, respectively (Table 3).

Table 2: Evaluation of Insecticides on young larvae (Laboratory Evaluation 29/5/1993).

Insecticide tested	Dose (ml/l)	Number of larvae		Percentage kill (%)
		Living	Dead	
Rolfan	2	00	20	100
Marshal	3	00	20	100
Control	Water	20	00	00

Table 3: Evaluation of insecticides on one-month old larvae (Laboratory Evaluation).

Insecticide tested	Dose (ml/l)	Number of larvae		Percentage kill (%)
		Living	Dead	
Rolfan	2	01	33	97.0
Marshal	3	05	35	87.2
Control	Water	36	04	02.3

2. *Pupae:* Pupae were 100% and 80% killed by Rolfan and Marsha, respectively (Table 4).

Table 4: Evaluation of insecticides on pupae (Laboratory Evaluation 26/11/1994).

Insecticide tested	Dose (ml/l)	Number of living pupae			Percentage kill (%)
		1/12/94	4/12/94	14/12/94	
Rolfan	2	7	0	0	100
Marshal	3	7	3	2	80
Control	Water	10	10	10	00

3. *Adults:* Rolfan and Marshal also reduced the number of adults by 100 and 80%, respectively (Table 5).

Table 5: Evaluation of insecticides on adults (Laboratory Evaluation 19/11/1994).

Insecticide	Dose (ml/l)	Sex no.	21/11/94			24/11/94			1/12/94			Kill (%)
			L	P	D	L	P	D	L	P	D	
Rolfan	2	5 M	0	2	3	0	0	5	0	0	5	100
		5 F	0	0	5	0	0	5	0	0	5	
Marshal	3	5 M	0	5	0	2	3	0	2	0	3	80
		5 F	0	5	0	0	5	0	0	0	5	
Control	Water	5M	5	0	0	5	0	0	5	0	0	0
		5 F	5	0	0	5	0	0	5	0	0	

M: Male – F: Female – L: Living – P: Paralyzed – D: Dead

FIELD EXPERIMENT

1. *Small Scale Experiment:* In the four Centres where infested palm trees were injected with Rolfan, infestation was reduced by and average of 96.4%. externally no dry leaves were observed, while new offshoots were developed and fruiting was up to 79.8% (Table 6).

Table 6: Effect of insecticide (Rolfan) of weevil infestation based on external symptoms (Field Experiment).

Centre	Dry leaves	Dryness of heart	Fruits presence (%)	New off shoots (%)	Death (%)	Palm recovery (%)
Saad East	0	0	57.1	90.5	0.0	95.2
Saad Sout	0	0	76.2	95.2	4.8	95.2
She Bin Ammar	0	0	90.5	95.2	0.0	95.2
Al Yahar	0	0	95.2	85.7	0.0	100
Average	0	0	79.8	91.7	1.2	96.4

2. *Large Scale Survey:* The large scale survey carried out during three congestive seasons in thirty Centres with 6.177 farms with a total of 1,108,723 date palm trees. Survey showed that the percentages of infested farms were 28.7%, 33.4% and 20.3% in seasons 1994/95, 1995/96 and 1996/97, respectively (Table 7).

On the other hand, the number of infested palm trees, injected with insecticide privimicid, Marshal, Rogodial, or Rolfan were 15,224 11,944 and 7,769 in seasons 1994/95, 1995/96 and 1996/97, respectively. It is clear that insecticidal injection reduced the number of infested palms from 15,224 in season 1994/95 to 7,769 in season 1996/97, which is about 49% reduction (Table 8).

On an average insecticide injection reduced infestation to 1.3%m 1.1% and 0.7% in seasons 1994/95, 1995/96 and 1996/97, respectively (Table 7). Again, injection reduced infestation by up to 46% in season 1996/97 as compared to season 1994/95.

AGGREGATION PHEROMONES

I. Small Scale Experiment: It is clear that during the winter the adult insects are very active and increased in number as from January. Maximum catches in Al Saad West were 14.3 and 37.8 and in She Bin Ammar 15.0 and 30.5 insect per trap in March 1995 and March 1996, respectively. Then in both Centres and during the two seasons catches were getting less as temperatures increased (Table 9).

Table 7: Percentages of infested farms and infested palm trees in thirty centres (Field Experiment – Seasons 1994/95, 1995/96 & 1996/97)

Centre	Total no. of farms	Percentage of infested farms (%)			Total no. of palms	Percentage of infested palms (%)		
		94/95	95/96	96/97		94/95	95/96	96/97
Abu Samra	384	25.2	30.4	8.6	54,355	0.5	0.3	0.4
Al Ain	95	22.6	26.9	36.8	59.957	9.3	1.9	0.3
Al Arad	188	19.5	28.3	16.0	21.307	1.3	1.5	2.0
Al Fagah	70	37.3	25.5	14.3	18.002	0.8	0.3	0.1
Al Hayer	189	36.9	28.8	39.7	48.366	1.5	0.9	0.6
Al Khazna East.	258	27.4	40.5	33.3	43.937	1.0	1.6	1.6
Al Khazna West	209	25.6	37.7	36.8	37.956	0.8	1.6	1.4
Al Oya	230	9.4	26.7	20.0	20.608	0.2	0.5	1.0
Al Qattara	213	8.4	5.4	19.2	102.973	0.1	0.2	0.2
Al Saad East	90	33.6	29.1	38.0	19.938	2.1	1.3	2.2
Al Saad South	175	19.8	30.6	21.1.	24,561	0.6	0.5	0.9
Al Saad West	136	24.8	34.8	36.0	32.523	0.8	1.3	0.5
Al Shewaib	50	0	2.0	4.0	13.371	0	0	0.5
Al Sulimat East	283	46.	51.8	10.6	36.850	1.8	2.5	1.6
Al Sulimat West	307	23.0	31.5	8.0	39.800	0.4	0.8	0.4
AL Wagon East	86	12.8	26.7	32.6	17.171	0.2	0.4	0.7
Al Wagon West	344	56.2	55.6	14.0	69.782	0.9	0.6	0.7
Al Yahar	54	84.2	45.6	66.7	39.646	1.8	1.5	1.7
Gumoth	476	19.5	24.9	11.1	62.588	0.4	0.5	0.7
Moheir	153	0	4.6	10.5	24.313	0	0.4	0.4
Ramah	213	27.5	56.9	32.2	140.590	1.2	1.8	0.3
She Bin Ammar	138	44.1	44.9	29.7	68.759	1.1	1.0	0.7
Sewaihan	218	65.0	60.0	50.0	68462	2.4	2.1	1.4
Um Ghafa	71	0	0	7.0	14.343	0	0	0.1
Total	6.177	28.7	33.4	20.3	1.108.723	1.3	1.1	0.7

Table 8: Number of palm trees with insecticides primicid, Marshal, Rogodial, and Rolfan (Field Experiments – Seasons 1994/95, 1995/96 & 1996/97).

Centre	Total number of palm trees	Number of treated palm trees (Injection)		
		1994/95	1995/96	1996/97
Abu Samra	54.355	252	175	211
Al Ain	59.957	5.602	1.127	185
AL Ain Exp. St.	1.940	1	10	16
Al Arad	21.307	283	312	419
Al Fagah	18.002	149	59	25
Al Hayer	48.366	744	420	302
Al Khazna East.	43.937	415	707	707
Al Khazna West	37.956	312	608	529
Al Oya	20.608	40	104	207
Al Qattara	102.973	113	166	217
Al Saad East	19.938	414	252	430
Al Saad South	24.561	134	122	221
Al Saad West	32.523	257	453	158
Al Shewaib	13.371	0	2	60
Al Sulimat East	36.805	663	936	585
Al Sulimat West	39.800	138	334	161
Al Wagon East	17.171	25	73	120
Al Wagon West	69.782	640	442	146
Al yahar	39.646	727	595	667
Gumoth	62.588	263	336	431
Moheir	24.313	0	89	93
Remah	140.590	1636	2504	463
She Bin Ammar	68.759	756	699	445
Sewaihan	68.462	1660	1429	961
Um ghafa	14.343	0	0	9
Total	1.108.723	15.224	11.944	7.769

Table 9: Average weevil catch by aggregated pheromone (Adult/Trap) (Field Experiment – 1995 and 1996 seasons).

Month	Season 1995		Season 1996	
	Saad West	She Bin Ammar	Saad West	She Bin Ammar
January	0.7	0.4	1.4	0.5
February	0.8	1.6	21.7	13.5
March	14.3	15.0	37.8	30.5
April	6.8	2.7	13.4	.6.4
May	4.9	4.0	3.5	2.7
June	6.3	3.0	3.4	1.5
July	9.6	4.8	1.0	2.3
August	0.8	1.5	1.4	0.1
September	0.8	1.8	1.4	0.5
October	1.0	0.7	2.2	1.3
November	1.3	0.5	0.6	0.8
December	0.4	0.3	0.1	0.3

2. Large Scale Survey: Similarly catches increased in winter reaching maximum in the eight Centres, with an average of 4.2 and 9.2 insect per trap in March and April, respectively Again, catches decreased in number during the summer (Table 10).

Table 10: Total number of weevil catch by aggregation pheromone (Season 1996)

Month	Abu Samara	Al Ain	Qattara	Sulimat West	Saad West	Saad South	Fagah	Wagan East	Month average
Oct.	26	35	17	34	93	66	13	6	0.6
Nov.	70	56	16	77	268	120	53	22	1.5
Dec.	56	26	12	43	143	84	16	9	0.8
Jan.	39	18	28	25	99	88	10	12	0.7
Feb.	165	37	9	114	190	100	164	34	1.5
Mar.	338	117	46	212	658	217	278	77	4.2
Apr.	947	328	145	708	1004	621	368	159	9.2
May.	111	148	22	27	326	90	61	7	1.7
Jun.	65	109	9	43	183	112	73	11	1.3
Jul.	12	219	22	16	171	115	731	18	1.4
Aug.	77	184	22	7	159	68	72	10	1.3
Sep.	72	132	8	16	89	83	19	34	1.0

A correlation between the use of pheromone traps and weevil infestation was observed. Infestation was reduced by 63.5% and 35.8% in the farms with or without pheromone traps, respectively (Table 11).

Table 11: Percentages of infested palm tree with or without aggregation pheromone traps and total number of weevil catch.

Centre	Total catch	Number. Of infested palms (pheromone present0		Number of infested palms (No pheromone)	
		1995/96	1996/97	1995/96	1996/97
Abu Samara	1.987	66	97	109	114
Al Ain	1.409	694	116	433	69
Qattara	356	5	8	161	209
Sulimat West	1.322	61	48	273	116
Saad West	3.383	164	41	289	117
Saad South	1.764	63	82	59	139
Fagah	1.100	52	16	7	9
Wagan	399	17	2	56	118
Total	11.711	1.122	410	1.387	891
Percentage Reduction (%)		63.3		35.8	

From these results, spraying program for the control of Red Palm Weevil may be planned in January and February before the adults reach their maximum population in March and April. Adults should be controlled before they lay their eggs, as larvae are the most destructive stage.

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SUSCEPTIBILITY OF SOME DATE-PALM CULTIVARS TO THE ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA*

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ABSTRACT

Seventeen date-plam cultivars were screened to determine the effect of the tested date-palm seedlings on development and reproduction of *Meloidoyne incognita*. The nematode development and reproduction varied according to the tested cultivar. Zanati was the only immune cultivar as nematode infestation did not survive on its roots. Six highly resistant cultivars; Aynat, Malakabi, Orabi, Sakkoti, Samani and Seqii were recorded in this study. Other cultivars presented different degrees of resistance. Production of phenols and/or inhibitory hormones and/or toxins to the parasitizing nematodes are probably responsible of resistance mechanism in early growth stage of date-plam.

INTRODUCTION

The world produce 4.4 Million tons of date (FAO, 1997) 97.1% of the World date production are from Arabian and Islamic countris. Date-plam is not only valuable as economic and social aspects; but also it is documented in relegions, history and arts.

Several nematode pests were recorded as parasites to date-plam roots causing losses in the early stage of growth (Nurseries). The root-knot nematodes, *Meloidogyne spp.* are some of the most comon wide-spread nematodes all-over the World (Sasser, 1989). These pests act as endoparasites and have hundreds of hosts under field conditions.

Few studies have been conducted on host reaction of date-plam cultivars to detect their relative susceptibility to root-knot nematode species. Carpenter (1964) tested 50 date-palm cultivars against *Meloidogyne javanica* infection. The cultivars Braim, Hayany and Honey were rated as susceptible cultivars to the nematodes, but Amhat and Deglet Noor were ranked as tolerant to nematode infection. Lamberti and Greco (1977) reported that four cultivars of date-palm, i.e., Bou Feggous, Kabkab, Medijool and Deglet Noor, were screened for resistance to three populations of both *Meloidogyne incognita* and *M. javanicap.* Deglet Noor cultivar was generally rated as poor host to nematode infection. Grifftth and Koshy (1990) stated that young seedlings of 50 date-palm cultivars were susceptible to infection by root-knot nematode. Moreover, 90% of the tested seedlings were killed prior to emergence when seeds were sown in heavly infected soil.

The present article investigates the susceptibility of 17 date-palm cultivars, at their early stage of growth, to *M. incognita*.

MATERIALS AND METHODS

Under greenhouse conditions, 17 date palm cultivars were screened to *M. incognita* infection. The tested cultivars were Aglani, Amhat, Aynat, Bent-Eisha, Gondela, Hayany, Malakabi, Orabi, Saidi, Sakkoti, Samani, Seqii, Shamya, Sokarya, Wardy, Zaghlool and Zanati. Seeds of each cultivar were soaked in renewable tap water for one week, then incubated in wetted cloth for two weeks. Sprouted seeds were planted in 20 cm diameter clay pots filled with sterilized sandy loam soil. Two weeks later, five replicates from each cultivar were inoculated with 200 newly hatched purified *M. incognita* larvae/pot. Other five non inoculated pots from each cultivar kept as untreated control. The pots were watered regularily for 10 months.

Nematode extraction followed Jenkins (1964) technique. Nematode counting was done by 1 ml Hawksley eelworm counting slide. Nematode identification followed (Mai & Lyon,1975).

Roots were stained for further examination (Franklin and Goodey,1949). Data were recorded for number of root galls (G), developing larvae stages (D.S.), females (F) and egg-laying females (E.F.) per root system were estimated. Rate of nematode penetration, maturation, reproduction, potential eggmasses production, potential population density, rate of susceptibility and build-up were calculated according to the following formula (Oostenbrink, 1966): -

-Rate of penetration (R.P.) = $\frac{\text{Count of total nematodes in root tissues}}{\text{Count of nemetodes used for inoculation}}$ X100

- Rate of maturation (R.M.)= $\frac{\text{Total count of females+egg-laying females}}{\text{Total count of nematodes in the root tissues}}$ X100

-Rate of reproduction (R.R.)= $\frac{\text{Count of egg laying females}}{\text{Total count of females +egg-laying females}}$ X100

- Potential eggmasses production (P.E.P.)= $\frac{\text{Number of eggmasses/ cultivar}}{\text{Number of eggmasses/potential cultivar}}$ X100

-Potential population density (P.Pop.)= $\frac{\text{Total final population/cultivar}}{\text{Total final puplation of potential cultiver}}$ X100

-Rate of susceptibility (R.S.)= Average of P.E.P.+P.pop.

-Rate of build up (R.B.)= $\frac{\text{Total final counts of nemetodes in root and soil } (P_f)}{\text{Initial count of nematode used for inoculation } (P_i)}$ X100

RESULTS AND DISCUSSION

Susceptibility of seventeen date-palm cultivars to *M. incognita* was tested. Data on number of galls, nematode developmental stages, rates of reproduction and population build-up were recorded, ten months after the inoculation (Tables 1-3). Host susceptibility or resistance rates were also deterimned (Table 4). Reactions to *M. incognita* infection differed remarkably among date-palm cultivars. Aglani, Bent-Eisha and Zaghlool cultivars showed the highest *M. incognita* root gall index of four (Table 2). While, Aynat and Malakabi had the lowest index of 1.2. The other cultivars showed moderate root-gall indices. Zaghlool cultivar supported the highest *M. incognita* rate of build-up comparing to cultivar Orabi which showed the lowest rate (Table 3). Based on number, relative number of galls, developmental larval stages, mature and egg-laying females host susceptibility of cultivars was determined according to Hadisoeganda and Sasser (1982). The average of the aforementioned rates for each cultivar defined its host suitability category to nematode infection (Table 4). In this respect, cultivars Aglani, bent-Eisha and Zaghlool were rated as highly susceptible and cultivars; Amhat, Hayany and Slkarya were considered moderately susceptible. On the other hand, cultivars Aynat, Malakabi, Orabi, Saidi, Sakkoti, Samani and Seqii were categorized as highly resistant. The most promising cultivar was Zanati which proved to be immune to the tested *M. incognita* population. The nematode population density in soil were generally not always in consistence with their densities in the root system.

Growth response of date-palm cultivars to infection with *Meloidogyne incognita*:

The impact of *M. incognita* infection on the growth of 17 date-palm cultivars was studied. data on number of leaves, lengths and weights of both shoots and roots were recorded (Table 5). It is obvious that growth of all plants was greatly affected by the nematode infection. The reduction in number of leaves of most inoculated plants was not significant except for cv. Zaghlool which was 20.9%. The shoot length of all inoculated plants was not significantly different from uninoculated plants except for cvs. Aglani, Bent-Eisha and Saidi which were 27.5, 16.4 and 20.8% reduction, respectively. The shoot fresh weight reduction in all inoculated cultivars were not significant except for cvs. Amhat, Aynat, Shamya and Wardy which were 33.9 , 34.4, 21.8 and 20.7% reduction, respectively. Shoot dry weight in all inoculated cultivars were not significantly different from control plants except for Amhat, Aynat, Bent-Eisha and Malakabi which showed reduction of 28.9, 32.9, 21.5 and 16.4%, respectively. On the other hand, root length of most inoculated cultivars were significantly different from respective checks. However, reduction in root fresh weight and dry weight of most inoculated cultivars was not significant except for cultivars Aglani and Zaghlool.

Results indicated that most of the examined date-palm cultivars were infected with *M. incognita.* The tested cultivars, however, varied in their suitability as hosts to this nematode pest. They were classified into five groups starting from immune to highly susceptible. Immune and resistant date-palm cultivars may be cosidered the most economical components for *M. incognita* management. In this respect, one immune cultivar, Zanati, and six highly resistant cultivars; Aynat, Malakabi, Orabi, Sakkoti, Samani and Seqii were identified in the present study. The resistant cultivars probably produce phenols, enzymes, inhibitory hormones and/or toxins to nematode which prevent its development.

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Table (1): Number of *Meloidogyne incognita* developmental stages on seventeen date-palm cultivars +.

Cultivars	No. of developmental stages / root					
	2nd larvae	3 rd larvae	4 th larvae	Mature females	Total	Eggmasses
Aglani	2529	6	26	317	2878	102 bc
Amhat	426	13	48	183	670	30 cde
Aynat	0	0	0	3	3	1 e
Bent-Eisha	1036	127	194	755	2112	262 a
Gondela	0	75	33	55	163	24 de
Hayany	569	4	20	194	787	84 bcd
Malakabi	0	7	7	16	30	10 de
Orabi	0	3	4	5	12	5 e
Saidi	0	18	15	58	91	14 de
Sakkoti	332	4	4	17	357	12 de
Samani	21	20	12	34	87	15 de
Seqii*	0	6	2	14	22	8 de
Shamya	469	96	43	128	736	48 cde
Sokarya*	2123	57	42	116	2338	83 bcd
Wardy	0	119	74	100	293	35 cde
Zaghlool	2437	5	36	361	2839	145 b
Zanati	0	0	0	0	0	0

+ Means of 5 replicates.
+ Cultivars from Saudi Arabian origin.
- Data in columns followed by a common letter are not significantly different (P 0.05) accoridng to Duncan's multiple range test (DMRT).

Table (2): **Number of *Meloidogyne incognita* galls, second stage in soil, total nematode in root system and gall index on date-palm cultivars+.**

Cultivars	No. of 2nd stage in soil per plant	Total nematode stages in root system	Total	No. of galls per root	Root-gall index
Aglani	2387# a	2882 a	5269	51 b	4.0
Amhat	805 de	680 b	1485	26 cd	3.2
Aynat	195 g	3 g	198	2 h	1.2
Bent-Eisha	2422 ab	2119 a	4541	64 a	4.0
Gondela	527 def	163 d	690	5 fh	2.0
Hayany	1279 bcd	792 b	2071	45 b	3.8
Malakabi	158 fh	30 f	188	3 h	1.2
Orabi	53 g	12 h	65	10 efh	2.2
Saidi	0	94 e	94	16 def	2.1
Sakkoti	42 g	357 c	399	25 cd	2.0
Samani	122 h	89 e	211	17 de	2.2
Seqii*	48 g	22 f	70	9 efh	2.2
Shamya	256 efh	736 b	992	11 efh	2.4
Sokarya*	1026 cde	2338 a	3364	32 c	3.4
Wardt	431 def	293 cd	724	15 def	2.3
Zaghlool	2990 abc	2843 a	5833	56 ab	4.0
Zanati	0	0	0	0	0.0

+ Values are means of 5 replicates.

* Cultivars from Saudi Arabian origin.

Final nematode population/pot containing 2 kg soil where the initial nematode population. Were 200 larave/pot.

- Data in columns followed by a common letter are not significantly different (P 0.05) according to Duncan's multiple range test (DMRT).

Table (3): Nematode development and reproduction on date-palm cultivars infected with root- knot nematode, *Meloidogyne incognita.*

Cultivars	Rate of penetration[+] (R.P.)	Rate of maturation[+] (R.M.)	Rate of reproduction[+] (R.R.)	Rate of build-up[+]
Aglani	1650.5	12.7	75.7	28.4
Amhat	446.5	23.9	85.9	9.2
Aynat	3.5	57.1	75.0	1.03
Bent-Eisha	1568.0	32.4	74.2	27.8
Gondela	121.0	32.6	69.6	3.8
Hayany	534.5	25.9	69.8	11.7
Malakabi	28.0	46.4	61.5	1.1
Orabi	11.0	45.5	50.0	0.4
Saidi	83.0	43.4	80.6	0.8
Sakkoti	193.0	7.9	58.6	2.1
Samani	69.0	35.5	69.4	1.3
Seqii[*]	22.0	50.0	63.6	0.5
Shamya	456.0	19.3	72.7	5.8
Sokarya[*]	1268.5	7.8	58.3	17.8
Wardy	214.5	31.5	74.1	4.3
Zaghlool	1679.0	15.1	71.3	31.7
Zanati	0.0	0.0	0.0	0.0

[+] As indicated in materials methods.
[*] Cultivars from Saudi Arabian origin.

Table(4): Reproduction and population density of *Meloidogyne incognita* on 17 date-palm cultivars.

Cultivars	D.S	M.F	E.M	NL/S	T.F.P	R.P	R.M	R.R	P.E.P	P.Pop	Factor	R.S
Aglani	2882	317	102	2387	5688	1650.5	12.7	24.3	38.90	89.7	64.3	H.S
Amhat	680	183	30	805	1698	446.5	23.9	14.5	11.50	26.8	19.2	M.R
Aynat	3	3	1	195	205	3.5	57.1	25.0	0.38	3.2	1.8	H.R
Bent-Eisha	2119	755	262	2422	5558	1568	32.4	25.8	100.00	87.7	93.9	H.S
Goodela	163	55	24	527	769	121	32.6	30.4	9.20	12.1	10.7	M.R
Hayany	792	194	84	1279	2349	534.5	25.9	30.2	32.10	37.1	34.6	M.S
Malakabi	30	16	10	158	214	28	46.4	38.5	3.80	3.4	3.6	H.R
Orabi	12	5	5	53	75	11	45.5	50.0	1.90	1.2	1.6	H.R
Saidi	94	58	14	-	166	83	43.4	19.4	5.30	2.6	3.9	H.R
Sakkoti	357	17	12	42	428	193	7.9	41.4	4.60	6.8	5.7	H.R
Samani	89	34	15	122	260	69	35.5	30.6	5.70	4.1	4.9	H.R
Seqii	22	14	8	48	92	22	50	36.4	3.10	1.5	2.3	H.R
Shamya	736	128	84	256	1168	456	19.3	27.3	18.10	18.4	18.3	M.R
Sokarya	2338	116	83	1026	3563	1268.5	7.8	41.7	31.70	56.2	43.9	M.S
Wardy	294	100	35	431	860	214.5	31.5	25.9	13.40	13.6	13.5	M.R
Zaghlool	2842	361	145	2990	6338	1674	15.1	28.7	55.30	100.0	77.7	H.S
Zanati	-	-	-	-	-	-	-	-	-	-	0.0	—

D.S. = Developmental stage
M.F = Mature female
E.M.= Eggmass
NL/S = No.of larvae in soil
T.F.P.= Total final. population
R.P.= Rate of production
R.M.= Rate of maturation
R.R.= Rate of reproduction.
P.E.P= Potential egg mass production
P.Pop= Potential population
R.S.= Rate of susceptibility

HR 1-10 %
M.R 10-20 %
M.S. 20-50 %
H.S. >50 %

Table (5): Plant growth response# of seventeen date-palm cultivars as influenced by *Meloidogyne incognita* infection

Cultivars	Shoot growth +								Root growth +					
	No.of leaves		Length (cm)		Fresh weight (gm)		Dry weight (gm)		Length (cm)		Fresh weight (gm)		Dry weight (gm)	
	Con.	Inf.	Con.	Inf.	Con.	Inf.	Con.	Inf.	Con.	Inf.	Con.	Inf.	Con.	Inf.
Aglani	5	4	42.0	29.6*	3.9	3.8	1.5	1.4	63.0	32.8*	4.6	3.9	1.90	1.3*
		(20)		(27.5)		(3.5)		(6.9)		(47.7)		(14.4)		(24.9)
Amhat	4	4	31.4	27.8	6.7	4.1*	2.3	1.7*	60.8	28.6**	3.1	4.5	1.10	1.50
		(-)		(11.5)		(33.9)		(26.1)		(52.3)		(-)		(-)
Aynat	5	5	35.2	33.8	5.9	3.8*	2.3	1.5*	41.2	43.2	2.6	2.9	0.94	1.07
		(-)		(4.9)		(34.4)		(32.9)		(-)		(-)		(-)
Bent-Eisha	6	5	37.0	33.8*	6.8	6.3	2.2	1.8**	67.0	38.8**	3.4	5.9	1.03	1.60
		(20)		(16.4)		(3.2)		(21.5)		(43.1)		(-)		(-)
Gondela	4	5	32.0	36.2	8.4	8.8	2.4	2.4	40.0	44.0	3.7	5.2	1.50	1.40
		(-)		(-)		(-)		(-)		(-)		(-)		(6.7)
Hayany	5	5	31.8	33.8	6.04	7.2	2.3	2.4	57.0	36.0**	4.04	6.7	1.50	1.80
		(-)		(-)		(-)		(-)		(40.2)		(-)		(-)
Malakabi	4	4	30.4	33.6	6.5	5.5	2.3	2.1*	49.4	41.2*	2.9	4.1	1.04	1.2
		(-)		(-)		(15.4)		(16.4)		(19.1)		(-)		(-)
Orabi	4	4	21.4	20.4	3.7	3.6	1.4	1.5	50.4	43.20	4.2	4.2	1.20	1.40
		(-)		(6.7)		(3.7)		(-)		(14.3)		(-)		(5.0)
Saidi	4	4	40.6	31.8*	4.1	4.04	1.6	1.4	58.8	31.8**	3.3	3.5	1.20	1.2
		(-)		(20.8)		(1.5)		(13.5)		(43.6)		(-)		(-)
Sakkoti	4	4	30.8	29.4	3.08	4.5	1.18	1.58	21.0	34.4	2.7	4.2	1.06	1.6
		(-)		(4.5)		(-)		(-)		(-)		(-)		(-)
Samani	4	4	40.4	35.8	5.90	5.7	2.1	2.0	66.2	41.2*	2.6	2.9	1.08	1.3
		(-)		(11.4)		(3.7)		(4.8)		(34.2)		(-)		(-)
Seqii	5	5	29.2	28.0	5.3	6.7	2.1	2.4	47.6	42.4	3.7	3.9	1.5	1.6
		(-)		(4.1)		(-)		(-)		(10.9)		(-)		(-)
Shamya	6	6	37.6	37.2	9.4	7.5	2.8	2.3	54.6	48	4.2	5.5	1.4	1.9
		(-)		(1.1)		(21.8)		(17.9)		(12.1)		(-)		(-)
Sokarya	5	4	20.8	20.8	5.1	4.8	1.9	2.02	59.0	41.9**	2.2	2.3	1.0	1.8
		(20)		(-)		(5.9)		(-)		(23.9)		(-)		(-)
Wardy	5	4	30	34.4	5.8	4.5*	2.2	1.8	47.4	36.2*	2.9	3.7	1.06	1.5
		(20)		(-)		(20.7)		(18.2)		(24.4)		(-)		(-)
Zaghlool	7	5*	35.8	31.8	11.5	9.6	3.2	2.8	85.2	30.4**	6.9	4.5*	2.3	1.3*
		(20.9)		(13.2)		(17.6)		(13.8)		(64.4)		(37.8)		(43.5)
Zanati	4	4	19.8	19.8	2.8	2.8	1.2	1.3	59.0	62.0	2.4	2.6	1.4	1.5
		(-)		(-)		(-)		(-)		(-)		(-)		(-)

\# Values are means of 5 replicates.

(-) Figures in parenthesis indicated the percentage of reduction over the check plants.

* and ** indicate the significant and highly significant at p = 0.05 and 0.01, respectively.

HISTOLOGICAL RESPONSE OF SUSCEPTIBLE AND RESISTANT DATE-PALM CULTIVARS TO THE ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* INFECTION.

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ABSTRACT

The cellular alteration in *M.incognite* infected roots of susceptible and resistant date-palm cultivars were histologically studied. The most obvious cell reaction of the susceptible cultivar "Zaghlool" was the giant cell formation. In resistant cultivars "Deglet Noor" and "Samani" the infected roots reacted to the nematode infection by forming necrotic area around the invading nematode localities. Deformed portions of dead nematodes were found surrounded by deeply stained necrotic cells. In few cases, malformed small giant cells were observed in association with nematode larval stages.

INTRODUCTION

Numerous nematode pests were reported to attack date-palm roots causing considerable damage to the plants especially in their early stages. The root-knot nematodes, *Meloidogyne spp.* are some of the serious date-palm nematode pests. In 1993 Buhrer et al reported the occurrence of root-knot nematodes on date-palm in USA. Carpenter (1964) proved that cultivars of Deglet-Noor and Amhat were tolerant to root-knot nematode infection, while Braim, Hayany and Honey were rated as susceptible cultivars. Lamberti and Greco (1977) reported Deglet-Noor cultivar as least susceptible to *M.javanica* in Algeria. Minz (1963) from Palestine; Stephan (1986) from Iraq; Eissa et al. (1979) from Saudi Arabia and Ismail & Eissa (1993) and Youssef & Eissa (1994) from Egypt reported root-knot pathogenicity to date-palm. Griffin and Koshy (1990) stated that young seedlings of date-palm were killed (90%) in heavily ifested soil by root-knot nematodes.

Objective of this work is to illustrate the histological alterations of the infected date-palm roots.

MATERIALS AND METHODS

Date-palm seeds cvs. Zaghlool, Deglet Noor (Tunisian source) and Samani was prepared and planted . One inoculum level of *M.incognita* was introduced to the 4-weeks-old seedlings of each cultivar grown in 20 cm diameter clay pots. The inculum level was 5000 newly hatched *M.incognita* larvae/plant. For each cultivar four replicates were made. Inoculation was made by pipetting the proper aliquot into three holes around the root system of each seedling. All pots were kept in a greenhouse at 30 ± 5°C in a complete randomized block design and agronomically treated the same. After four months from inoculation time, the experiment was terminated and plants were uprooted and data on plant growth criteria and nematode populations were determined.

Portions of *M.incognita* infested roots of date-palm cvs. Zaghlool, Deglet Noor and Samani were fixed in F.A.A. and processed for histological technique according to the standard methods of Sass(1964). Dehydration was carried out in a serial concentrations of known volume of ethanol and butanol alcohols. Dehydrated root tissues were then infiltrated and imbedded in paraffin wax at 52°C for 10 days. During the wax infiltration process, air bubbles were removed from root tissues by vacuum. Sectioning of the processed root parts was made by a rotary microtome at 12 microns thickness. Staining was made by Safranin and Fast green and the stained sections were mounted in canada balsam. Sections were then examined under a light microscope.

RESULTS AND DISCUSSION

Stained root sections of the susceptible (Zaghlool) and resistant (Deglet Noor and Samani) cultivars of date-palm were examined under stereoscopic microscope. Cross and longitudinal sections of the susceptible cultivar root revealed that the nematode developed and reproduced normally within the root tissues. The most obvious cell reactions to the nematode infection were cell hyperplaisa and hypertrophy in comparison with the healthy date-palm root section (Fig.1). The hypertrophied giant cells were initiated in both cortical and stelar regions of the roots which then developed abnormal xylem elements expanding into the cortex (Fig.2). Parenchyma type cells bordering the giant cells were small, have dense protoplasm, and irregular in shape. The well devloped giant cell had uniformly dense cytoplasm, numerous large nuclei and thickened walls. The number of nuclei per giant cell ranged from 10 to 18, which were scattered within the giant cell or aggregated in the center (Fig.2) . a group of giant cells consisting many clusters are usually located close to anterior part of the nematode. The giant cells were irregular in shape, however, they tend to be elongated or rounded (Figs. 2b and 2c).

On the other hand, the root tissues in the resistant cultivars reacted in a different way. It seems that as the nematode have invaded the cortical layer, a negative reaction to nematode existence was exhibited by forming a necrotic area around the nematode body (Figs. 3 and 4). In few cases, the nematode succeeded to survive for a while, hence a slight host reaction was noticed. In such cases, vaculated and empty giant cells were found. Vacuoles and apparently empty regions were often associated with the cytoplasm of such giant cells and frequently seemed to lack turgidity, in comparison to adjacent healthy tissues. Poorly developed larvae usually observed in association with those giant cells (Figs. 3and4). Ismail 1985 obtained similar results on corn plants.

Observations on *M. incognita* infected roots of the highly susceptible cultivar Zaghlool indicated an acute histological respons. Different developmental stages could be easily observed within the infected root tissue either in cortex or in close vicinity to the stelar regions (Fig. 2). The cells sites became hypertrophied with several swollen nuclei (Fig. 2). The formation of characteristic multinucleate and well developed giant cells was found at the anterior part of the the nematode in the infected plant tissues with the root-knot nematode, *M. incognita* (Fig.2). The secreted nematode enzyme through parasitism dissolved cell walls in susceptible host. Such host do not secrete ample or any phenols and/or other nematistatic compounds to contradict nematode parasitism.

In unsuitable host, nematodes are always faced with antagonistic reaction initiated by the host plant. The most common reaction in resistant or less suceptible (Deglet Noor and Samani) cultivars was cell necrosis (Figs.3 and 4). Often, after inducing necrosis, the nematode juveniles migrated to non-necrotic cells and commended feeding these cells subsequently became necrotic. Necrosis can result in death of the nematode either through direct toxicity or by destruction of the plant tissues, thus causing starvation.

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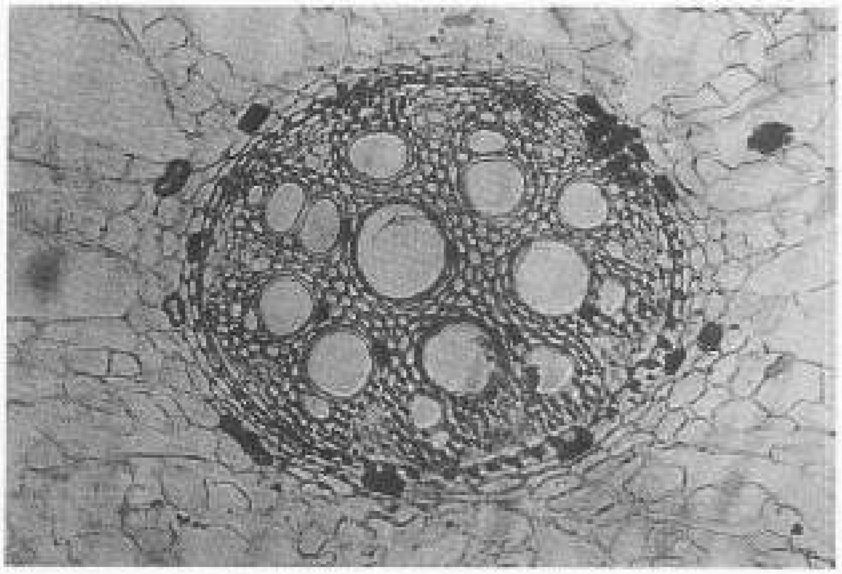


Figure 1: Cross section of healthy date-palm root.

A

B

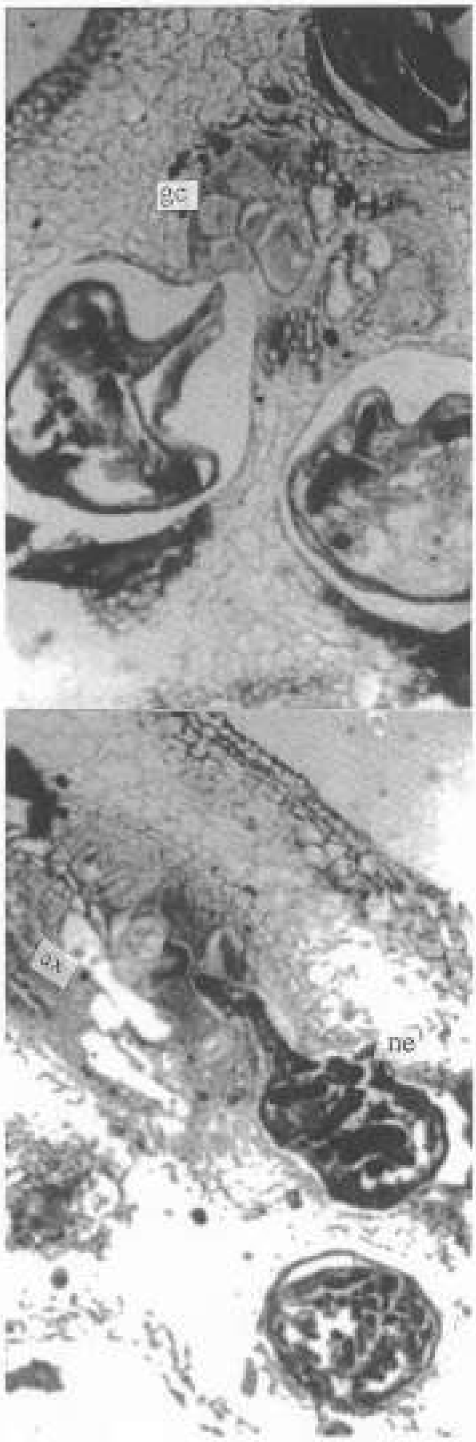
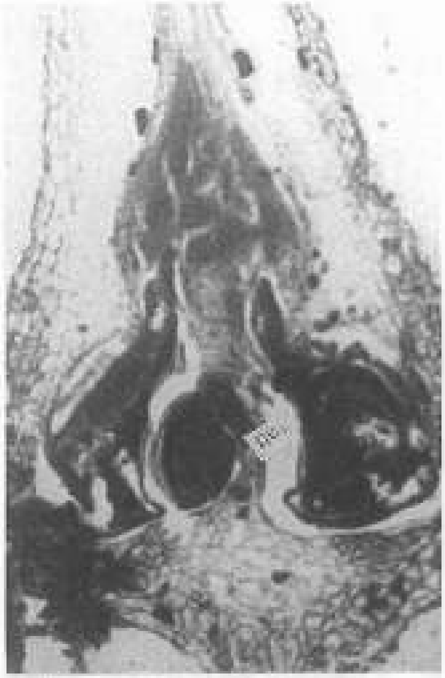


Figure 2: Cellular reaction of the susceptible Zaghlool date-palm cultivar to *M. incognita* infection.

A. Cross section of Zaghlool cultivar infected root showing the hypertrophied cells

B. Cross section of Zaghlool cultivar infected root (note the groups of giant cells and abnormal xylem).

C



D

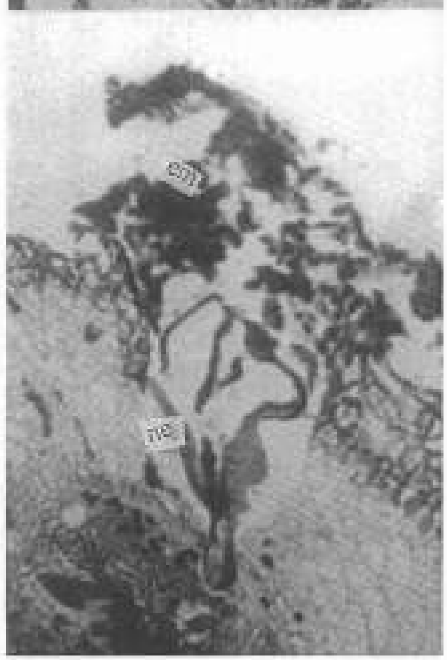


Figure 2: Cellular reaction of the susceptible Zaghlool date-palm cultivar to *M. incognita* infection.

C. Longitudinal section of zaghlool dultivar infected root (note the mature females and giant cells inside stellar tissues).

D. Cross section of Zaghlool cultivar infected root (note the mature female and egg-mass).

ax = abnormal xylem; ge= giant cell; ne=nematode;

em= egg-mass; ht= hypertrophy.

A

B

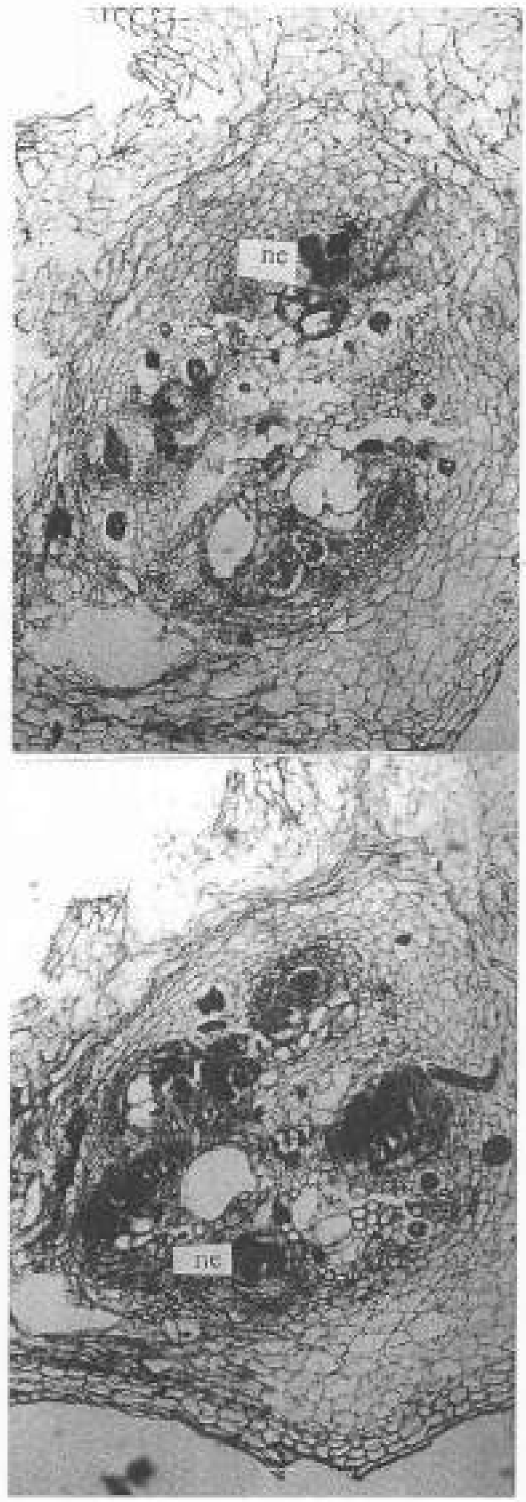


Figure 3: Cellular reaction of the resistant Deglet Noor date-palm cultivar to *M. incognita* infection.

A,B= Cross section of cv. Deglet Noor infected root by *M. incognita* (note the necrotic tissues around nematode body).

C

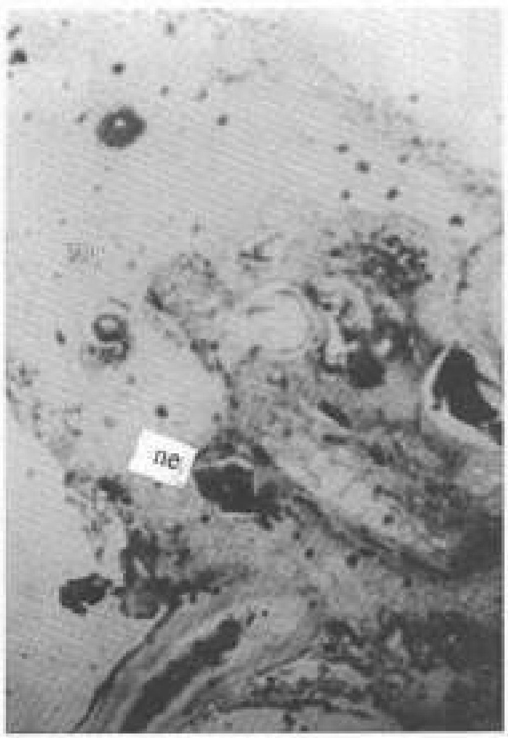


Figure 3: Cellular reaction of the resistant Deglet Noor date-palm cultivar to *M. incognita* infection.

C= Cross section of cv. Deglet Noor infected root by *M. incognita* (note the necrotic tissues around nematode body).

A

B

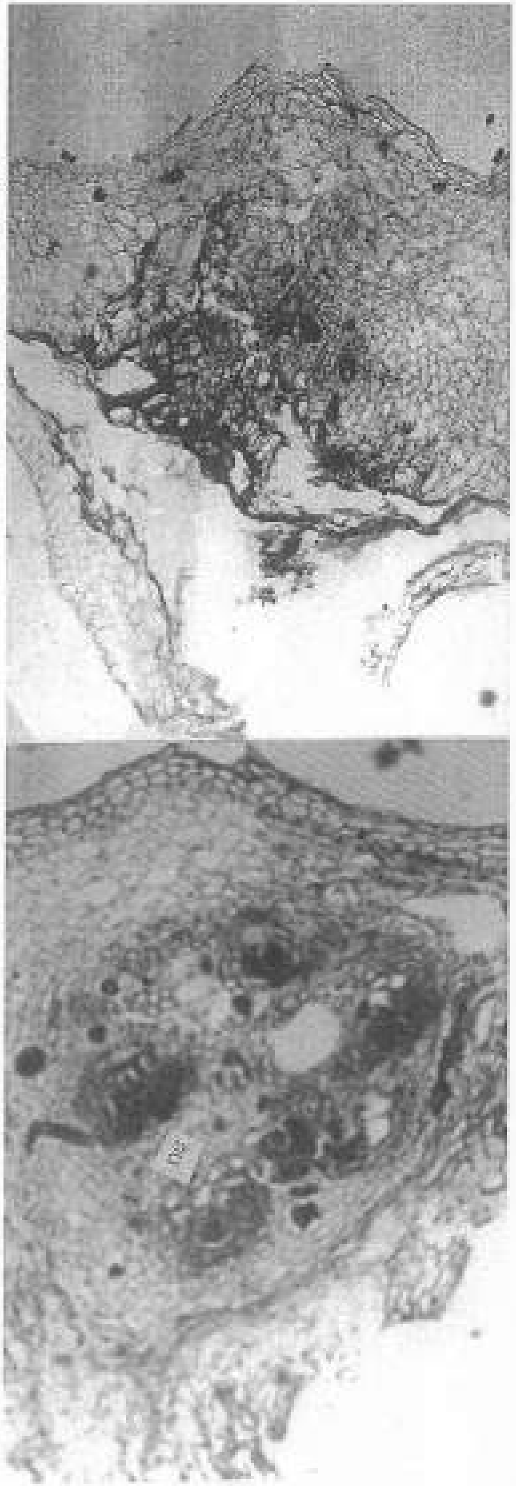


Figure 4: Cellular reaction of the resistant Samani date-palm cultivar to *M. incognita* infection.

A,B= Cross section of cv. Samni infected root by *M. incognita* (note the necrotic tissues around nematode body).

C

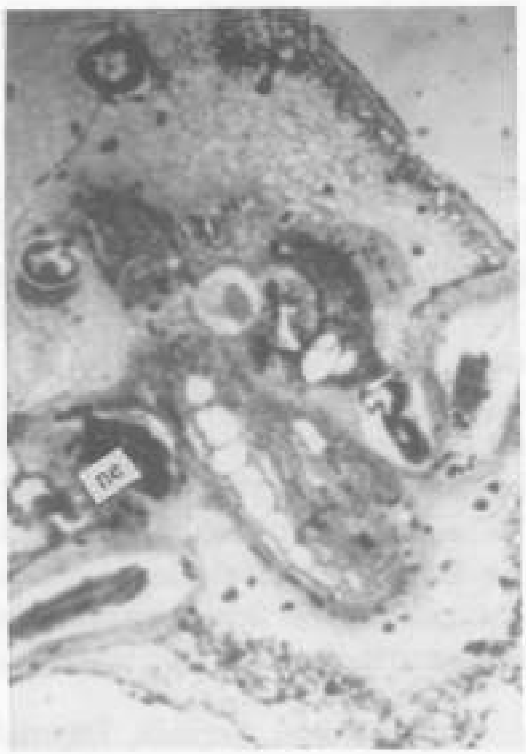


Figure 4: Cellular reaction of the resistant Samani date-palm cultivar to *M. incognita* infection.

C= Cross section of cv. Samni infected root by *M. incognita* (note the necrotic tissues around nematode body).

BAYOUD TOXIN ISOLATION AND USE FOR SCREENING OF DATE PALM PLANTS FOR DISEASE RESISTANCE

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ABSTRACT

This study consists of the evaluation of toxicity of different toxin peptidic constituents secreted by *Fusarium oxysporum* f..sp. *albedinis,* agent of Bayoud disease. Three fractions FI, FII, and FIII have been isolated. The most toxic one is FII. The toxicity has been checked on palm seedling, plantlets from tissue culture and on detached leaves. The active fractions were purified on high performance liquid chromatography (HPLC). Some peptidic components, specially T3 (as labelled) were shown to be small polypeptide. and produced similar symptoms (leaf rolling) which usually occur when plants are inoculated with the pathogen. These compnents could be exploited for pre-selection of plants for resistance to Bayoud disease among plants originating either from, irradiated or not, tissue cultures or from conventional breeding programmes. Some toxin characteristics and their production strategies were determined.

Addional Index Words: Toxin, peptide, Bayoud, date palm, selection, resistance, *Fusarium*

INTRODUCTION

Bayoud disease of date palm is one of the serious diseases in the world which is difficult to control. In Morocco, selection of resistant varieities is the impotant way and strategy to control this disease. The main results obtained in field and laboratory concerning this way was reported by Saaidi et al, 1981, Sedra (1995), Sedra *et al.* (1996) and Zaher and Sedra (1998). Recently phytotoxins have been recognised as useful tools for the induction and selection of disease resistant plants using *in vitro* selection (Chawla and Wenzel, 1987; Bhatt *et al.*, 1988 and Drakov, 1995). Phytotoxins are generally classified into two major groups: non specific and specific. The possible involvement of fusaric acid, a non specific toxin, in disease development have been reviewed (Pegg, 1981). Several *Fusarium oxysporum* strains have been reported to produce low molecular-weight phytotoxins with different chemical nature (Mepsted *et al.*, 1995; Sutherland *et al.*, 1995 and Herrman *et al.* 1996). *Fusarium oxysporum* f. sp. *albedinis* (Foa) produces substantial quantities of fusaric acid in culture filtrate (Surico and Graniti, 1977). Recently, Mokhliss (1987), Sedra *et al.* (1993), El Fakhouri *et al.* (1996a,1996b) have reported that in addition to fusaric acid, Foa produces *in vitro* various peptidic toxins. In this paper, we confirmed these findings. We also describe some biochemical characteristics and phytotoxicity of these new phytotoxins. Moreever, it was a need to develop a rapid and complementary method for selection of date palm plants for disease resistance.

MATERIALS AND METHODS

Fungal culture and toxins extraction procedure

To produce toxins, Foa was grown in Czapeck medium. This medium was shown to be the best for fungus growth and sporulation (Sedra, 1993). Its composition is (g/l): sucrose, 30; $NaNO_3$, 2; K_2HPO_4, 0.5; $MgSO_4$, $7H_2O$, 0.01; $FeSO_4$, $7H_2O$; KCL, 0.5). The pH was adjusted to 5 using H_3PO_4. The medium was inoculated with 1ml of spore suspension 10^6 spores/ml, and shaken at 200rpm for 10 days. The Erlenmeyer flasks were kept at 27 ± 3°C with 12 hr photoperiod. The mycelium was separated from fluid by centrifugation at 10.000 g for 10 minutes and discarded. The centrifuged filtrates were evaporated under vacuum below 45°C to about 10% to its initial volume (4 liters). The concentrate, about 400ml, was mixed with an equal quantity of methanol and placed at 5°C for 48 hr. The small amount of precipitated materiel was removed by filtration. The filtrate and washings were concentrated under vacuum below 45°C to remove methanol. The concentrate was then placed on (4 x 90cm) column of Norite-Cellite. The fractions containing toxins were eluted from the column with the gradient aqueous pyridine (10% F_I, 30% F_{II}, 50% F_{III}).

Effect of the carbon and nitrogen source on toxins production

Moreover, it was demonstrated that Czapek's medium was more suitable than Richard's medium for toxins production (Fig.1) (El Fakhouri *et al.*, 1996b). In order to improve the production of the peptidic toxins. Four chemically different media derived from Czapeck medium were used. The carbon and nitrogen sources were chosen as the best for sporulation and growth of the fungus (unpublished results). Table 1 summarises the four media.

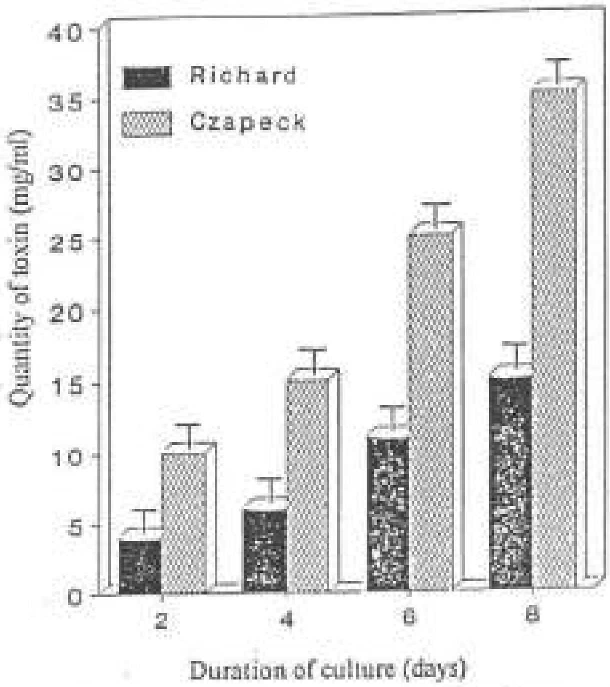


Figure 7. Quantity of toxin secreted by *Fusarium oxysporum* f.sp. *albedinis* in culture media with respect to time.

Table 1. Composition of culture media using different sources of carbon and nitrogen.

Culture medium	Carbon source	Nitrogen source
M1	mannose	KNO_3
M2	dextrose	$NaNO_3$
M3	sucrose	NH_4NO_3
M4 (control)	sucrose	$NaNO_3$

Methods for evaluating the effect of toxins on date palm <u>in vitro</u>:

Assays for toxin activity were carried out on three different plant materials of palm tree: young *in vitro* plantlets, seedlings, and detached leaves.

A- on plantlets

The young *in vitro* plants used were produced by the tissue culture technique in Physiology laboratory at INRA-Marrakech: susceptible Jihel (JHL) and resistant Tadmante (TDMT) varieties.

The activity of the fractions FI, FII et FIII (extracted as mentioned above) of toxin were applied on plantlets in tubes which contained each 25 ml of sterile water and toxin with concentration 0.5 mg/ml. In the case of the control, the *in vitro* plant roots were immersed in water only. The symptoms observed during 34 days are:

- browning of roots
- rolling of leaves
- withering of leaves
- death of plantlet

B- On Seedlings

The used plantlets were issued from seeds obtained from two controlled crosses between susceptible parents (varierty Jihel x local male) and resistant ones (variety Black Bousthami x male NP4). The activity of the fractions FI, FII and FIII of toxin were evaluated on plantlets using the same procedure. mentioned before.

C. On detached leaves

Several detached leaves from susceptible (Boufeggous) and resistant (Sairlayalate) varieties were used in this study. The leaves were taken off from greenhouse-grown plants and then immersed into toxin solution in test tubes.

Purification of fractions

Fractions from the Norite-Cellite column were purified on a KRATOS HPLC equipped with RPC_{18} column 5µm (4 x 250mm). The solvents A and B used for analysis consisted of 0.1% TFA in H_2O, and 0.1% TFA in CH_3CN respectively. A linear gradient of 01-02% of B was achieved in 35 minutes for F_I, 05-40% of B in 30 minutes for F_{II} and 01-10% of B in 30 minutes for F_{III}, at a flow rate of 1 ml/min. Eluent from the column was monitored at 230 nm with a varian wavelength detector UV-KRATOS.

Leaf bioassay using purified toxins

Only the four toxins obtained from the most phytotoxic fraction F_{II} (Sedra *et al.*, 1993) was used in this study. The toxicity of the four toxins were carried out on detached leaves from susceptible and resistant seedlings of date palm "TDMNT" and "BSK" respectively. Leaves were detached when seedlings reached one to two leaves (about three months) then placed into test tubes containing fied solutions. Toxins were diluted to 20, 10, 5 and 1 µg/ml in water. Petioles of leaves were dipped into such solution and kept in a controlled-growth chamber at 27°C, 80% RH and 16 hr photoperiod (17.2 klux). The susceptibility of leaves to different toxins was recorded after 4 to 6 days. Leaves dipped in water were considered as controls. The reaction was considered positive if necrotic lesions, chlorosis and petioles browning were recorded, and negative if the leaf remained unaffected. The toxin-caused lesions observed in these bioassays were indistinguishable from the lesions caused by the fungus growing on the same cultivars. For the following characterization of the toxins, we focused our studies on the phytotoxic toxins.

Ultra-violet (UV) absorption

The UV spectrum was recorded in H_2O + 0.1% TFA on UVICON 810 UV, the spectrum was enregistrated between 400nm and 230nm.

Amino acid analysis

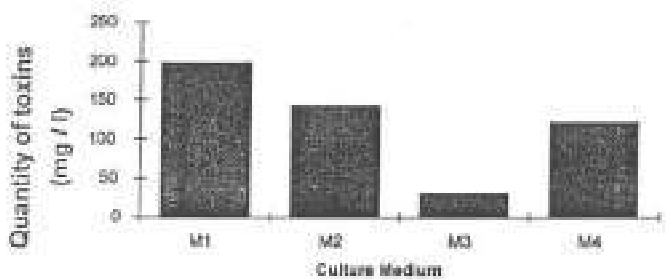
Hydrolysis of T2, T3 and T4 were performed by HCL 6N and 1% of phenol at 150°C for 90 minutes under vacuum using a Pico-Tag station (Millipore/waters associates). The amino acid composition was calculated from the analysis carried out on a Beckman 6300 apparatus.

RESULTS AND DISCUSSION

Effect of culture medium on toxins production

The chromatography purification of the three fractions obtained from Foa yielded four toxins from each fraction. It was demonstrated using analytical HPLC that the composition of the culture medium affect the ability of the pathogen to produce toxins. As shown in figure 2, the production of the toxins was improved with the use of other carbon and nitrogen source. In fact, the medium containing mannose and KNO_3 was the more suitable for toxins (195 mg/l) than Czapeck medium (130 mg/l) production.). The nature of carbon and nitrogen at plays, thus a necessary role in culture medium. Furthermore qualitative analysis by HPLC demostred that toxin's composition was not affected by the composition of the culture medium used.

Fig. 2. Effect of culture medium on toxins production by the Foa. (M1: Czapeck modified by mannose and KNO_3; M2: Czapeck modified by dextrose ; M3: czapeck modified by NH_4NO_3; M4: czapeck (control)). The results which are indicated by the same letter are not significantly different.



Development of an effecient method to evaluate the effect of toxins on date palm.

Effect of toxins on in vitro plantlets

The tested varieties produced the symptoms characterized by root browning, then leaves rolling and withering and the death of plantlets. The control was without symptoms. However, the symptoms appear very early in case of the susceptible variety. The statistic at disease analysis (not presented) of the results showed that there was no significantl difference in the response of the susceptible and resistant varieties to the toxic fractions. The most toxic fraction was fraction II with 75% and 50% of mortality respectively of susceptible and resistant plants (Fig.3).

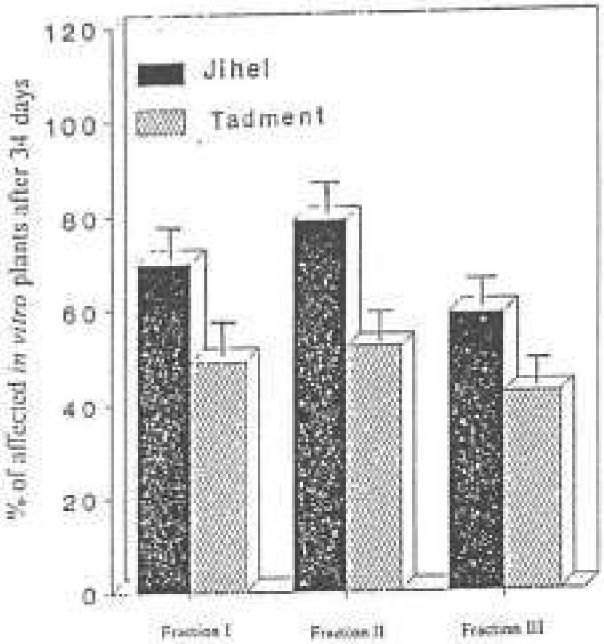


Figure 3. Effect of toxic substances excreted by *Fusarium oxysporum* f.sp. *albedinis* on *in vitro* plants.

Effect of toxins on seedlings

The symptoms begin to appear during the first week. After three weeks the plants that were treated with the toxin produced similar symptoms (leaf rolling) which occurs when plants are inoculated with the pathogen. The fraction FII was the most toxic and the resitant and susceptible plantlets can show different reactions using these toxins.

Effect of toxins on detached leaves

Infection, generally became evident after 4-5 days, as chlorotic and necrotic spotting on inoculated leaves, petioles, and stems. Such symptoms did not appear in the leaves used as a control in water. This study showes similar results as for other plant test materials.

Purification of the fractions F_I, F_{II} and F_{III}

From each fraction, four toxins were obtained by HPLC purification. Only toxins obtained from F_{II} were lyophilised and kept at -4°C until further analysis

Effect of the purified toxins on detached leaves

Table 2 summarises the effect of the purified toxins in both susceptible and resistant cultivars of date palm BSK and TDMNT respectively. From the four phytotoxins, only three were phytotoxic in detached leaves bioassay giving the typical signs of (Foa). As shown in table 2, T1 was not toxic to both cultivars at any concentration. T3 was the most toxic , it revealed severe symptoms to both cultivars at concentrations from 5 to 20 µg/ml. Furthermore, T2 shows no toxicity when applied to the resistant cultivar, but had moderate toxicity on susceptible cultivars at 15 and 20 µg/ml. Moreover, no symptoms appeared in the leaves used as controls and 5 µg/ml was the minimum concentration required for visible chlorosis development. 10 µg/ml was the concentration required for differentiation between susceptible and resistant cultivars.

In conculsion, concerning possible role of this fungal peptide in the pathogenecity *in vivo* of date palm, T1, T2, T3 and T4 were bioassayed in detached leaves, only T2, T3 and T4 were phytotoxic and gave the typical effects of the fungi. This led to the conclusion that these phytotoxins play a necessary role in pathogenesis. We have remarked that sensibility of the date palm was correlated with its susceptibility to *Fusarium oxysporum* f. sp. *albedinis* suggesting that these toxins may be host-specific. These phytotoxins can be used as selection agent of the *in vitro* selection of resistant material of date palm.

Tab. 2. Symptoms produced by peptidic toxins of *Fusarium oxysporum* f. sp. *albedinis* on detached leaves of date palm cultivars

	Symptom intensity[a]							
	1μg/ml		5μg/ml		10μg/ml		20μg/ml	
Toxins[b]	S	R	S	R	S	R	S	R
T1	-	-	-	-	-	-	-	-
T2	-	-	-	-	-	-	+	-
T3	-	-	+	-	++	-	+++	++
T4	-	-	-	-	+	-	++	+

[a] Symbols: +++ = very severe, ++ = moderate, + = wild, - no symptoms.

[b] based upon severity of symptoms expressed in date palm cultivars after 10 days when treated with 20, 10, 5 and 1μg/ml of the toxins.

S: susceptible cultivar" BSK".

R: resistant cultivar "TDMNT".

Biochemical characterisations.

Amino acid analysis of the three toxins T1, T2 and T3 done after hydrolysis revealed the peptidic character of the toxins. Its amino acid composition were given in table 3. This result was confirmed by the results of UV spectrum which shown that all the toxins have absorption maxima at 215 and 271 nm. These maxima are similar to those of proteins.

Table 3. Amino acid analysis of peptidic toxins T2, T3 and T4 from *Fusarium oxysporum* f. sp. *albedinis*

	T2			T3			T4		
amino acid	nanomoles	Nb residues	theory	nanomoles	Nb residues	theory	nanomoles	Nb residues	theory
Asp	0.511	2.1	2	1.566	4.2	4	0.283	1.6	2
Thr	0.319	1.2	2	0.935	2.5	3	0.164	0.9	1
Ser	1.427	5.7	6	4.343	11.6	12	0.195	1.1	1
Glu	1,101	4.4	4	3.315	8.9	9	0.333	1.9	2
Pro	0.222	0.8	1	0.661	1.8	2	0.398	2.3	2
Gly	1.279	5.1	5	5.469	14.7	15	0.575	3.2	3
Ala	0.553	2.2	2	1.909	5.1	5	0.176	0.9	1
Cys	0	0	0	0	0	0	0.023	0.1	1
Val	0.329	1.3	1	0.653	1.8	2	0.384	2.1	2
Met	0	0	0	0.027	0.1	1	0.020	0.1	1
Ile	0.129	0.5	1	0.373	1	1	0.266	1.5	2
Leu	0.177	0.7	1	0.555	1.5	2	0.293	1.7	2
Tyr	0.104	0.4	1	0.469	1.3	1	0.111	0.6	1
Phe	0.079	0.3	1	0.421	1.1	1	0.268	1.5	2
His	0.248	1	1	0.818	2.2	2	0.048	0.3	0
Lys	0.334	1.3	2	0.939	2.5	3	0.082	0.5	1
Arg	0.098	0.4	1	0	0	0	0.053	0.3	0

In general conclusion, the results showed that the culutre filtrate of *F.o.f.sp.albedinis* produced toxic activity on three date palm materials. The rapid and the most procedure was using the detached leaves. Recent works on toxin characterization and procedure development for selection allowed interesting results: - using fragments and small detached leaves, - determination of minimal toxin concentration which could differentiate resistant and susceptible varieties. - stydies on toxin specificity and research on the optimal conditions for its production and activity. However, it was a need to develop others procedures such as for *in vitro* selection.

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ACKNOWLEGEMENTS

This work was supported by both the International Atomic Energy Agency (FAO/IAEA division of Nuclear Techniques in Food and Agriculture), the Date Palm Research & Development Network (ACSAD, Syria) through the breeding action (INRA- Marrakech, Morocco) and the French-Moroccan Co-operation Program (PRC n°95/15). Thanks are due to all staff of (LPGLM) Laboratory INRA-Marrakech and of Bio-organic Chemistry Laboratory, Faculté des Sciences-Semlalia. Marrakech.

We thank Canarelli S. and Pascal M. (laboratoire de Biochimie, ingénierie des protéines, Fac. Médecine nord, Marseille,France) for their assistance and Valuable discussions.

A REPORT ON POST HARVEST FUNGI ON DATE FRUITS IN LIBYA

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ABSTRACT

The study aimed to identify the fungi that cause market diseases of dates in Libya. The following fungi were isolated and identified *Aspergillus niger*, *A. ochraceus*, *Penicillium corylophilum*, *P. citrinum*, *P. funiculosum*, *Rhizopus stolonifer*. Yeast was also found involved in the deterioration of dates. *A. niger* was the most common fungus associated with the dates .*P. corylophilum*, *P. citrinum* and *P. funiculosum* were new records on date palm fruits. Among the varieties of dates included in the study, the coastal belt varieties (Bikrary, Taboni and Bronssi) were to deterioration by fungi more than liable desert varieties.

Additional Index Words: *Aspergillus niger*, *A. ochraceus*, *Penicillium corylophilum*, *P. citrinum*, *P. funiculosum*, *Rhizopus stolonifer*.

INTRODUCTION

Date palm *Phenix dactylifer L.* is very important tree in the Arab world and Libya is not an exception. The studies indicated that the Arab countries are the main source of dates in the world (Mohamed, 1982). About 5 million date palm trees are cultivated in Libya distributed in the desert as well as in the Eastern and Western coastal belt regions where about 400 varieties are recognized (Ismail et al., 1989). In the past, the number of date palm trees in Libya was more than the listed number (Al – Shurfa, 1982). The diseases attacking the trees might play a role in this situation. According the reports from the Ministry of Agriculture, *Diplodia* rot is one of the serious diseases in Libya that causes death of date palm trees (Anon., 1991). El – Jerbi (1991) mentioned that blossom rot (Khamedj disease) which was known in North Africa including Libya can cause severe losses. The fruit rot diseases of date palm received attention in several parts of the world. They causes losses reached to 50% in tunisia; 25% in Algeria (El – Jerbi, 1991); 25% in Yaman; 2% in Iraq and 5% in USA Hussain, 1985). They study was proposed to study the rot of date palm fruits in Libya aiming to identify the fungi causing their deterioration.

MATERIALS AND METHODS

During regular visits (October & November 1997) to Benghazi market of date palm fruits where the varieties from the coastal belt and desert regions are sold, fruits look infected (if possible) were collected. Then 10 fruits were taken at random from the collected fruits. 4 small piecies were cut from each fruit, surface sterilized with O.5 % sodium hypochlorite, washed with sterilized distilled water and plated on potato dextrose agar and incubated at 25 ± 2°C. under 12 hr. light alternating with 12hr. darkness. If the infected fruit showed fungal growth, parts of its mycelium were plated directly on PDA. The isolated fungi were subcultured on PDA and examined under microscope. Identification of isolated fungi was based on morphological characters. *Penicillium spp.* Were identified after subculturing on Czapeck – Dox agar. The isolated fungi were keyed out Based on specialized taxonomic literature as shown by Samson et al., 1981. The percentage of the isolated fungi was calculated.

RESULTS AND DISCUSSION

The following fungi were isolated from the infected date palm fruits:

Aspergillus niger. Van Tighem

The most common post harvest pathogen isolated from the deteriorated fruits (Table 1). Its colonies are black. Conidiophores brownish in color, vesicles globose or subglobose 48-65 *u* m in diam., phialides biseriate bearing globose roughened conidia measuring 4-5 *u* m in diam.

Aspergillus ochraceus Wihelm.

It was detectedin low incidence and only from the deteriorated fruits of Hamri and Jadage varieties (Table 1). Colonies are yellow, conidiophores rough walled end with hyaline globose vesicle measuring 35-50 *u* m in diam phialides biseriate bearing smooth surface conidia of 2.5-3.5 *u* m in diam.

Penicillium spp.

Isolated from many of the date palm fruits collected in the study with the highest incidence in bikrari variety (Table 1). Three species of Penicillium were identified:

p. corylophilum Dierckx:

colonies blue green in color exceeding 1 cm in diameter within one week, conidia globose or subglobose 2-3 *u* m in length and smooth walled.

Conidiophores one stage branched and of smooth stipes. Phialides flask shaped of 9-13 u m in length and 6 to 8 of them on each metula.

P. citrinum Thom

Morphologically similar to *P. corylophilum* but of shorter phialides 7-12 u m in length .*P. citrinum* colonies are restricted in growth reaching less than 2 cm after incubation for two weeks on Czapeck – Dox agar. The colonies are blue green with yellowish center and the reverse is orange.

P. funiculosum Thom

Growing faster than the other two spp. Having dark green to grey colonies. Conidia smooth globose to subglobose 2.5-3.0 u m, conidiophores are one – stage branched and of smooth stipe. Metula bearing 4-6 phialides. The phialides lanceolate of 11-14 u m length.

Rhizopus stolonifer (Ehenb. ExFr.) Lind.

Infecting only the varieties of the coastal belt region (Taboni, Bronsi, and Bakrari) and in low percentage (Table. 1). The fungus have whitish to grayish colonies of black heads. Sporangiophore is coulorless to brownish in color of 1.2-2.6 mm in length and have branched rhizoids. Sporangia brown to black in color, globose to subglobose 176-320 u m in diameter. Sporangiospores are striate, irregular in shape 8-10 u m.

Yeast:

Isolated in highter frequency from the rotted date palm fruits of the coastal belt than from the desert region and coming next to *Asperigillus* in deterioration of the fruits (Table. 1). From the variations in morphology of the isolated colonies and variations in the shape of their cells indicate a mixture of yeast are responsible for rotting of date palm fruits. The involoved yeast have not been identified.

Table 1 percentage of fungi isolated from date palm fruits

Variety	*Asperigillus niger*	*A. ochraceus*	*Penicillium spp.*	*Rhizopus stolnifer*	Yeast
Bikrary*	42		28	6	8
Taboni*	38		10	12	36
Bronssi*	36		22	8	20
Saeedi	16				18
Tidss	20				
Saifi	24		12		14
Hamri	28	10	4		
Tagiat	22				
Jadag	26	14	16		6
Tasvert					
Taleess					

* varieties from coastal belt region, the rest were cultivated in the desert region.

The study showed that the fungal fruit rot of date palm can be a problem causing a serious losses as post harvest disease especially for the varieties cultivated in coastal belt region where the relative humidity is high compared to the desert region. Lower percentage of rotting were detected on the desert varities. The study showed that on two of the common desert varieties (Tasvert and Taleess) no infection with post harvest fungi was observed. Unfortunately coastal belt varieties (Bikrari, Taboni and Bronssi) are the ripening varieties and so they may be exposed to high relative humidity and / or rain resulting in severe loss by post harvest pathogenic fungi. Similar situation was reported from Tunisia, Algeria and Moroco (El – Jerbi, 1991). Since the Ministry of Agriculture in Libya is directing more attention to increase the number of date palm trees, it is has recommended based on this study, that early ripening varities should be introduced in the coastal belt region.

In this study six post harvest fungi were isolated from deteriorated date palm fruits and identified. Some of these fungi have been reported (Al – Hussain, 1985 and El- Jerbi, 1991). As far as the available literature is concerned *Penicillium corylophilum, P. funiculosum* and *P. citrinum* can be considered new records on date palm fruits. Further study is needed to prove their pathogenicity and confirm their importance.

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FERTILIZATION OF DATE PALM TREE

(Phoenix dactylifera) IN IRAQ

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ABSTRACT

Date palm tree requires relatively great amounts of macro and micro nutrients to achieve good growth and to give reasonable and economical production. Fertilization is therefore, one of the important practices which increase dates production and improve fruits quality. The amount of fertilizer needed by palm tree depends on soil type, kinds of intercrops grown under, as well as variety and age of the tree.

This article discusses the fertilization practices being followed in Iraq and outlines the importance of the use of chemical fertilizers in improving dates production.

From that review it is obvious that fertilization of date palm tree in Iraq depends wholly on local indigenous and individual experiences, rather than sound scientific basis. There is a need for better understanding of the date palm physiology, concerning water and nutrients uptake to comeout with better fertilization program for that important tree in the region.

Regional cooperation between scientists and institutions is vital to achieve that goal.

Additional Index Words: Nutrients requirement, chemical fertilizers, farm manure, tidal irrigation.

INTRODUCTION

Iraq may be considered the date palm country. Apart from the northern part. of the country, date palm trees grow every where. Its growth extends between 35°, 18 latitude which passes through Tickret on Tigris and Ana on Euphrates, down to the Fauo on the Arabian gulf, 30° latitude. It is estimated that the number of palm trees in Iraq exceeds 22 millions tree which covers an area over 120000 hectares. (Al-Dejaili and Al-Dejaili, 1989). Date palm tree concentrated in Basra Governorate, recent statistic which is considered the largest date palm forest in the world. It is estimated that the number of date palm trees in this Governorate

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exceeds 13 millions with over 400 varieties and cover an area over 50.000 hectares. (Al-Dejaili and Al-Dejaili 1989).

Date fruits constitute a substantial part of the diet of the Iraqi people through the ages, especially for those of low income group. Dates fruits contain substantial amounts of sugars, minerals and vitamins (Tables 1&2). Considering the daily requirements of macro elements by human reported by Robinson, 1972, 15 dates fruits would provide more than 80% of daily body requirement of magnesium, 70% of sulfur, 25% of potassium,, 20% of calcium, and a substantial amount of the body requirements from iron, manganese, copper mid zinc. (Underwood, 1977).

Table 1: Chemical Composition of Four Commercial Iraqi Date Cultivators*

Composition	Hallawi	Sayer	Khadrawi	Zahdi	Mean
Moisture % (FW)	7.3	7.5	9.5	8.3	8.1
Total Soluble Solids FW	84.2	81.3	80.8	82.1	82.1
Total Insoluble Solids FW	17.9	10.0	9.5	9.2	11.7
Protein % (DWB)	2.3	2.8	2.4	2.2	2.4
Fat % DWB	0.5	0.3	0.5	0.4	0.4
Ash % DWB	1.9	1.8	2.1	1.8	1.9
Crude Fiber DWB	1.8	1.7	2.3	2.5	2.1
Sugar on dry weight basis					
Total Sugar %	87.9	86.1	87.7	86.8	87.1
Reducing Sugar %	82.7	82.6	81.9	73.4	80.2
Sucrose %	4.8	3.5	4.5	12.7	6.4
Glucose %	43.7	44.8	44.7	32.8	
Fructose %	37.2	38.0	38.5	39.2	41.5
Vitamins (mcg/100g) dry weight basis					
Thiamine (B_1)	99.0	130.0	94.0	80.0	100.8
Riboflavin (B_2)	173.0	135.0	149.0	167.0	156.0
Biotin (H)	4.6	4.7	4.1	5.7	4.8
Folic acid	57.0	70.0	43.0	63.0	58.2
Ascorbic acid © (mg/100g)	3.6	17.5	3.2	2.4	6.7

* After Yousif, et. Al. 1982. ** Fresh Weight *** Dry Weight Basis

Table 2: Macro and Micro Elements in Four Iraqi Date Cultivators* mg/Kg. Dry Basis.

Element	Hillwai	Sayer	Khedrawi	Zahdi	Mean
P	160	130	150	140	145.0
K	8540	8330	8940	8870	8670.0
S	100	200	140	210	162.5
Ca	1840	2030	1330	2070	1357.5
Mg	560	580	600	590	582.5
Cl	2600	3120	2660	3420	2950.0
Fe	52.6	32.1	45.0	103.7	58.4
Mn	58.6	52.5	51.4	51.6	53.5
Cu	27.7	28.9	25.4	27.5	27.4
Zn	13.9	18.2	12.9	7.4	13.1
Co	7.6	9.6	9.6	9.5	9.1
F	2.0	1.2	1.4	1.2	1.5

*After Yousif, et. al. 1982.

Palm tree is a sacred tree which play an important role in the life of Iraqi and Arabs throughout the history. People not only benefited from dates fruits, but they benefited from all parts of that tree, including trunk, rachis, leaves, rachis base and fiber sheath as well as pits for animal nutrition.

In the last 20 years, this important tree however, did not receive attention by farmers as far as agricultural practices which resulted in low production and thus low income for farmers (Table 3). This leads to the abandon of this important tree for economical reasons. In this review, I will give a brief on the date palm tree nutrient requirement and fertilization practices being followed in Iraq.

Table 3: Date Palm Production and Number of Trees in The Main Date Producing Countries*

Country	No. of Trees$_x$ (1000)	Dates production Tons (mean to 91,92,93)	1994	Mean Production Kg/tree
Iraq	21500	542333	35000	20-25
UAE	20800	292300	236000	29
Saudi Arabia	12000	551666	555000	60-70
Egypt	11000	612766	500000	30-50
Oman	8050	123100	172000	25-30
Libya	7000	76000	180000	20-25
Algiers	7500	243666	172000	

Palm Tree Nutrients Requirement and Fertilization:

Until recently, there was a false believe between farmers that date palm tree does not need fertilizer addition. This belief may come out because palm tree has a big root system which may extends to 10m from trunk and 3-7m deep or to the water table level. This huge root system makes palm tree resistant to unfavorable conditions. More over, before dams construction upstream, million tons of sediments are brought up by rivers and precipitated in the plains where palm trees are grown adding great amounts of mineral nutrients to the soil yearly. In the middle palls of Iraq, this root system enables the date palm tree to make use of the fertilizers being added to citrus trees as well as vegetables and forage. crops grown under. However, experiments carried out in the country and elsewhere, showed that fertilizer addition is necessary to improve date palm growth and to increase date fruits production. AL-Baker, 1972, reported that a five years experiment in AL-Tanooma, near Basra, showed that the addition of 1.2Kg of nitrogen, 600g of P_2O_5 and 1.2Kg of K_2O per one palm tree increased the yield 2-3 times and doubled the number of leaves per tree. AL-Dejaili and AL-Dejaili, 1989, outlined that date palm trees are sensitive to fertilizer addition especially, to nitrogen fertilizer, and that the nitrogen deficiency in palm trees caused leaves yellowing, low number of leaves and small leaves as well as low fruit production.

El-Shurafa, 1984, reported that the amount of nutrients lost yearly by one palm tree var. Taboni (Lebia), through dates fruits and leaf pruning is 472. 47, 422. 219, 36. 5.8, 1.2. and 1.3g for N, P, K. Ca. Na, Fe, Mn, and Zn respectively. This estimate assume a total fresh weight of 100KG of dates from 10 date bunches and 20 leaves which give a total dry matter of 82.4 Kg. These loses of nutrients does not include nutrient losses by leaching or volatilization or other loses. If we assume that the fertilizer-use efficiency to be 30%, then the amount of nitrogen, phosphorus and potassium needed by one tree would be 1.416, 0.141 and 1.266 Kg. respectively. Al-Dejaili and Al-Dejaili, 1989, reported that the average amount of nitrogen needed by palm tree is ranged from 1.8 - 2.7 Kg. yearly. They added that this amount of nitrogen should be added at three doses during the year (Furr, et. al. 1951), showed that the addition of 2.7 to 3.6 Kg of nitrogen to date palm tree var. DeglatNoor resulted in 20% increase in dates production as compared with unfertilized trees through four years experiment. The trunk growth as well as leaves number were increased also, while the quality of fruits did not change or even lowered. He showed that fertilization caused an increase in the number of bunches per tree and number of fruits per bunch but not fruit weight.

It is obvious that although little knowledge are available concerning the amount of fertilizers which should be added to date palm tree, fertilization is necessary to improve the growth and production of the tree. The amount of fertilizers needed by one tree vary with soil type and depth, as well as dates variety and age of the tree.

In Iraq, farmers are usually following methods used by their ancestors in the fertilization of palm trees. These practices differ from place to place as outlined below:

Fertilization Practices in the Basra Area

In this area palm trees are planted in small distances of 5-6m apart. The soil is heavy soil and the water table is not deep. Irrigation is carried out by tidal stream or what called fingers irrigation. During the last 20 years, salinity is become a problem in this area. Under such conditions, palm trees depend wholly on lateral roots for the absorption of water and nutrients. Fertilization practices followed by farmers in this area is to use farm manure once event 4-5 years. A circular ditch around the tree of 3-4m diameter is made. The ditch is very shallow near the trunk and become deeper until the water table in the outside of the ditch. Manure is then spread in the ditch 0.5-1.5in^3 of manure per tree is used. The process is carried out in Autumn or Winter and the soil then is part back. Chemical fertilizers are rarely used in this area. When other crops are grown especially in orchards where date palm trees were planted at 8-10m distances, chemical fertilizer especially urea-N is used. In this area, because of the method of irrigation, nitrogen fertilizer is the main fertilizer need to be added at different intervals throughout the year, as other nutrients would be provided from Irrigation water. Scientific experiments on the use of chemical fertilizers for date palm tree need to be carried for many years in this area before a conclusive recommendations can be obtained.

Fertilization Practices in the middle Part of the Country:

In this large area which include many Governorates such as Wasit, Qasisia, Najaf. Karbalah, Babil, Baghdad, Deila, Salahuldeen, and Anbar, the soil is ranged from loam to silty loam. The soil is a deep soil. Palm trees are planted at 8-10m. distance, Citrus trees or vegetable crops are grown under palm trees. Palm tree roots in this area extend to more than 7m. from trunk and to a depth of about 3-4m. Results of an experiment carried out in Al-Zafarania near Baghdad, by (Abu-Khalid et. al. 1982), showed that 50% of roots were in the depth 0-60cm. and about 30% between 60-120cm. depth, while 20% between 120-180cm. and that the date palm tree absorb 50% of its water requirement from the upper layer (less than 60cm.) and 30% from the layer 60-120cm. (Table 4).

Table 4: Roots Distribution of Date Palm Tree in a Silt Loam Soil in Zafarania Area and the % of Water Absorbed from Different Depths. *

Soil Depth cm	% Roots Dry Weight	% Moisture Absorbed	% Active Roots with Depth at Two Distances from the Trunk	
0-60	51.6	52.0	23.3	27.8
60-120	28.5	34.0	32.8	25.9
120-180	19.9	11.0	27.1	26.5
180-240		3.0	5.6	5.0

* After Abu-Khalid et. al. 1982.

Shabana et. al. 1985, showed that most effective roots are in the 40-120 cm depth (Tables 5 & 6).

Table 5: Vertical Distribution of Date Palm Roots var. Zahdi in a Silty Clay Loam Soil*

Soil depth cm	% of roots of different size in a $10m^2$ section at different soil depth			
	Roots size mm			
	< 1 mm	1-2 mm	2-3 mm	> 3 mm
0-40	10.26	8.04	10.34	11.90
40-120	63.09	71.66	73.54	71.75
120-160	21.92	16.07	10.87	10.28
160-200	4.73	4.23	4.25	6.07

* Shabana, et. al. 1985.

Table 6: Horizontal distribution of date palm roots var. Zahdi*

Distance from trunk m	% of roots different size in 10 m^2 section			
	< 1 mm	1-2 mm	2-3 mm	> 3 mm
1	29.3	31.5	32.1	3.2
2	26.0	27.8	27.6	26.4
3	24.5	24.2	23.2	23.4
4	20.2	10.5	17.1	18.6

*Shabana, et. al. 1985.

Under such conditions, with such big root system, date palm trees would benefit from fertilizers being added to citrus trees or crops grown under. Therefore, farmers in this area rarely fertilize palm trees. The practice being used is that they fertilize citrus trees every 2-3 years, by plowing or turning over the soil around the trees including canals, then they make a trench 60-90 cm. wide and 40-60 cm. Deep in Autumn or Winter. Then they spread farm manure in the trench to a depth of 15-30cm., then they irrigate the trees. When vegetable crops are grown, chemical fertilizers are used in addition to farm manure. Green manure is also used in this area especially at the first 5-6 years of the establishment of the orchards.

Conclusions

From the above discussion, it is clear that date palm tree in Iraq does not receive great attention as far as fertilization and other agricultural practices which resulted in low growth rate and low production. Generally 1.5-3Kg of nitrogen, 0.5Kg of phosphorus and 2-3Kg of potassium per tree yearly is recommended to maintain optimum growth of palm tree. Long trials on the use of chemical fertilizers in different areas is needed. Cooperation between Arab countries and Scientific Institutions dealing with date palm tree studies is vital to face the econoical competition the world over in the 21st century. Large steps to modernize dates production, storage and processes need to be taken to make date palm growing is economical to farmers in Iraq as well as in the Arab World.

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تسميد أشجار النخيل في العراق

أحمد عبد الهادي الراوي[أ]

الخلاصة:

تحتاج نخلة التمر إلى كميات كبيرة من العناصر الغذائية المختلفة، لتحقيق نمو جيد وإنتاجية مقبولة من حيث الكم والنوع لذلك تعتبر عملية التسميد، إحدى العمليات الزراعية المهمة التي تلعب دوراً اساسياً في زيادة الإنتاج وتحسين نوعية الثمار. وتختلف كميات الأسمدة الواجب إضافتها للنخلة، حسب نوع التربة ودرجة خصوبتها، ونوع المحاصيل المزروعة تحت أشجار النخيل. وكذلك حسب صنف وعمر النخلة، بالإضافة إلى نوع الأسمدة المستعملة.

وهذا البحث يلقي الضوء على الأساليب المتبعة في العراق لتسميد نخلة التمر. ويخلص هذا البحث إلى أن الأساليب المتبعة في العراق لتسميد نخلى التمر تعتمد على الخبرة المحلية المتوارثة والخبرات الفردية للفلاحين ولاتعتمد على تجارب علمية رصينة. وبصورة عامة تحتاج نخلة التمر سنوياً إلى 5-1.5 كغم نيتروجين حر، 0.5 كغم فوسفور و 2-3 كغم بوتاسيوم لتحقيق نمو مناسب. وهناك حاجة ملحة لفهم أكثر للعمليات الفسلجية المتعلقة بإمتصاص الماء والعناصر الغذائية لوضع صيغة علمية لتسميد هذه الشجرة المهمة في المنطقة. وإن التعاون بين الباحثين والمؤسسات العلمية في المنطقة يعتبر أمراً حيوياً لتحقيق هذا الهدف.

[أ] مركز اباء للأبحاث الزراعية ص. ب. (٣٩٠٩٤) بغداد العراق

PERFORMANCE OF DIFFERENT DATE PALM CULTIVARS UNDER HYPER ARID-SUPPLEMENTARY IRRIGATED WESTERN PLAINS OF RAJASTHAN (INDIA)

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ABSTRACT

Evaluation trial on performance of 34 date palm cultivars under hyper arid-partially irrigated western plains of Rajasthan (India) was conducted at Date palm Research Center, Rajasthan Agricultural University, Bikaner. The height of palm in cultivar Medjool (4.15 M) recorded a maximum and minimum in Ruziz (0.20 M). plant spread (EwxNS) was found maximum of 6.28x6.16 M in cultivar Barhee followed by Zagloul (5.66x5.69 M), Nagal Hilali (5.64x5.56 M), Medjool (5.60x5.67 M) an minimum in Khasab (2.70 x 2.75 M). The cultivar Medjool recorded the highest 76.8 leaves per palm and minimum in Ruziz and Khasab (12.0 leaves / palm). The time of spathe emergence was recorded in Nagal and Khuneizi and latest in Umshok. Duration of spathe emergence varied from 6 to 59 days, which was maximum in Khuneizi (59 days) and minimum in Umshok (6 days). Duration of spathe opening (flowering) was maximum in Halawy (43 days) and minimum of 8 days in Barshi. Medjool recorded highest fruit weight (22.7 g) and pulp thickness (0.88 cm). Pulp : Seed ratio was maximum in Khuneizi (15:1) and minimum in Nagal Hilali and Gizaz (3:1). The per cent total soluble solids in cultivar Khuneizi, Halawy, Barhee, Khalas, Sewi and Medjool was recorded 47.0, 30.7, 24.6, 25.8, 21.6 and 32.2, respectively. The average fruit yield per palm at full *doka* stage was recorded in cultivar Barhee (66.0 kg), Halawy (59.7 kg), Khalas (43.7 kg) and Medjool (35.0 kg). Medjool is suitable for preparation of dry dates (*Chhuara).* Halawy, Barhee, Khuneizi, Khalas and Sewi cultivars are good for dessert purpose.

Additional Idex Words: *Phoenix dactylifera* L., *doka (Khalal),* vegetative growth, flowering, yield and physico-chemical characters.

INTRODUCTION

The fruits of the date palm (*Phoenix dactylifera* L.,) are consumed as raw eating fresh fruits (*daka*), soft dates *(pind Khajoor)* and dry dates *(chhuara)*. Cultivation of date palm has great promise in hyper arid-partially irrigated plains of Rajasthan which realm the Bikaner, Jaisamer and part of Churu districts. In the past, some studies on evaluation of date palm cultivars were conducted in the arid trach of India (1,2,3,4,5,6,7&8) though with limited number of cultivars. In the present study 34 cultivars have been included.

MATERIALS AND METHODS

The present study was conducted at the Date palm Research Center, Rajasthan Agricultural University, Bikaner. At this center total 34 cultivars of date palm are being maintianed. For the present study observations were recorded during year 1997 on 31 cultivars (which were planted 16 years ago) and 3 cultivars (which were planted 4 years back). Under vegetative growth characteristics, plant height, girth of trunk, number of leaves per palm, length of leaf and plant spread (East to West and North to South) were studied in 34 cultivars. For flowering wee recorded in 31 date palm cultivars. Three trees in each cultivar wer used as a replicate in Randomized Block Design. Under yield parameters number of bunches per palm number of strands per bunch, number of fruits per strand and average yield per palm were also studied in 16 promising cultivars of date. In physico-chemical characteristics of fruits (length and width of fruit, pulp thickness, average fruit weight and stone weight, pulp: seed ratio, per cent TSS and per cent acidity) were studied in 31 cultivars.

RESULTS AND DISCUSSION

The height of plant (Table 1) was recorded maximum in Medjool (4.15 M) and minimum in Ruziz (0.20 M), where as trunk girth was maximum in Gizaz (1.95 M) and minimum in Ruziz (0.50 M). the cultivar Medjool recorded the highest 76.8 leaves per palm and minimum in Ruziz and Khasab (12.0 leaves / palm). The length of leaf varied from 1.63 m (Tayar) to 3.36 M (Barhee). Plant spread was found maximum in Barhee (6.28 x 6.16 M) and minimum in Khasab (2.70 x 2.75 M).

The time of spathe emergence was recorded from mid December to first week of March. The earliest spathe emergence was recorded in Nagal and Khuneizi (31.12.96) and latest in Umshok (1.3.97). duration of spathe emergence was recorded a maximum in Khuneizi (59 days) and minimum in Umshok (6 days). Duration of spathe opening (Flowering) was maximum in Halawy (43 days) and minimum of 8 days in barshi (Table 2). attributed to the spathe initiation in cultivars during 1997 differed from previous years (Chandra *et al.*, 1994) which might be variation in monthly mean temperatures during the different years before and at the time of flowering.

The maximum number of bunches per tree recorded was 10 in the cultivar khalas and the minimum five in Umshok (Table 3). The maximum number of strands per bunch was recorded in Zagloul (70.5) followed by Barhee (62.5), Medjool (62.0), Tayar (61.2) and the minimum in Hayani (19.0). the cultivar Zahidi recorded maximum fruits per strand (31.3) and minimum in Hayani (9.3). the fruit yield at full *daka* stage in cultivar Barhee, Halawy, Khalas and Medjool was recorded 66.0 kg. 59.7 kg, 43.7 kg and 35.0 kg per palm, respectively.

The data (Table 4) exhibited that fruit weight of Medjool (22.7 g) was recorded significantly higher than all the others. It was followed by Khuneizi (16.0 g), Nagal (13.0 g) Khasab (12.0 g) and minimum in Medinin (3.1 g). length of fruit varied rom 2.29 cm (Hatemi) to 4.6 cm (Medjool). Fruit width ranged between 1.55 cm (Medini) and 2.82 cm (Medjool). The pulp thickness was maximum in cultivar Medjool and Medinin (0.88 cm) and minimum of 0.39 cm in Bintaisha. Stone weight ranged between 0.7 g (Medini and Abdul Rehman) to 2.5 g (Nagal). The pulp: seed ratio at full *doka* stage was maximum in cultivar Khuenizi (15:1) and minimum in Nagal Hilali and Gizaz (3:1). The per cent total soluble solids (TSS) was recorded highest in Khuneizi (47.0) and lowest in nagal (13.0). The acidity varied from 0.13 per cent in Tayarto 0.66 per cent in Sedami (Table 4).

Due to better fruit size and pulp thickness Medjool was found suitable for preparation of dry dates (*chhuara).* Date cultivars Halawy, Khalas, Khuneizi and Sewi were found suitable for dessert purpose at full *doka* stage being sweet, edible, very less astringent.

ACKNOWLEDGEMENTS

The authors wish to thank Director (Research), RAU, Bikaner and Project Coordinator, AICRP on Arid Fruits (ICAR) for their financial and technical assistance.

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Table 1: Plant charecteristics of different date palm cultivars at Bikaner

Sl. Name of No. cultivar	(m) Height of palm	(m) Girth of trunk	No of leaves/ palm	(m) length of leaf	(m) Plant spread	
					East to West	North to South
1. Medjool	4.15	1.41	76.8	3.05	5.60	5.67
2. Halawy	3.62	1.46	36.2	2.84	5.13	5.11
3. Khadrawy	1.44	1.46	30.0	2.64	4.92	4.98
4. Shamran	2.14	1.43	53.2	3.02	5.32	5.16
5. Zahidi	1.90	1.56	32.4	2.80	4.76	4.54
6. Khalas	1.98	1.57	33.3	3.05	5.20	4.80
7. Hayani	0.95	1.00	28.2	2.24	3.70	3.62
8. Bintaisha	0.88	1.18	26.2	2.33	4.15	4.13
9. Sedami	3.16	1.14	44.2	3.10	4.42	5.49
10. Nagal Hilali	1.48	1.88	27.0	3.02	5.64	5.56
11. Zagloul	2.69	1.41	32.0	3.14	5.66	5.69
12. Sewi	2.66	1.38	25.0	2.73	4.35	4.35
13. Bikaner	1.48	1.69	22.0	2.47	4.00	4.02
14. Medini	1.77	1.85	35.0	2.47	4.65	4.75
15. Migraf	1.76	1.30	25.0	2.38	4.30	4.30
16. Abdul Rehman	1.72	1.88	22.0	2.65	4.60	4.65
17. Gizaz	2.10	1.95	25.2	3.24	4.75	4.77
18. Suria	2.70	1.68	39.2	2.65	4.70	4.70
19. Sri Ganganagar	1.55	1.70	23.5	2.82	4.30	4.20
20. Hamra	1.63	1.67	28.2	2.41	4.38	4.38
21. Muscat	1.82	1.60	40.2	2.88	5.04	4.92
22. Umshok	2.24	1.56	27.0	2.96	4.52	4.54
23. Sayar	1.46	1.45	30.6	2.74	4.54	4.48
24. Barhee	2.25	1.90	30.0	3.36	6.28	6.16
25. Nagal	0.98	1.42	30.0	2.68	4.82	4.76
26. Khuneizi	0.97	1.22	21.0	2.65	4.84	4.82
27. Hatemi	0.38	0.66	17.8	1.96	3.26	3.56
28. Barshi	0.40	0.80	20.0	2.01	3.40	4.00
29. Ruziz	0.20	0.50	12.0	1.70	3.00	2.96
30. Khasab	0.30	0.55	12.0	2.00	2.70	2.75
31. Tayar	0.43	0.52	13.3	1.63	2.80	3.00
32. Sakloti	0.42	0.50	36.0	1.76	3.23	3.27
33. Amri	0.30	0.30	24.0	1.00	2.10	1.90
34. Agolani	0.23	0.28	18.3	1.37	2.47	2.70
S.Em ±	0.05	0.02	26.9	0.01	0.71	0.75
CD (P = 0.05)	0.32	0.19	7.2	0.10	1.17	1.20

Table 2: Flowering behaviour of different date palm cultivar at Bikaner during the year 1997.

S. No. Name of cultivator	Date of Spathe emergence		(Days) Duration of spathe emergence	Date of spathe opening		(Days) Duration of spathe emergence
	First	Last		First	Last	
1. Medjool	28.1.97	6.3.97	38	28.2.97	18.3.97	19
2. Halawy	31.1.97	6.3.97	35	1.2.97	15.3.97	43
3. Khadrawy	6.2.97	24.2.97	19	7.3.97	17.3.97	11
4. Shamran	14.2.97	1.3.97	16	7.3.97	18.3.97	12
5. Zahidi	28.1.97	3.3.97	35	18.2.97	15.3.97	26
6. Khalas	1.2.97	1.3.97	29	18.2.97	15.3.97	26
7. Hayani	11.2.97	3.3.97	21	7.3.97	15.3.97	09
8. Bintaisha	6.2.97	27.2.97	22	7.3.97	15.3.97	09
9. Sedami	18.1.97	1.3.97	43	18.2.97	15.3.97	26
10. Nagal Hilali	1.2.97	6.3.97	34	3.3.97	16.3.97	14
11. Zagloul	16.2.97	6.3.97	18	3.3.97	15.3.97	13
12. Sewi	24.1.97	28.2.97	36	28.2.97	18.3.97	19
13. Bikaner	16.2.97	3.3.97	16	28.2.97	18.3.97	19
14. Medini	28.1.97	6.3.97	38	28.2.97	16.3.97	17
15. Migraf	18.1.97	28.2.97	42	28.2.97	15.3.97	16
16. Gizaz	24.2.97	6.3.97	11	4.3.97	18.3.97	15
17. Abdul Rehman	19.2.97	6.3.97	15	6.3.97	16.3.97	11
18. Suria	11.2.97	6.3.97	24	3.3.97	18.3.97	16
19. Sri Ganganagar	19.2.97	28.2.97	09	7.3.97	15.3.97	09
20. Muscat	4.1.97	24.2.97	52	5.2.97	15.3.97	39
21. Hamra	24.1.97	1.3.97	36	21.2.97	17.3.97	25
22. Umshok	1.3.97	6.3.97	06	7.3.97	18.3.97	12
23. Sayar	29.1.97	1.3.97	32	6.3.97	16.3.97	11
24. Barhee	29.1.97	1.3.97	32	6.3.97	18.3.97	13
25. Nagal	31.12.96	12.2.97	44	10.2.97	1.3.97	20
26. Khuneizi	31.12.96	27.2.97	59	19.2.97	18.3.97	28
27. Barshi	12.2.97	19.2.97	08	8.3.97	15.3.97	08
28. Ruziz	19.2.97	1.3.97	11	10.3.97	18.3.97	09
29. Hatemi	6.2.97	1.3.97	24	7.3.97	15.3.97	09
30. Khasab	12.2.97	27.2.97	16	7.3.97	16.3.97	10
31. Tayar	28.12.96	10.1.97	14	7.3.97	18.3.97	12
32. Sakloti	No spathe emergence during the year					
33. Amri	No spathe emergence during the year					
34. Agolani	No spathe emergence during the year					

Table 3: Yield and its components of date palm cultivars at Bikaner

S. No. Name of Cultivar	Number of bunches/palm	Number of strands/bunch	Number of fruits/strand	(kg) Yield/ palm
1. Medjool	8	62.0	19.2	35.0
2. Halawy	9	55.0	19.1	59.7
3. Khadrawy	8	44.3	16.2	21.7
4. Shamran	7	53.2	18.8	23.5
5. Zahidi	8	43.2	31.3	32.0
6. Khalas	10	57.7	13.8	43.7
7. Hayani	6	19.0	09.3	10.4
8. Zagloul	8	70.5	14.3	24.2
9. Sewi	6	38.2	29.1	23.3
10. Bikaner	7	59.2	20.5	32.5
11. Medini	7	41.0	22.2	28.7
12. Hamra	6	46.3	13.6	11.4
13. Umshok	5	42.0	17.7	17.0
14. Sayar	8	61.2	18.6	26.3
15. Barhee	8	62.5	24.3	66.0
16. Khuneizi	6	60.0	20.9	06.3
S.Em ±	2.86	3.74	1.29	4.02
CD (P = 0.05)	2.34	2.68	1.58	2.78

Table 4: Physico-chemical characteristics of fruit of different date palm cultivars at Bikaner.

S. No. Name of cultivar	(cm) Length of fruit	(cm) Width of fruit	(cm) Pulp thick ness	(g) Fruit weight	(g) Stone weight	Pulp/ seed ratio	(%) TSS	(%) Acidity
1. Medjool	4.61	2.82	0.88	22.7	2.2	9.32	32.2	0.30
2. Halawy	3.75	2.09	0.59	9.4	1.5	5.27	30.7	0.16
3. Khadrawy	3.32	1.83	0.55	6.5	1.4	3.64	31.2	0.30
4. Shamran	3.78	2.44	0.55	7.9	1.6	3.94	31.8	0.26
5. Zahidi	3.43	2.09	0.55	8.3	1.8	3.61	23.4	0.26
6. Khalas	3.42	2.11	0.67	11.4	1.4	7.14	25.8	0.26
7. Hayani	3.17	2.12	0.46	6.7	1.5	3.47	25.2	0.33
8. Bintaisha	2.64	1.65	0.39	5.1	1.2	3.25	32.0	0.42
9. Sedami	3.46	2.13	0.52	8.2	1.5	4.47	32.9	0.66
10. Nagal Hilali	2.44	1.63	0.43	4.0	1.0	3.00	30.1	0.29
11. Zagloul	3.79	1.69	0.57	8.4	1.5	4.60	18.6	0.34
12. Sewi	2.72	2.44	0.54	7.2	1.4	4.14	21.6	0.26
13. Bikaner	2.85	1.92	0.56	6.2	1.3	3.77	23.0	0.30
14. Medini	2.32	1.55	0.88	3.1	0.7	3.43	37.0	0.19
15. Migraf	2.34	1.66	0.43	3.5	0.8	3.37	32.0	0.28
16. Abdul Rehman	2.32	1.68	0.45	3.8	0.7	4.43	28.0	0.17
17. Gizaz	2.97	2.06	0.53	4.0	1.0	3.00	29.5	0.27
18. Suria	2.85	1.64	0.45	6.2	1.2	4.17	27.5	0.32
19. Sri Ganganagar	2.45	1.86	0.52	5.5	1.0	4.50	24.0	0.19
20. Hamra	2.70	1.74	0.53	6.2	1.5	3.13	23.5	0.35
21. Muscat	2.23	1.76	0.44	6.1	1.1	4.54	25.5	0.23
22. Umshok	3.00	1.86	0.50	5.6	1.2	3.67	26.0	0.20
23. Sayar	3.63	1.98	0.64	8.7	1.4	5.21	29.0	0.38
24. Barhee	2.96	2.02	0.64	9.4	1.0	8.40	24.6	0.17
25. Nagal	4.21	2.21	0.70	13.0	2.5	4.20	13.0	0.32
26. Khuneizi	3.33	2.31	0.85	16.0	1.0	15.0	47.0	0.35
27. Hatemi	2.29	1.96	0.54	5.4	1.0	4.40	23.0	0.26
28. Barshi	3.17	2.44	0.75	9.2	1.3	6.08	19.2	0.15
29. Ruziz	2.98	1.99	0.53	6.2	0.8	6.75	20.1	0.22
30. Khasab	3.00	1.91	0.58	12.0	1.6	6.50	25.0	0.38
31. Tayar	2.94	1.68	0.42	5.0	1.0	4.00	20.0	0.13
S.Em ±	0.19	0.07	0.003	0.99	0.06	0.27	13.21	0.001
CD (P = 0.05)	0.60	0.38	0.08	1.38	0.36	0.72	5.04	0.04

IRRIGATION SCHEDULING OF PALM TREES IN THE UNITED ARAB EMIRATES

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ABSTRACT

A computer model is developed to determine irrigation needs of palm trees on the basis of fixed quantity at different times (calendars). The model is based on the computation of reference evapotranspiration, crop coefficient, water holding capacity of the soil, ground cover, effective contact volume of the root zone, leaching requirements, irrigation efficiency and daily soil water crop yield. It is developed for different tree ages and soil types. The model used has been shown to produce reliable estimate of soil water balance. The predictions are sensitive to the accuracy of the input data measured on the farm. The model is intended to improve water management practices by the farmers. Preliminary test showed that irrigation water could be decreased from $130m^3$ to $74m^3$ per year at Dhaid in the Central Region of UAE.

INTRODUCTION:

The objectives of irrigation management are well stated in Huygen et al., 1995: "Maximize net return... minimize irrigation cost...maximize yield...optimally distribute a limited water supply...minimize ground water pollution". To achieve these goals, it is necessary to schedule irrigation accordingly, in other words, when to irrigate and how much to irrigate. It is well known that over or under irrigation has a negative effect on quantitative and qualitative yield.

Timing and depth criteria for irrigation scheduling (Huygen et al., 1995) can be established by using several ways based on soil water measurements, soil water balance estimates and plant stress indicators, in combination with simple or complex models. These require knowledge on crop water requirements and yield responses to water, irrigation methods and equipments, and the limitation of water supply.

In the United Arab Emirates (UAE), 53.4% of the cultivated land are covered by palm trees. It consumes 63.2% of the irrigation water. Improper irrigation water management leads to some physiological disorders and/or diseases. Fruits quality can also be affected. Over irrigation will cause some diseases at Rutab stage. It has a major effect on nitrogen leaching from the root zone especially in sandy soils.

The objectives of this study are to adopt an appropriate irrigation scheduling method for palm in UAE could lead to increase in yield, significant water savings, reduce environmental impact of irrigation and improve sustainability of irrigated agriculture.

MEASUREMENTS AND CALCULATIONS

Soil moisture balance method for irrigation scheduling is used to accurately determine when and how much to irrigate. This method sums daily crop water requirements and subtracts this quantity from the water holding capacity in the effective root zone. When the water holding capacity drops down to a predetermined level, then it is time to apply water by refilling the effective root zone to the field capacity.

This method needs knowledge of daily water requirements, water holding capacity of the soil, effective root zone volume, management allowable depletion, times and amounts of precipitation.

1- Crop Water Requirements:

The effects of radiation, temperature, humidity, wind speed, available soil water, size of tree canopy and time during the year on water requirements are well stated by many authors. Fortunately, technologies have made the collection and the calculation of crop water requirements values available. The meteorology section of the water and soil department at the Ministry of Agriculture and Fisheries in the UAE is currently collecting weather data information in more than 24 locations.

Reference crop evapotraspiration (ETref) was estimated using modified Penman (Doorenbos and Pruitt, 1977, FAO) instead of Penman - Montieth equation (Allen et al., 1994). A comparison of ETref estimation by different methods indicated that Penman - Montieth equation under estimated ETref values by at least 25% for five different zones in the UAE. These variations may be caused by the choice of the constants values for the surface resistance in Penman Montieth equation.

Modified Penman Equation is:

$$ETref=C[W. Rn + (1-W) . f(u) . (es - ea)] \qquad (1)$$

Where:

ETref is reference crop evapotranspiration, mm

C is a correction factor

$$W= \Delta /(\gamma + \Delta) \qquad (2)$$

Δ is the slope of the saturation vapor pressure – air temperature, mbar/°C

γ is psychrometric constant mbar/°C

Rn is net radiation, mm/day

f(u) is a function of wind speed

es is saturated vapor pressure, mbar

ea is actual vapor pressure, mbar

Effective Rainfall:

As input of monthly rainfall, the average, dependable or actual rainfall data can be given. Careful consideration should be taken in selecting the appropriate values for dependable rainfall. To account for the losses due to surface runoff and deep percolation the effective rainfall was calculated using the USDA Soil Conservation Method (Allen et al., 1994) as follow:

$$Peff = Ptot\ (125 - 0.2Ptot) / 125 \quad \text{for } Ptot < 250mm \qquad (3)$$

$$Peff = 125 + 0.1\ Ptot \quad \text{for } Ptot > 250mm \qquad (4)$$

Where:

Peff is effective rainfall in mm.

Ptot is the monthly rainfall in mm

2- CROP

Crop Coefficient (KC):

Crop coefficient is mainly controlled by the crop characteristics namely the resistance to transpiration of different plants. To maintain good growth and high yields of good quality a regular water supply is needed throughout the year with a possible exception just prior and during harvest and at winter time. Water deficiencies during early April to late July have been shown to hasten ripening but reduce volume and quality of the fruits.

The crop coefficient was determined by the following equation (Hess, 1996)

$$KC = (KCb \cdot KS) + Ke \qquad (5)$$

Where:

KCb is the basal crop coefficient when the water is not a limiting factor for plant growth. KCb is set equal to 0.8 (Doorenbos and Pruitt, 1977).

KS is a soil water availability factor (0 - 1). KS is equal to 0.9 for the period from mid January to late March, 1.0 from late March to late July and 0.7 from late July to mid January for the most common varieties in UAE.

Ke is soil water evaporation coefficient. Ke was equal to 0.1 from experimental data measuring soil evaporation under the canopy at different locations.

For the period from mid January to late March KC is:

$KC = (0.8 \times 0.9) + 0.1 = 0.82$

For the period from late March to late July, KC is:

$KC = (0.8 \times 1.0) + 0.1 = 0.9$

For the period from late July to mid January, KC is:

$KC = (0.8 \times 0.7) + 0.1 = 0.66$

After mid July, the fruits reach the Rutab stage for the most common varieties. At this stage the water content of the fruits is maximum. During this stage the water content of the fruits will be decreased. Therefor, it is necessary to expose the tree to a mild stress. This is very important practice especially in the humid regions in order to have a good fruit quality.

Ground Cover:

The canopy of palm trees intercepts only a portion of the incoming solar radiation. The amount of the interception depends on the size of the canopy and varies with age of the palm tree.

A reduction factor, Kr, will be used to correct water requirement calculations. The reduction factor is calculated from the ground cover value (GC). It is defined as the fraction of the total surface area actually covered by the foliage of the trees when viewed directly from above. In order to calculate the GC, it is necessary to measure the ground cover by the leaves (LC). Large numbers of LC measurements were made for different varieties of palms at different ages. Figure (1) shows the relationship between the LC and palm tree age for the most common varieties in UAE. The LC varies from 0.6 to 3.0m for the age one to seven years. The statistical analysis indicated significant increases in the LC from the first to sixth year of the offshoot planting. After the sixth year no significant increases in the LC value were recorded.

Logistic function was used to express the relationship between LC and palm tree age as follow:

$$LC = \frac{LCm}{1 + b\ e^{cA}} \qquad (6)$$

Where:

LC is ground cover by the leaves (the distance from the stem to the end of the shaded area), m

LCm is the maximum ground cover by leaves at maturity, m. It is equal to 3.1m for the most common varieties in UAE.

b and c are statistical parameters and equal to 19.3 and -1.112, respectively.

A is the age of palm trees, year.

The correlation coefficient (r) was 0.99

The ground cover is calculated by dividing the actual surface area covered by the foliage on the total ground area according to the spacing between trees.

The reduction factor (Kr) is estimated using Killer and Karmeli (1974) equation as follow:

$$Kr = GC/ 0.85 \qquad (7)$$

Effective Root Zone Volume (Contact Volume):

The effective crop rooting zone volume refers to the volume of the soil at which roots extract 80% of the water utilized by the tree. Though the actual rooting volume is greater, the effective rooting volume should be used in irrigation scheduling. It is well known that the root growth is genetically controlled but environmentally modified. Root zone volume varies with palm tree age, physical properties of the soil and irrigation method. Root depth and distribution patterns for palm trees from planting the offshoot to maturity have been determined by the excavation method at different

Locations in UAE for different varieties. Figures (2 & 3) show the effective vertical and horizontal root distributions at different ages of palm trees. The statistical analysis indicated significant increases in both vertical and horizontal root distributions from planting the offshoot to the seventh year. No significant increases in root distribution after the seventh year. It should be stated that the soils varied from sandy to loamy sand. The hardpan was at least 2.3m from the soil surface. The irrigation system was bubbler. The irrigated area around the tree varied in diameter from 1.0 to 4.5m according to the age of the tree.

Logistic function is used to express the relationships between the effective root distributions and palm tree age as follow:

$$RLv = \frac{RLvm}{1 + b\,ec^{cA}} \qquad (8)$$

Where

RLv is the effective vertical root length, m

RLvm is the maximum effective vertical root length, m. It is equal to 1.3m.

b and c are statistical parameters and equal to 9.5 and -0.79, respectively.

A is the age of the palm tree, year.

The correlation coefficient (r) was 0.966.

For the horizontal root distribution the equation is:

$$RLh = \frac{RLhm}{1 + b\,e^{cA}} \qquad (9)$$

Where:

RLh is the effective horizontal root distribution from the stem, m.

RLhm is the maximum effective horizontal root distribution from the stem, m.

b and c are statistical parameters and equal to 15.1 and -0.89, respectively.

The correlation coefficient (r) was 0.963.

Equations 8 & 9 made it possible to determine the volume of the effective root zone in order to calculate the exact amount of the water application without any over irrigation.

3- FIELD

Water Holding Capacity:

The water holding capacity (WHC) of the soil is defined as the amount of soil water content held between the field capacity (FC) and the wilting point (WP). It is determined as follow:

$$WHC = (FC - WP) \,.\, Pd \,.\, 10 \,.\, 1.0m \qquad (10)$$

WHC = mm/1.0m depth of soil or liter/ m^3 of soil

Where:

FC is the water content at field capacity on weight basis, %
WP is the water content at the wilting point on weight basis, %
Pd is the bulk density of soil, g/ cm^3

The percentage of WHC that can be used by the crop without loss of yield or quality will vary with stage of crop development and ETref. The maximum fraction of WHC that a crop can extract without loss of yield or quality is called Management Allowable Depletion (MAD). It should be considered when calculating the net water requirements (NWR). For palm trees, the MAD is set equal to 0.5 at flowering, pollination and fruits formation to Rutab stage. This Period is from mid

January to late July. During the rest of the year, MAD is equal to 0.65. For young palm trees, it is necessary to keep water at optimum conditions throughout the year (MAD = 0.5).

The maximum amount of water uptake that the palm tree can absorb from the root zone without any decrease is calculated as follow:

$$EASW = WHC.\ ERV.\ MAD \qquad (11)$$

Where:

EASW is the easily available soil water, liter.

ERV is the effective root zone volume, m^3.

WHC is water holding capacity, liter/m^3

Actual Evapotranspiration (Eta):

Easily available soil water decreases as the palm tree uses water. The daily water use by palm tree is calculated as follow:

$$ETa = ETref\ .\ KC\ .\ Kr.\ Ar \qquad (12)$$

Where:

ETa is actual daily water use by the palm tree in liter.

Ar is the area specified for each tree, m^2.

The daily water use by the palm tree (ETa) is subtracted from EASW. When EASW reaches close to zero, irrigation will start again to refill the root zone back to field capacity. Attempting to store water beyond field capacity can increase the occurrence of leaching valuable plant nutrients below the root zone. The EASW is equal to the net amount of the applied water (NAW). To calculate the gross amount of the applied water (GAW), it is necessary to know the application efficiency (AF) of the irrigation system and leaching requirements (LR).

The application efficiency includes both distribution uniformity and uniformity coefficient. The leaching requirements are calculated using Hoffman and van Genuchten (1983) approach.

The GAW is calculated as follow:

$$GAW = (NAW / AF)(1 + LR) \quad \text{in liters} \qquad (13)$$

4- YIELD WATER RELATIONSHIP:

The manner in which water deficit affects crop growth and yield varies with crop species and growth period. In order to quantify this effect of water stress on yield, Doorenbos and Kassam (1979) equation was used. The equation is:

$$(1 - Ya/Ym) = ky\,(1 - ETa/ETm) \qquad (14)$$

Where

Ya and Ym are actual and maximum harvested yield.

ETa and ETm are actual and maximum evapotranspiration.

ky is yield response factor.

In this program the soil water is at optimum conditions from mid January to late July. Hence, fruit yield is always maximum.

5- Testing the Model:

The model was tested for six months period. Soil water content was measured in both vertical and horizontal directions from the stem to cover the effective root zone. Reasonable agreement was obtained between measured and calculated data in the soil water balance system. The model needs to be test for longer time.

CONCLUSIONS:

Simple model was developed to calculate irrigation needs for palm trees. The model is reliable and intended to promote easy and ready adoption of improving water management practices by the farmers. The model gave a close estimation of the irrigation water needed by palm trees throughout the season that improve yield and quality. The calendar is simple and could be used by any person. Further information and help in using the calendar can be found at your local Ministry of Agriculture and Fisheries Cooperative Extension Office in your region.

Flowchart of the Program

ETref Station Identification

Input Data

Rs, T, U, RH, n, P

Calculate ETref

Pen77

Pen-Mon

Calculate effective Rainfall

USDA Equation

Crop Palm

Input Data

Spacing Between Trees

Age of the Tree

MAD

Calculate Crop Coefficient

Calculate Contact Volume of the Root

Horizontal Distribution of the Root

Vertical Distribution of the Root

Calculate Ground Cover

Calculate Reduction Factor

Field Input Data

FC, WP, Pd, LR, AF

Calculate Water Holding Capacity

Calculate Easily Available Soil Water

Irrigation Scheduling

Calculate ETa

Calculate Yield Reduction

Calculate Irrigation Intervals

Calculate Gross Applied Water

EXAMPLE

Soil Moisture Balance Sheet for Checkbook Irrigation Scheduling

Field No: *10* Region: *Central*

Farmer Name: *MAF*

Date Palm Cultivar: *Mixed* Age of Trees: *7*

Effective Rooting Depth Volume m^3: *20* m^3

Water Holding Capacity of the Soil: *1400 liters/ 20*m^3

Reduction Factor: *0.55*

Water Quality: *1000 ppm*

Spacing Between Trees: *8m x 8m*

Irrigation System: Two Bubblers per Tree (Bubbler Emission is 360 liter/ hr)

Month	Day	Water Use Liter/Day	Rainfall	Net Irrigation Liter	Soil Moisture Liter
Jan.	1	70	0	0	1400
	2	70			1330
	3	70			1260
	4	70			1190
	5	70			1120
	6	70			1050
	7	70			980
	8	70			910
	9	70			840
	10	70			770
	11	70		700	1400

EXAMPLE

Soil Moisture Balance Sheet for Checkbook Irrigation Scheduling

Field No: *10*　　　　Region: *Central*

Farmer Name: *MAF*

Date Palm Cultivar: *Mixed*　　　　Age of Trees: *7*

Effective Rooting Depth Volume m^3: *20* m^3

Water Holding Capacity of the Soil: *1400 liters/ 20*m^3

Reduction Factor: *0.55*

Water Quality: *1000 ppm*

Spacing Between Trees: *8m x 8m*

Irrigation System: Two Bubblers per Tree (Bubbler Emission is 360 liter/hr)

FARM 10　　　　Region: Central

700 liters / Irrigation

MONTH	DAY
JAN	1, 11, 21, 31
FEB	7, 14, 21, 28
MARCH	5, 10, 15, 20, 25, 30
APRIL	3, 7, 11, 15, 19, 23, 27
MAY	1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31
JUNE	2, 5, 7, 10, 12, 15, 17, 20, 22, 25, 27, 30
JULY	2, 5, 7, 10, 12, 15, 17, 20, 22, 25, 27, 30
AUGUST	3, 7, 10, 14, 17, 20, 24, 27, 31
SEPT	4, 8, 12, 16, 20, 24, 28
OCT	3, 8, 13, 18, 23, 28
NOV	2, 9, 16, 23, 30
DEC	7, 14, 21, 28

NO. of Irrigation is 87

Net Irrigation 61m^3 / season

Gross Irrigation 74m^3

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Sheet1 Chart 1

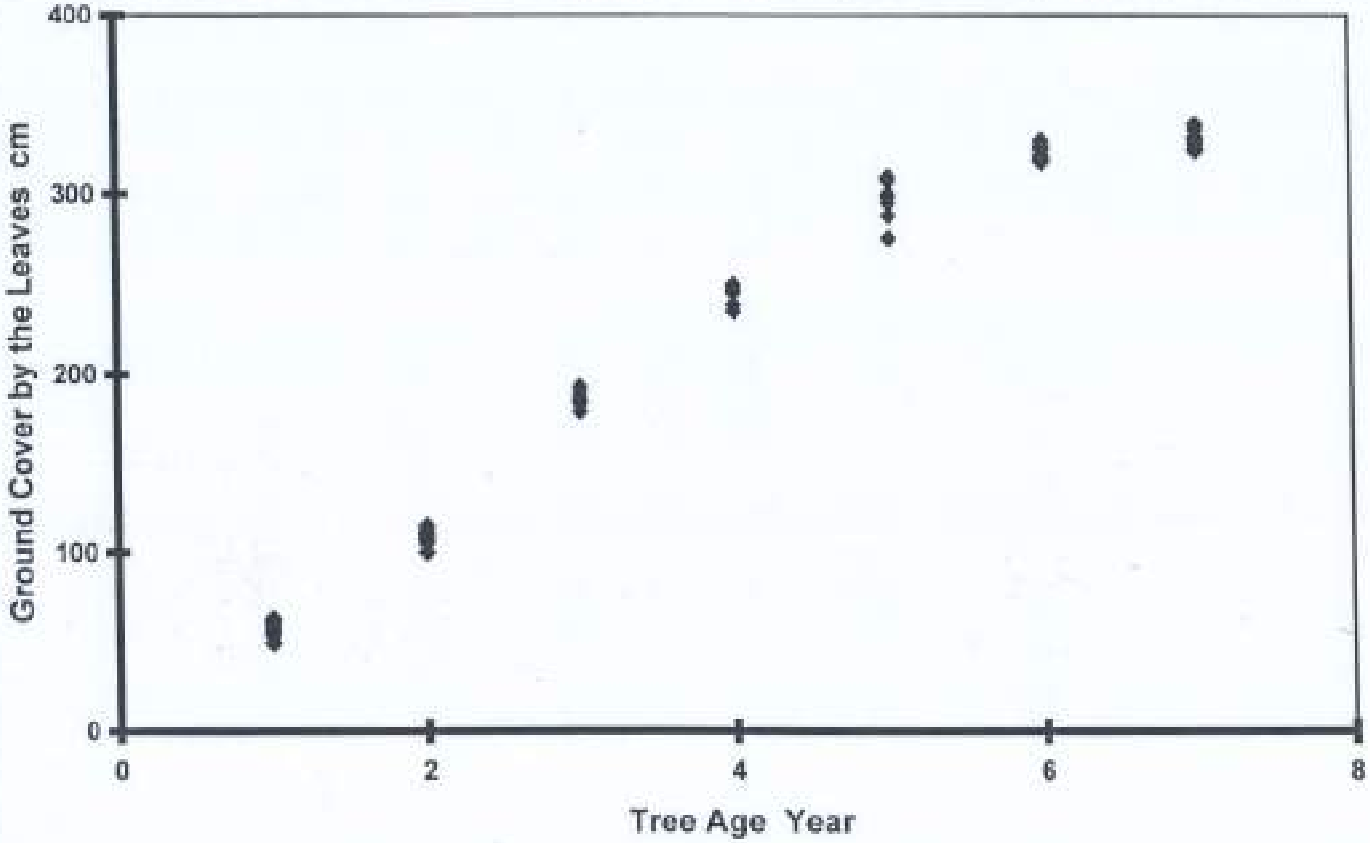

Fig. (1). Ground Cover by the Leaves at Different Ages of the Palm Tree

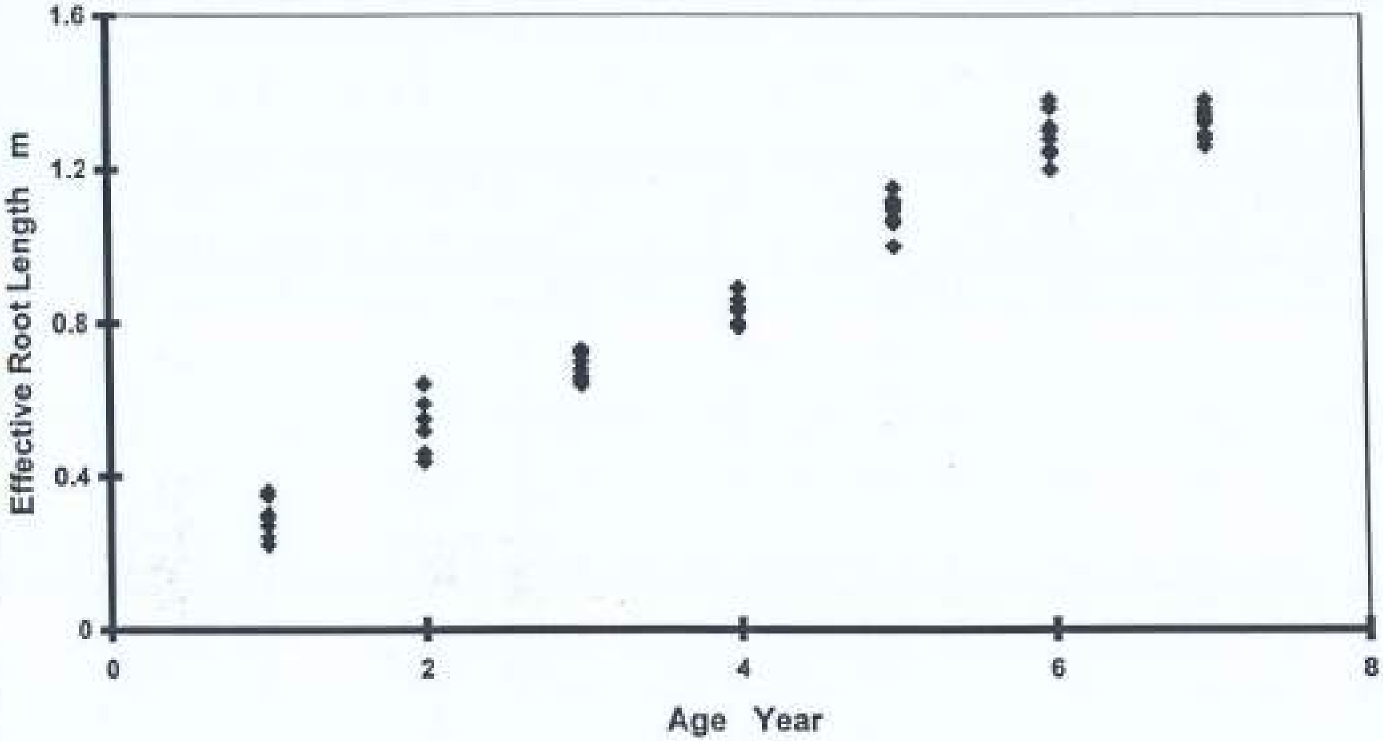

Fig. (2). Effective Vertical Root Length of Palm Tree at Different Ages

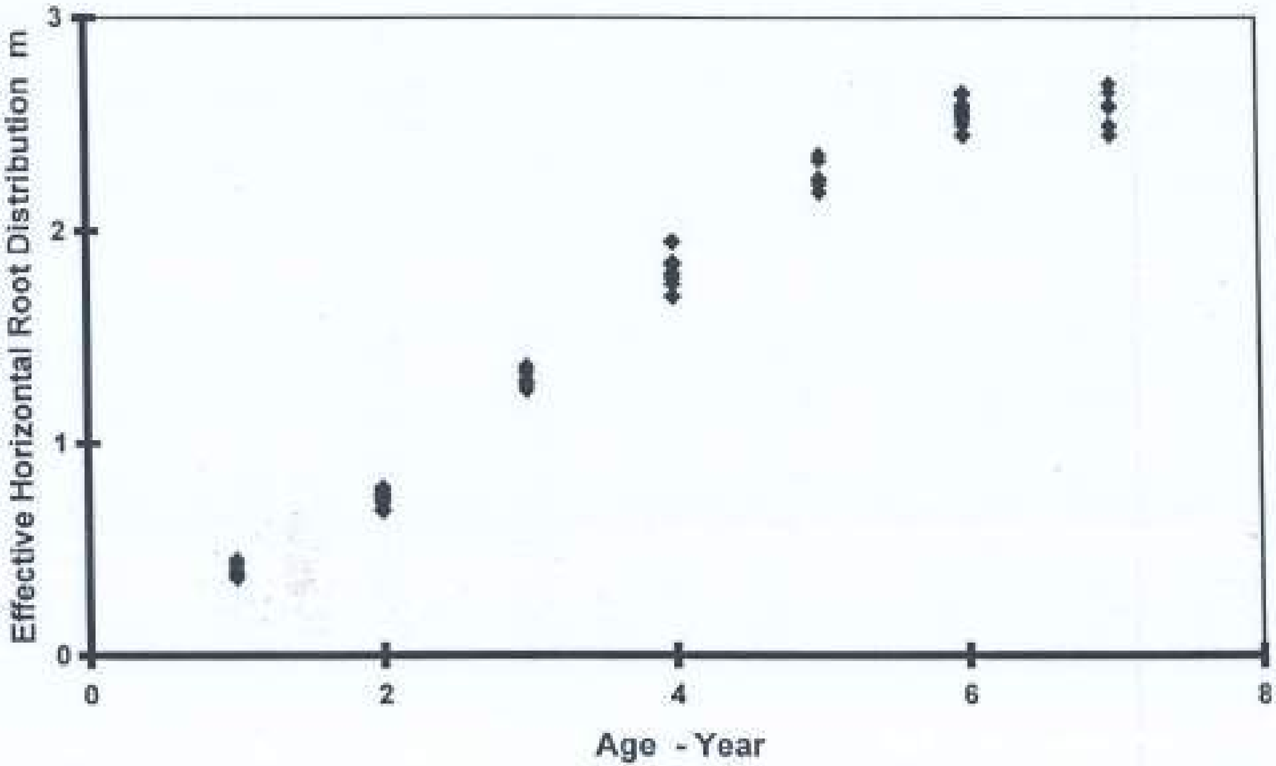

Fig. (3). Effective Horizontal Root Distribution from the Stem for Palm Tree at Different Ages

STUDIES ON FRUIT THINNING OF DATE PALMS

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ABSTRACT

Different hand thinning treatments were conducted on "Seewy" date palms to study the effect of thinning on yield and fruit quality. Date palms were thinned by removing 10, 20, 30 and 40% of the total number of strands from the center of each bunch, in three different periods of each one namely: 2, 4 and 6 weeks after pollination. The obtained results revealed that the average yield per palm and per bunch for the different treatments was lower than the control. However, thinning treatments improved both physical and chemical properties of fruits where they increased significantly fruit weight, flesh weight, fruit dimensions, TSS and total sugars % than those of the control. In addition, they reduced tannins content in fruit considerably than the control. Removing 30% of the total number of strands from the center of each bunch, 4 weeks after pollination gained the highest fruit quality as compared with other thinning treatments. Consequently, such treatment considered as a recommended treatment in such experiment.

"Key Words": Date palms, thinning, yield, fruit quality

INTRODUCTION

Alternate bearing is common in some cultivars of date palm. Fruit thinning is one of the major practices that often helps in overcoming this problem, in addition, it enhances fruit quality of dates and reduces compactness of fruit bunches, beside increase adequate flowering for the following year (Nixon, 1935 & 1955; El-Fawal, 1962; Hussein, 1970; Hassaballa et al., 1983; Moustafa et al., 1984 and Khalifa et al., 1987). Such results could be obtained either by reducing the number of fruits per bunch or by reducing the number of bunches per palm. The method of thinning recommended was dependent on the date cultivar. Nixon (1951) noticed that in the small-fruited date palm cultivars, removing strands or individual fruit thinning on the strands may be more desirable.

The purpose of the present study is to obtain some information about the best degree and time of thinning that would result in higher fruit quality without remarkable reduction in fruit yield of "Seewy" date cv. under El-Fayoum Governorate conditions.

MATERIALS AND METHODS

This work was conducted during two successive seasons of 1995 and 1996 on 39 female date palms (Phoenix dactylifera, L.) of "Seewy" cultivar. Palms were of 40-year-old grown in a loamy sand soil at El-Bassionia orchard, El-Fayoum Governorate, Egypt. Such experimental palms were chosen uniform as far as possible in their size and growth vigour and they were in the on-year in the first season. Palms were subjected to the normal schedule of cultural practices. Hand pollination was carried out during the third week of April in both seasons using the same pollen sources (two male seedling "Seewy" palms grown at the same orchard). The leaf bunch ratio was maintained at 7 : 1. Nine bunches nearly similar in age and vigour were selected on each palm in both seasons.

Four Thinning degrees namely: 10, 20, 30 and 40% of the total number of strands from the center of each bunch were removed. Strands removal for each thinning degree was done 2, 4 or 6 weeks after pollination. Thus, this experiment involved 12 thinning treatments (4 thinning degrees x 3 thinning dates) arranged in a complete randomized blocks design. Each treatment was replicated three times with one palm for each replicate. In addition to that, three palms were left without fruit thinning to serve as a control.

All bunches of the investigated palms were harvested at full color stage (Khalal) and weighed, then the average of bunch weight and yield per palm (in kg.) was calculated for each treatment. Samples of 70 date fruits from each replicate were randomly picked for determining its physical and chemical properties. Fruits of each sample were weighed and measured. The seeds were extracted and weighed, then flesh weight was calculated. Total soluble solids (TSS) were determined by a hand refractometer. Total sugars as gm. per 100 gm. of the fresh flesh weight were estimated (using the method described by Schaffar and Hartman, 1921). Tannins as gm. per 100 gm. fresh weight were assayed according to the method A.O.A.C. (1970).

The obtained results of this study were statistically analysed as outlined by Snedecor (1967).

RESULTS AND DISCUSSION

1. Effect of Fruit Thinning on Yield:

1.1 *Palm Yield*:

As shown in Table (1), fruit thinning of "Seewy" palm significantly decreased yield per palm than that of the control. The reduction in yield was positively correlated to the severity of thinning. In other words, palm yield was decreased as thinning degree increased. Nevertheless, differences between various degrees of thinning were too small to reach the significant level. Moreover, differences between thinning dates in each thinning degree were negligable in most cases. Meanwhile, palms received fruit thinning of 20 or 30 or 40%, 6 weeks after pollination showed the lowest palm yield.

As for the second season (Table 2) it is obvious that palms treated with 10 or 20% thinning at any time after pollination as well as those received 30% fruit thinning 2 weeks after pollination gave similar yield as the control. On the other hand, other treatments significantly reduced yield per palm than the control. Meanwhile, 40% thinning, 6 weeks after pollination was the most inferior treatment. This finding confirms the result obtained by El-Fawal (1962) and Moustafa et al. (1984) on "Samany" and "Hayany" dates, respectively.

2 - *Bunch weight*:

Similar trend was found as palm yield. The different thinning treatments significantly decreased bunch weight than the control in the first season (Table 1). Meanwhile, the reduction in bunch yield was increased as the thinning degree increased. However, differences between thinning at 2 or 4 weeks after pollination in each thinning degree were lack of significancy in most cases.

In the second season (Table 2) palms received thinning degree of 10 or 20% at different times, as well as those treated with 30% thinning at 2 weeks after pollination, did not differ considerably than the control. On the contrary, other studied treatments showed remarkable reductions in bunch weight. These results are in general agreement with those published by Nixon (1935, 1936, 1951 and 1955); Hussein (1970) and Miremadi (1970) on several date cultivars.

2. Effect of Fruit Thinning on Some Physical Properties of Fruit:

2.1 - Fruit Weight:

It is clear from Tables (1 & 2) that all the studied treatments of fruit thinning significantly increased the average fruit weight of "Seewy" dates as compared to that of the control in both seasons. The increase in average fruit weight which occurred by thinning may be due to the reduction in fruits compactness which prevents their accumulation within bunch. Consequently, such fruits take the opportunity of natural growth (Nixon, 1940). Comparing the increasing effect of thinning treatments on fruit weight, it was found that removing 30% of the total number of strands from the bunch center, especially, 4 weeks after pollination significantly increased the average fruit weight than other thinning treatments in the two seasons. On the other hand, difference between 10 and 20% thinning of fruits was too small to reach the significant level regardless the time of application. The obtained results are similar to those of Nixon (1935, 1936, 1940 and 1955); Anon (1953); Monciero & Werthimer (1956); El-Fawal (1962); Hussein (1970); Hasaballa et al. (1983); Moustafa et al. (1984) and Khalifa et al. (1987). They all reported that fruit thinning increased the fresh weight of date fruit.

2 - Flesh weight:

It is obvious from Tables (1 & 2) that all thinning treatments significantly increased fruit flesh weight than the control in both seasons. Meanwhile, trees which thinned by 30%, 4 weeks after pollination showed the significantly highest flesh weight of fruits as compared with other studied treatments. Regardless the thinning time, removing 30% of the total strands seems to be more effective than other thinning degrees. In addition, there was no significant difference between 10 and 20% thinning degrees regardless the application time. This feature is strongly supported by Nixon (1955) on "Deglet Noor"; El-Fawal (1962) on "Samany"; Hassaballa et al.

(1983) and Kalifa et al. (1987) on "Zaghloul" and Moustafa et al. (1984) on "Hayany" date cultivars.

2.3 - Fruit Dimensions:

***2.3.1- Fruit Length*:**

Data given in Tables (1 & 2) indicate that trees thinned by 30%, 4 weeks after pollination produced the significantly maximum increase in the average fruit length in both seasons. Results also indicated that there were no significant differences between different thinning times in each removal degree. In general, thinning of 30% of the total strands regardless the time of application seems to be the most effective treatment under such study.

***2.3.2- Fruit Diameter*:**

Concerning the effect on fruit diameter, it is shown that thinning of 30% of the total strands at any time after pollination, generally, gained the significantly highest fruit diameter as compared with the control and other thinning treatments in the two seasons (Tables 1&2).

Similar effects of fruit thinning on fruit dimensions (length and diameter) were reported by other investigators on several date cultivars (Nixon, 1935, 1936 & 1951; Schroeder & Nixon, 1959; El-Fawal, 1962; Hussein, 1970; Hussein et al., 1976; Hassaballa et al., 1983; Moustafa et al., 1984 and Khalifa et al., 1987).

3. Effect of Fruit Thinning on Some Chemical Properties of Fruit:

3.1 - Total Soluble Solids %:

Data of Tables (1 & 2) clearly indicated that different thinning treatments had increased TSS % in fruit in both seasons than the control. The most effective treatment in such concern was thinning of 30% of the total number of strands, 2 weeks after pollination. In general, differences between thinning times as well as thinning degrees were negligable.

3.2 - Total Sugars Percent:

Values of total sugars % followed a trend similar to that of total soluble solids percent especially in the first season of study (Table 1). Whereas, in 1996 season (Table 2), thinning 40% of strands regardless of application time as well as thinning 30%, 2 weeks after pollination showed the significantly highest total sugars %.

3.3 - Tannins Content:

As shown in Table (1) thinning 30 or 40% of the total number of strands significantly decreased tannins content in fruits. Differences between various times of thinning however, were lack of significancy. In the second season of study (Table 2) it is obvious that all the thinning treatments has reduced significantly tannins content in fruit flesh. Meanwhile, thinning 30% of the total strands either after 2 or 4 weeks from pollination gained the significantly lowest tannins content in fruit.

Table (1): Effect of fruit thinning on yield and fruit quality of "Seewy" date during 1995 season.

Thinning treatments		Yield		Fruit weight (gm.)	Flesh weight (gm.)	Fruit dimensions		TSS %	Total sugars %	Tannins %
Degree	Time after pollination	Per palm (Kg.)	Per bunch (Kg.)			Length (cm.)	Diameter (cm.)			
0	(Control)	132.00 a	14.67 a	15.12 f	13.07 e	3.70 c	2.30 g	38.00 c	30.44 d	0.33 a
10%	2 weeks	120.00 b	13.33 b	16.30 de	14.22 d	3.72 bc	2.59 ab	41.27 abc	32.67 b	0.32 ab
	4 "	106.50 bcdef	11.83 cd	16.52 cde	14.43 cd	3.81 b	2.37 fg	40.67 bc	32.47 b	0.32 ab
	6 "	114.24 bc	12.69 bc	16.10 e	14.02 d	3.82 bc	2.33 g	38.67 c	32.67 b	0.33 a
	Mean	113.58	12.62	16.31	14.22	3.78	2.43	40.20	32.60	0.32
20%	2 weeks	114.00 bc	12.67 bc	16.68 cde	14.60 cd	4.00 abc	2.44 cdef	41.45 abc	33.33 ab	0.32 ab
	4 "	119.91 b	13.32 b	16.90 cd	14.83 c	4.02 abc	2.41 g	39.33 c	32.67 b	0.31 bc
	6 "	100.33 ef	11.15 de	16.65 cde	14.57 cd	3.95 abc	2.38 defg	40.00 bc	32.94 b	0.32 ab
	Mean	111.41	12.38	16.74	14.67	3.99	2.41 efg	40.26	32.98	0.32
30%	2 weeks	114.00 bc	12.67 bc	18.20 ab	16.11 a	4.22 ab	2.68	43.33 a	35.00 a	0.29 c
	4 "	111.00 bcd	12.33 bc	18.72 a	16.63 a	4.30 a	2.70 ab	41.67 ab	33.33 ab	0.29 c
	6 "	99.00 ef	11.00 de	18.00 b	15.93 b	4.25 a	2.63 a	40.28 bc	32.59 b	0.29 c
	Mean	108.00	12.00	18.31	16.22	4.26	2.67 ab	41.76	33.64	0.29
40%	2 weeks	99.00 ef	11.00 de	17.10 c	15.02 b	4.00 abc	2.58	42.07 ab	34.00 ab	0.30 c
	4 "	106.20 bcdef	11.80 cd	17.80 b	15.69 b	4.15 ab	2.57 ab	42.67 ab	33.65 ab	0.31 bc
	6 "	94.50 ef	10.50 e	17.00 c	14.92 c	4.10 ab	2.53 b	40.67 bc	33.33 ab	0.31 bc
	Mean	99.90	11.10	17.30	15.21	4.08	2.56 bc	41.80	33.66	0.31

Values having the same letter in a column are not significantly different at 5% level.

Table (2): Effect of fruit thinning on yield and fruit quality of "Seewy" date during 1996 season.

Thinning treatments		Yield		Fruit weight (gm.)	Flesh weight (gm.)	Fruit dimensions		TSS %	Total sugars %	Tannins %
Degree	Time after pollination	Per palm (Kg.)	Per bunch (Kg.)			Length (cm.)	Diameter (cm.)			
0	(Control)	99.00 a	11.00 a	14.90 f	12.84 h	3.64 d	2.30 d	38.00 d	31,10 d	0.33 a
10%	2 weeks	93.00 ab	10.33 a	16.14 e	14.07 fg	3.70 cd	2.37 cd	40.67 abc	32,90 abc	0.30 d
	4 "	85.20 ab	9.47 a	16.20 de	14.12 efg	3.71 cd	2.32 d	40.67 abc	32.50 bc	0.31 c
	6 "	84.51 ab	9.39 a	16.00 e	13.92 g	3.66 d	2.30 d	39.24 cd	32.12 c	0.32 b
	Mean	87.57	9.73	16.11	14.04	3.69	2.33	40.19	32.51	0.31
20%	2 weeks	90.00 ab	10.00 a	16.62 de	14.57 ef	3.90 bc	2.32 d	40.33 bc	32.50 bc	0.30 d
	4 "	84.00 ab	9.33 a	16.72 d	14.67 e	3.95 b	2.31 d	41.00 abc	33.00 abc	0.31 c
	6 "	82.50 ab	9.17 a	16.60 de	14.53 ef	3.91 bc	2.30 d	40.17 bcd	32.10 c	0.32 b
	Mean	85.50	9.50	16.65	14.59	3.92	2.31	40.50	32.53	0.31
30%	2 weeks	84.00 ab	9.33 a	18.16 b	16.08 b	4.10 ab	2.60 a	42.67 a	33.80 a	0.28 f
	4 "	81.00 bc	9.00 b	18.80 a	16.71 a	4.27 a	2.61 a	41.31 abc	33.20 ab	0.28 f
	6 "	72.60 cd	8.07 bc	18.10 b	16.03 bc	4.25 a	2.59 a	41.00 abc	33.12 ab	0.29 e
	Mean	79.20	8.80	18.35	16.27	4.21	2.60	41.66	33.37	0.28
40%	2 weeks	75.00 cd	8.33 bc	17.56 c	15.48 cd	4.00 b	2.47 bc	42.00 ab	33.71 a	0.28 f
	4 "	64.80 cd	7.20 bc	18.00 bc	15.90 bcd	4.10 ab	2.53 ab	41.77 ab	33.70 a	0.29 e
	6 "	60.00 d	6.67 c	17.48 c	15.42 d	4.03 b	2.44 bc	41.33 abc	33.65 a	0.29 e
	Mean	66.60	7.40	17.68	15.60	4.04	2.48	41.70	33.69	0.29

Values having the same letter in a column are not significantly different at 5% level.

In general, these findings concerning the response of "Seewy" fruit chemical characteristics to the different treatments of fruit thinning goes in line with those found by El-Fawal (1962); Hussein (1970); Hussein et al. (1976); Hassaballa et al. (1983); Moustafa et al. (1984) and Khalifa et al. (1987). They all reported that thinning increased both total soluble solids and total sugars as well as decreased tannins content in date fruits.

From the foregoing results, it could be concluded that fruit thinning of "Seewy" date palm under El-Fayoum Governorate conditions generally reduced palm and bunch yield. The reduction in yield, however was positively correlated with the degree of thinning. On the other hand, thinning treatments has improved fruit characteristics where they increased significantly fruit weight, flesh weight, fruit dimensions, TSS and total sugars % than the control. In addition, they reduced tannins content in fruit considerably than the control. meanwhile, the most beneficial treatment in such concern was thinning 30% of the total number of strands from the center of bunches, 4 weeks after pollination.

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EFFECT OF BUNCH/LEAF RATIO ON THE YIELD AND QUALITY OF ZAGHLOUL DATE PALM

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ABSTRACT

Pruning effect on yield and quality of Zaghloul date palm was studied during 1983, 84 and 1985. Four pruning treatments of bunch/leaf ratio [1:3, 1:6, 1:7 and 1:9] were investigated at Assiut, Egypt. The 1:7 ratio was considered as a commercial practice. All treatments were loaded eight bunches only. The pruning 1:9 ratio gave the best yield, bunch weight, grade A and number of inflorescence, also it gave a consistent number of leaves during the consecutive years of the growth. Fresh weights of fruit and pulp, fruit dimensions were increased as the bunch/leaf ratio increased. The moisture content and total acidity of the fruit were not affected by the bunch/leaf ratio. The 1:9 ratio gave the highest increase in the T.S.S., reducing and non reducing sugars and anthocyanin.

Key words: *Phoenix dectylifera*, L.; Bunch/leaf ratio; Pruning.

INTRODUCTION

Zaghloul is the most important cultivar of soft dates in Egypt. The fruit of this cultivar is consumed freshly at the khalal stage.

As the objective of the growers is the fruits, they must recognize that the quantity and quality of the fruits are directly dependent on the number of actively photosynthesing leave.

Several investigators (Nixon 1943, Nixon and Carpenter 1978, Cornelissen, 1979) showed the importance of the presence of an adequate number of leaves per palm for maximum quantity and quality of fruit production. The bearing capacity of a date palm is in proportion to the number of leaves that it carries. An insufficient number of leaves in proportion to the number of flower clusters results in low-quality fruits during the current season and fewer inflorescence during the successive spring. So, it is recommended to retain an adequate number of green leaves per tree.

Hussein *et al.* (1977) studied the effect of leaf/bunch ratio on yield and fruit quality of Barhi date palm grown in Saudi Arabia. They found that size, fresh weight, pulp weight, the percentage of moisture content, total soluble solids, total sugars, reducing sugars and sucrose of fruit tended to increase as the number of leaves per bunch increased. The total yield per bunch and the percentage of fruit in grade I and II increased significantly with increasing leaves/bunch ratio up to 12 leaves/bunch. Similar results were reported by Abdulla *et al.* (1982) for Hayani date palm cultivar grown in Kalubia province, Egypt. Also, they found that the optimum yield of good fruit quality could be obtained in Hayani dates with 8 active leaves of each of 5 to 8 retentive bunches per palm. Similar results of yield and fruit quality of Zaghloul and Hayani date were obtained by Hassaballa *et al.* (1983). They found that pruning level at 8 leaves per bunch increased the number of productive leaves over those maintained under the ratio 6 : 1 especially with Zaghloul cultivar.

Based upon the reported studies here, the purpose of this study is to determine the most effective bunch/leaf ratio through pruning Zaghloul date cultivar grown under the conditions of Assiut, Egypt.

MATERIALS AND METHODS

This study was carried out at the Experimental Orchard of the Faculty of Agriculture, Assiut University during three successive growing seasons; 1983, 1984 and 1985.

A. Experimental work.

Twelve palm trees of uniform vigor (seven years old) grown on a clay soil were selected according to their bearing of approximately the same number of spathes and leaves. Regular agricultural practices except pruning treatments were done to the studied palm trees during all seasons. Pollination was conducted by using pollen grains from the same male palm trees in the three studied seasons to avoid residues of metaxinia. The treatments were carried out on 15^{th} of May in each season. The number of inflorescence was adjusted to 8 by removing the extra small flower clusters. The number of strands in every bunch was reduced to 60. So each bunch carried the same number of strands on every individual palm tree.

The palm trees were classified at random into four treatments of bunch/leaf ratio (A, 1 : 3; B, 1: 6; C, 1 : 7; and D, 1 : 9). Each treatment consisted of three replicates.

The date palm growers in Upper Egypt commonly cut off more leaves because they have a value in certain industry and which represent a source of income. They also believe that reduction the number of leaves per tree facilitates the operations of pollination and harvesting. Thus, treatment A represented the commercial practices of palm pruning by the growers of Upper Egypt to seedling palms.

Regarding the treatment D, there were 56 leaves on each palm representing the commercial practice of Zaghloul date palm pruning by the growers of Rosette and Edco regions. The bunch/leaf ratio was 1 : 7.

It was noticed at the beginning of the 2nd and 3rd seasons that the palms of treatment A gave less than 8 bunches per palm. So it was necessary to adjust the number of bunches to 7 and to remove more leaves to maintain the bunch/leaf ratio of 1 : 3 at the proper value.

B. Productive capacity and fruit characteristics.

The number of both inflorescences and new leaves were annually recorded for each replicate during the three studied growing seasons. All fruit bunches were harvested and weighed during the first week of September. Hundred fruits were picked at random from all bunches of each tree for the determination of physical and chemical characteristics. Two grades of fruits were identified as class A and B as recommended by (Rygg, 1948). Sugars were determined according to the method of Lane and Eynon outlined in A.O.A.C. (1975). The anthocyanin pigments in fruit skin were extracted by ethanolic and determined according to the method of Francis (1957) and Ranganna (1977). Data were statistically analyzed and the differences between treatment means were tested using L.S.D. test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

A. The productive capacity:

(1) Fruit yield:

Figure (1) shows the effect of four leaf/bunch ratios on Zaghloul yield during the present study. It was found that the total yield per palm increased significantly as the ratio increased. Maximum yield production from year to another was obtained for 1 : 9 ratio in comparison to either of the other ratio. As a mean of three seasons, the relative increases of yield were 39.7, 66.4 and 44.0% when the ratio of leaves per bunch was increased from 3 to 6, 9 and 7, respectively. These results are in agreement with those published by Bakr *et al.* (1976), on samani Hussein *et al.* (1977) on Barhi, Abdulla *et al.* (1982) on Hayani cv. and Hassaballa *et al.* (1983) on Zaghloul.

(2) Bunch weight:

The bunch weight is given in Figure (2), it is observable that the bunch weight exhibits similar trend as the yield. Thus, it could be obtained that a positive correlation between number of leaves per bunch and its average bunch weight. The mean of the three successive seasons of bunch weight increased according to the order of 23.7, 47.4 and 27.6% for 3, 6, 9 and 7 ratios, respectively. These results were in close agreement with those reported by Bakr *et al.* (1976), Hussein *et al.* (1977), Abdulla *et al.* (1982) and Hassablla *et al.* (1983).

(3) Number of inflorescence:

Figure (3) summarized the effect of bunch/leaf ratio on the subsequent number of inflorescence emerged during 1984 and 1985 seasons. Pruning level at 9 leaves per bunch proved superiority over the other pruning levels on producing maximum number of flower clusters. Thus, as a mean, the relative percent of increase in the number of the inflorescence of both 1984 and 1985 seasons were 39.3, 71.0 and 56.2% when the number of leaves per bunch was increased from 3 to 6, 9 and 7 respectively. The importance of leaves in this respect, however, was reported by many investigators; Aldrich and Young (1941), Nixon (1943), Nixon and Carpenter (1978) and Carnelissen (1979).

(4) Number of productive leaves:

Pruning treatment at 9 leaves (Fig. 4) gave a considerable yield accompanied by appropriate number of productive leaves. However, pruning treatment at 3 leaves per bunch produced more relative percent of leaves represented of the total retained leaves (24 leaves per palm). Such behaviour could be explained on the basis that the palm tended to modify the unbalanced top/root ratio. These results were in accordance with those of Hassaballa *et al.* (1983).

(5) Grade quality:

The percentage of grade A fruits was increased significantly towards a peak as the number of leaves per bunch increased from 3 : 1 to 9 : 1 during 1983 and 1984 seasons (Fig. 5). These results are agreement with those of Hussein *et al.* (1977) and Nixon and Carpenter (1978).

B. Fruit characteristics:

Data concerning the physical and chemical properties in both seasons are presented in Tables 1 and 2.

Physical properties:

1. Fruit weight (g):

The data obtained indicate that, the fruit weight was increased significantly by increasing leaf/bunch ratio. The bunch/leaf ratio 1 : 9 gave the largest fruit weight than that occurred with the other treatments. On the other hand, bunch/leaf ratio 1 : 3 gave the lowest fruit weight. Meanwhile, treatment 1 : 9 led to increase the fresh weight by 12.96 & 11.93% over treatment 1 : 3, 6.42 and 10.6% over treatment 1 : 6 and 4.6% & 2.64% over treatment 1 : 7 in 1983 and 1984 seasons, respectively. These results are in agreement with those reached by Hussein *et al.* (1977), Abdulla *et al.* (1982) and Hassaballa *et al.* (1983).

2. Fruit dimensions (cm):

Significant differences in fruit dimensions between treatment were obtained in 1983 season but there was no significant difference between 1:9 and 1:7 or between 1:6 and 1:3 ratios. However, in the 1984 season, such differences were not statistically significant. However, treatment 1:9 improved the fruit dimensions than other treatments. Such results are in partial agreement with those found by Abdulla *et al.* (1982) and Hassaballa *et al.* (1983).

3. Pulp weight percentage:

It is noticed from these data that during the two seasons, the pulp weight percentage of treatment ratio 1 : 3 was higher than that occurred in treatment 1 : 9 ratio. However, the flesh weight of fruits of treatment ratio 1 : 9 was higher than that of treatment 1 : 3 ratio. This result might be due to the lower seed weight of treatment ratio 1 : 3 than seed weight of treatment ratio 1 : 9. Meanwhile, pulp and seed weight increased significantly as the number of leaves per bunch was increased. Though, the differences between treatments were insignificant in 1983 season.

These data are in partial agreement with those reported by Hussein *et al.* (1977) and Abudalla *et al.* (1982). They found that the pulp weight of fruit increased with increasing leaf/bunch ratio. However, Hassaballa *et al.* (1983) illustrated that eight leaves per bunch increased flesh weight and flesh percentage than that occurred in six leaves per bunch.

Chemical properties:

1. Moisture content (%):

Noticeably, the moisture content was not significantly affected with bunch/leaf ratio during the investigated seasons. Though, Hussein *et al.* (1977) found that increasing the number of leaves per bunch increased the moisture content within the fruit pulp of Barhi cultivar at Saudi Arabia. Contradictive results were reported by Abdulla *et al.* (1982), who found that the percent of dry weight of fruit increased with increasing the number of leaf/bunch.

2. Total soluble solids:

Regarding the investigated treatments, data illustrate that as the number of leaves per bunch was increased, the total soluble solids significantly increased. Meanwhile, the treatment ratio (1 : 9) gave the highest values 35.13 & 35.33, followed by treatment ratio (1 : 7) 32.20 & 30.06 treatment ratio (1: 6) 27.53 & 28.00 and treatment ratio (1 : 3) exhibit the lowest values 25.60 & 27.66 in 1983 and 1984 seasons, respectively.

Such results could be due to the effect of adequate number of leaves on producing more carbohydrates.

These data are in parallel with those reported by Bakr *et al.* (1976), Hussein *et al.* (1977), Abdulla *et al.* (1982) and Hassaballa *et al.* (1983).

3. Total acidity (%).

Total acidity was not affected significantly by bunch/leaf ratio treatments in both seasons of the study.

These results somewhat agreed with those found by Abdulla *et al.* (1982) who reported that no significant changes occurred in the titratable acidity due to leaf/bunch ratio except in both 2 and 4 leaves per bunch which showed an increase in the acidity. but, the leaf/bunch ratio of 8 : 1 and 12 : 1 treatments slightly decreased fruit pulp acidity. However, Bakr *et al.* (1976) and Hassaballa *et al.* (1983) demonstrated that the fruit acidity showed a negative correlation with leaf/bunch ratio.

4. Sugar contents.

a. Reducing sugars (%):

Obtained data indicated that fruits of treatment 1 : 9 produced the highest values during 1983 season and 1:9 in 1984 season, however, fruits of 1 : 3 ratio gave the lowest percentages of reducing sugars. Such results might be due to the effect of more leaves per bunch which supplied the fruits with more sugars.

These data are in line with those of Hussein *et al.* (1977), Abdulla *et al.* (1982) and Hassaballa *et al.* (1983).

b. Non-reducing sugars (%):

The non-reducing sugars showed similar trend in both 1983 and 1984 seasons. Nevertheless, higher values of non reducing sugar content were recorded in 1984 more than 1983 season. Such results might be attributed to the higher temperature during 1984 than 1983 season as recorded by Assiut Agrometerological Station. Moreover, both bunch weight and the average yield per palm in 1983 season were higher than that occurred in 1984 season.

Concerning the effect of bunch/leaf ratio on non-reducing sugars, data also indicate that non-reducing sugars percentage was not affected significantly in the first season (1983), however, such percentage increased significantly with increasing the number of leaves per bunch. Meanwhile, the fruits of treatment 1 : 9 gave the highest percentage of non-reducing sugars, whereas fruits of treatment 1 : 3 produced the lowest percentage.

Actually, it is obvious that 9 leaves per bunch induced the highest values of non-reducing sugars by 2 weeks earlier than the other studied treatments. These findings might be due to the fruits of this treatment matured and began to discolour earlier than the other treatments.

These results are in line with those published by Hussein *et al.* (1977) and Abdulla *et al.* (1982) who found that non-reducing sugars were increased with increasing number of leaves per bunch. However, Hassaballa *et al.* (1983) reported that non-reducing sugars decreased significantly of 8 leaves per bunch compared with 6 leaves per bunch.

c. Total sugars (%):

Concerning the effect of bunch/leaf ratio on total sugars, it is evident that the percentage of total sugars tended to increase significantly as the number of leaves per bunch was increased up to the ratio of 1 : 9 in 1983 and 1984 seasons. Moreover, the pruning level at 1 : 9 induced fruits to reach its more total sugars two weeks earlier than the pruning level of 1 : 3 or 1 : 6.

These results are in accordance with those reported by Hussien *et al.* (1977), Abdulla *et al.* (1982) and Hassaballa et al., (1983).

5. Total anthocyanin (%):

The total anthocyanine values were increased by increasing leaf/bunch ratio during the two investigated seasons. Meanwhile, treatment ratio 1 : 3 ratio get lowest values of total anthocyanine. Whereas, treatment ratio 1 : 9 get the highest values of the anthocyanine. Moreover, treatment ratio 1 : 9 reached maximum values of total anthocyanine two weeks earlier than both treatments 1 : 3 and 1 : 6. Concerning this subject, there is no available literature.

In conclusion, pruning treatment at 9 leaves per bunch and 8 bunch per palm was the most suitable pruning treatment for Zaghloul cultivar under Assiut conditions for improvement the yield production and the least tendency of irregularity of bearing capacity from year to year. Moreover, such pruning level improved the fruit physical and chemical qualities of dates, superior quality and enhancing fruit maturity 2 weeks earlier than the commercial practices of palm pruning by the growers of Upper Egypt to seedling palms (3 leaves per bunch). Thus it could be recommended.

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Table (1). Effect of bunch/leaf ratio on fruit characteristics of Zaghloul date palm during the 1983 season.

Fruit characters	Bunch/leaf ratio				
	1 : 3	1 : 6	1 : 9	1 : 7	L.S.D.$_{0.05}$
Fruit weight (g)	20.25	21.23	22.64	22.09	1.140
Fruit length (cm)	5.46	5.65	5.85	5.66	0.197
Fruit diameter (cm)	2.62	2.67	2.70	2.71	0.060
Pulp weight %	91.15	90.90	91.50	91.45	(N.S)
Moisture %	65.23	64.13	61.56	64.73	(N.S)
T.S.S. %	27.66	27.53	35.13	32.20	0.42
Total acidity %	0.17	0.19	0.16	0.20	(N.S)
Reducing sugars %	14.48	14.91	17.76	16.51	0.48
Non-reducing %	11.46	9.94	15.44	13.05	(N.S)
Total sugar %	25.96	24.85	33.20	29.56	0.42
Total anthocyanin %	24.57	25.28	26.99	25.61	0.67

Table (2). Effect of bunch/leaf ratio on fruit characteristics of Zaghloul date palm during the 1984 season.

Fruit characters	Bunch/leaf ratio				
	1 : 3	1 : 6	1 : 9	1 : 7	L.S.D.$_{0.05}$
Fruit weight (g)	23.05	22.36	25.28	24.65	1.364
Fruit length (cm)	5.61	5.70	5.82	5.79	(N.S)
Fruit diameter (cm)	2.76	2.79	2.85	2.79	(N.S)
Pulp weight %	92.56	91.94	92.48	92.12	0.29
Moisture %	57.31	58.84	59.38	60.35	(N.S)
T.S.S. %	27.66	28.00	35.33	30.06	0.734
Total acidity %	0.14	0.14	0.15	0.16	(N.S)
Reducing sugars %	9.19	10.52	9.96	11.11	0.51
Non-reducing %	15.75	14.32	21.52	19.26	0.88
Total sugar %	24.92	24.90	31.55	30.37	1.00
Total anthocyanin %	26.51	31.67	41.53	38.23	1.15

تأثير نسبة الأوراق لكل عذق علي إنتاج وجودة نخيل البلح الزغلول

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الخلاصـــــة :

أجريت هذه الدراسة خلال ثلاث سنوات متتالية ١٩٨٣ ، ١٩٨٤ ، ١٩٨٥ علي نخيل البلح الزغلول المنزرع ببساتين كلية الزراعة – جامعة أسيوط بمصر وذلك لدراسة تأثير أربعة مستويات من نسبة الأوراق لكل عذق علي محصول وجودة الثمار وهي ١ : ٣ ، ١ : ٦ ، ١ : ٩ وكذلك ١ : ٧ وتم ترك عدد ٨ عذوق لكل نخلة . وكانت النسبة ١ : ٣ ما يجريه مزارعي النخيل في أسيوط علي نخيلهم المجهل أما النسبة ١ : ٧ ما هو متبع في مناطق تركيز زراعة ، صنف الزغلول في منطقة ادكو ورشيد – محافظة البحيرة وقد بينت الدراسة : إن النسبة ١ : ٩ أعطت أعلي محصول وزن سوباطة ونسبة رتبة الثمار الجيدة كذلك عدد الأغاريض الناتجة في الربيع بالإضافة إلي عدد تقريبا ثابت من الأوراق خلال السنوات المتتالية للنمو . كما زاد وزن الثمرة واللب وأبعاد الثمار بزيادة نسبة الأوراق لكل عذق . في حين لم يتأثر كل من المحتوي الرطوبي والحموضة الكلية للثمار بمستويات التقليم . كما أعطت أعلي قيمة في نسبة المواد الصلبة الذائبة والسكريات المختزلة والغير مختزلة كذلك صبغة الأنثوسيانين . بذلك ننصح بإتباع نظام تقليم يضمن ٩ جريدات لكل عذق للحصول إلي محصول مع صفات جودة عالية للثمار وانتظام الحمل لنخيل البلح الزغلول عام بعد عام في ظروف أسيوط .

الكلمات الدليلية : نخيل البلح – التقليم – نسبة الأوراق إلي العذق.

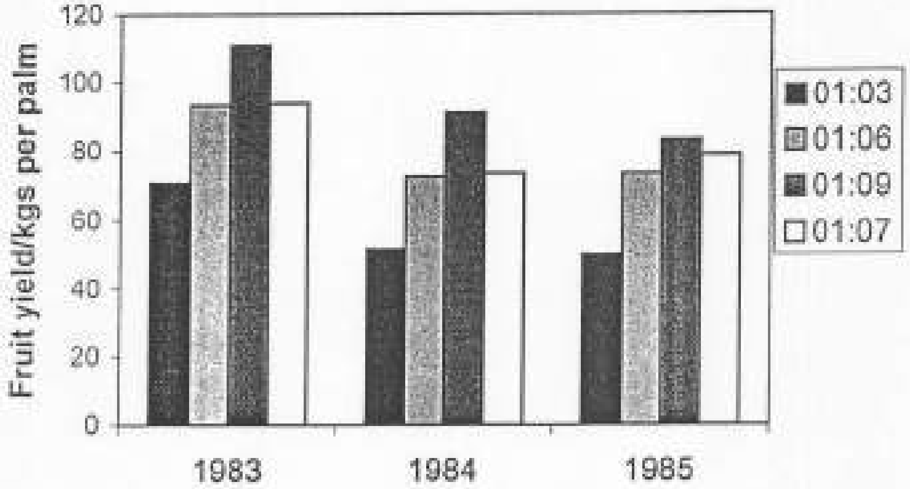


Fig. (1): Fruit yield (kgs per palm) of Zaghloul dates as influenced by bunch/leaf ratio during 1983, 1984 and 1985 seasons.

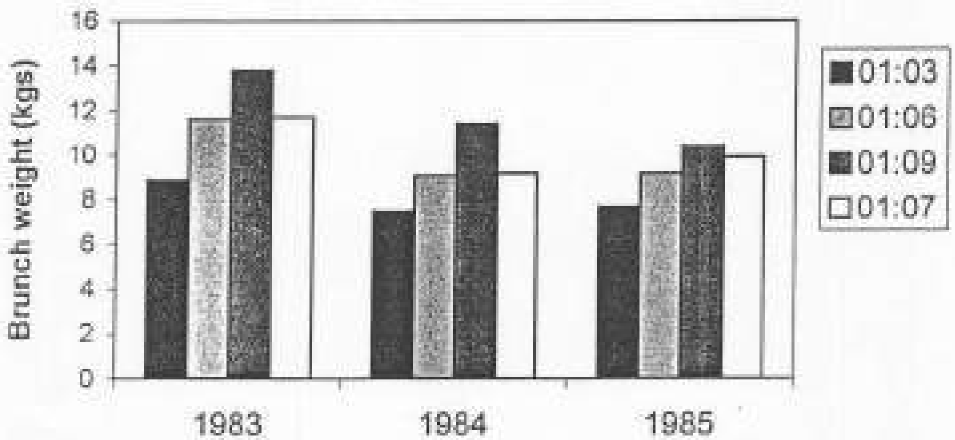


Fig. (2): Bunch weight in (kgs) of Zaghloul dates as influenced by bunch/leaf ratio during 1983, 1984 and 1985 seasons.

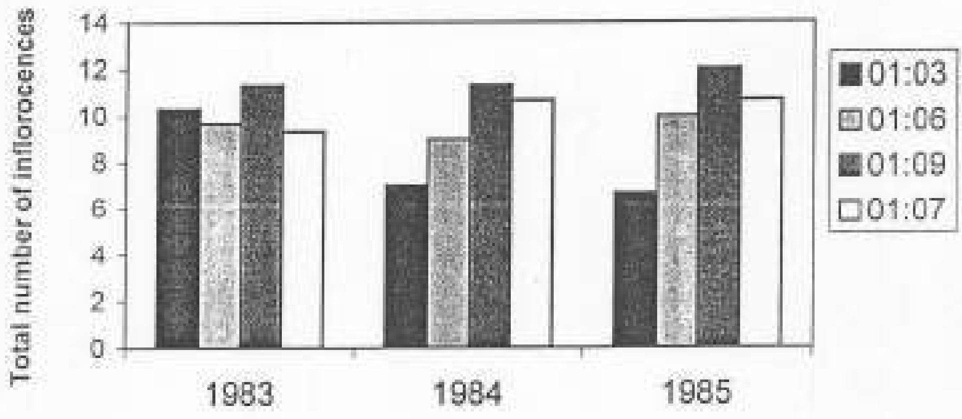


Fig. (3): Effect of bunch/leaf ratio on total number of infloroscences of Zaghloul date palm produced during 1983, 1984 and 1985 seasons.

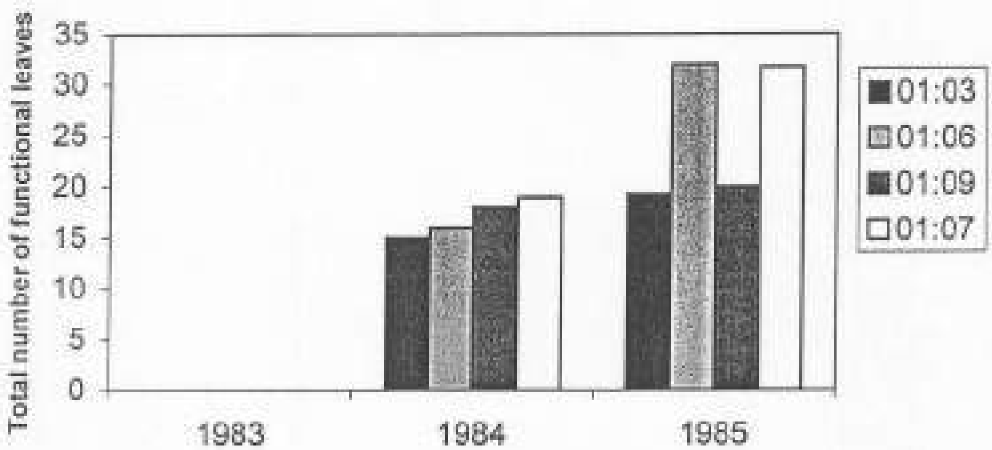
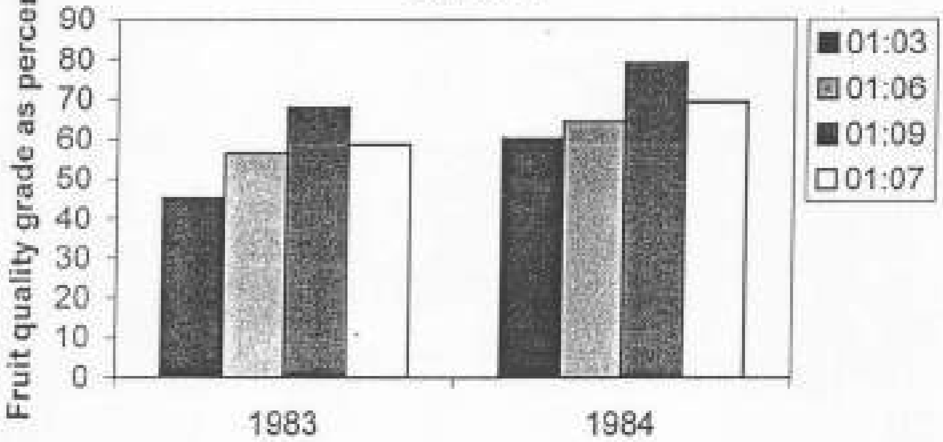


Fig. (4): Effect of bunch/leaf ratio on the total number of functional leaves of Zaghloul date palm produced during 1983, 1984 and 1985 seasons.

Grade A



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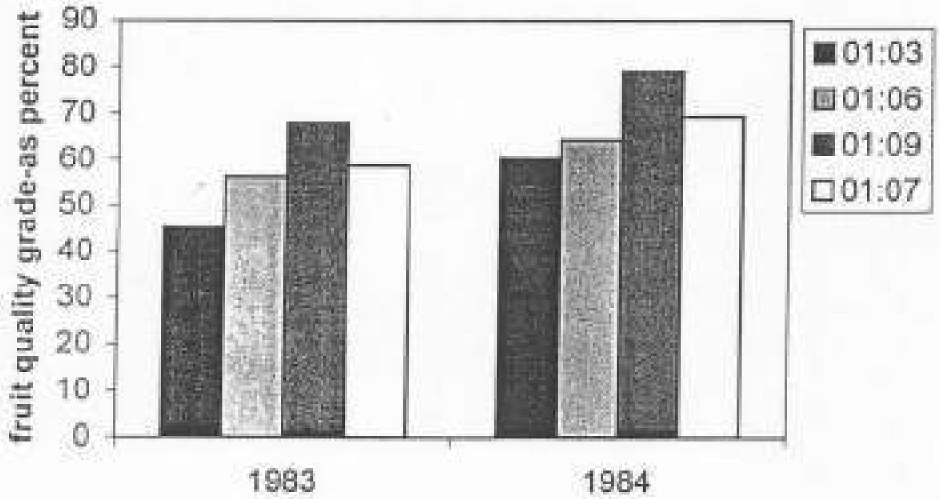

Fig. (5): Fruit quality grade of Zaghloul dates as influenced by bunch/leaf ratio during 1983 and 1984 seasons.

EFFECT OF BUNCH THINNING ON FRUIT QUALITY OF SOME DATE PALM CULTIVARS.

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ABSTRACT

This study was carried out for two seasons (1994 and 1995) at Al Hamraniyah Experimental Station. Four cultivars Ashhal, Hilali Ahmar, Jash Jafar and Jash Habash were investigated in the study. The treatments were four, eight, and twelve bunches per tree. Total yield of the tree, physical and chemical characteristics of the fruit were studied. The results showed that there were an invert relation between the number of bunches and volume and weight of the fruit and seed. However, the total yield of the tree showed a non linear relationship with the number of bunches. From the study it could be concluded that the eight bunches per tree is the best recommended under the condition of this study.

INTRODUCTION

Date palm trees usually carry large number of fruit full bunches. This number usually increase in well-managed farm, in which fertilization, Irrigation, weed control, and pest control programs are well considered.

The heavy bunching causes some physiological disorder like size, poor quality of fruit, ripening delay, alternative fruit bearing, wilting or some mechanical effect like bunch breaking.

Several investigations (1-10) studied the effect of fruit thinning to improve quality and size of fruit, these results indicated an interesting yield relationship between thinning and fruit quality.

Therefore it is necessary to study the effect of bunch thinning on dates quality of some commercial cultivars in the environmental condition of UAE. Also to testy the effect of thinning of quality of dates fruit of these commercial cultivars.

MATERIALS AND METHODS

The experiment was conducted at Al Hamraniyah Research Station, located in northern part of UAE for two seasons, 1995 and 1996.

Four commercial cultivars (Ashhal, Jash jaafer, Hilali Ahmar and Jash Habash) were selected for this experiment. Five trees were selected from each cultivar and the number of leaves per tree was same for each.

The trees were 10 years old and planted at 8m x 8m spacing.

The treatments were to thin the number of bunches to 12, 8 and 4 per tree.

The thinning was carried out during Hababok stage of fruit development.

(One week after setting). At the end of Khalal (Bisir) stage and biggening of the Rutab stage, the following analysis were measured:

1. Total yield per tree (Fresh weight)
2. Bunch weight
3. Fruit weight
4. Seed weight
5. Fruit volume
6. Total soluble solids (T.S.S), by Refractometer.
7. Fruit moisture content, was taken by drying fruits in an oven at 105°C for 24 hr.

The treatments were arranged in randomized block design. Each treatment was replicated five times.

RESULTS AND DISCUSSION

Table (1) shows the effect of bunch thinning on yield, bunch weight, and chemical analysis of the fruit. The result indicated an inverse relationship between the number of bunches on tree and their weights in all cultivars. The avarage weights of the bunch were 20.47, 12.50 and

9.57 kg for the 4,8,12 bunches per tree respectively for Ashhal cultivar. The statistical analysis indicated significant differences in bunch weight among treatments ($P < 0.05$). For Jash Habash cultivar, the avarage bunch weights were 18.25, 12.50 and 9.25 Kg. for the 4,8 and 12 bunch per tree respectively. The results were significantly varied. Ashhal and Jash Habash cultivars were more effected by bunch thinning, than Jash Jaafar and Hilali Ahmar.

Total yield increased as the number of bunches on tree increased.

Relationship between yields and number bunches per tree are positively correlated for the different treatments. The variations were significant for all cultivars. These results agree with previously published data by (1,3,5,10).

Generally, there were no significant effect on the T.S.S between the 4 and 8 bunches per tree, while the T.S.S were significantly higher than those of 12 bunches per tree for cultivars studied in this experiment. Therefore bunch thinning improve fruit quality.

The percentage of moisture content significantly increased as the number of bunches per tree increased.

Table (2) contains the data of weight and volume of fruit and seeds. The results showed that both weigh and volume of fruit and the seed increased significantly as number of bunches decrease for all cultivars. Similar results were reported earlier by (10).

From the above discussion it is reasonably to conclude that 8 bunches per tree gave high yield with acceptable fruit size and quality under the environmental conditions of UAE.

Table (1) Effect of bunches thinning on yield, bunch weight, fruit total soluble solids and moisture in some date palm cultivars, at Khalal (bisir) stage. Average of 1995 and 1996.

Cultivars	Bunches No.	Bunch wt. Kg.	Yield/palm Kg.	T.S.S	Moisture
Ashahal	4	20.47	82,03	56	47,01
	8	12,50	100,51	55	44,23
	12	9,57	114,38	51	48,06
LSD 5%		2,56	8,09	3,24	1,7
Jash Jaafar	4	14.52	58,08	45	53,03
	8	13,12	104,98	43	54,51
	12	11,5	138	36	61,20
LSD 5%		1,08	5,73	2,88	3,08
Hilal Ahmar	4	15,03	60,12	44	50,71
	8	12,20	97,60	38	57,22
	12	11,25	135	31	63,90
LSD 5%		0,93	6,83	3,01	4,35
Jash Habash	4	18,25	73	39	55,01
	8	12,50	100	32	59,18
	12	9,25	111	27	68,38
LSD 5%		2,07	7,83	3,72	5,12

Table (2) Effect of bunches thinning on fruits and seed, weight and volume at Khalal (bisir) stage of some date palm cultivars. Average of 1995 and 1996.

Variety	Bunches No.	Fruit wt. g.	Fruit volume cc.	Seed weigh	Seed volume cc.
Ashahal	4	11,53	11,75	0,935	1,00
	8	9,45	9,50	0,915	0,85
	12	7,73	7,80	0,855	0,75
LSD 5%		1,87	1,63	0,053	0,061
Jash Jaafar	4	7,25	7,0	0,87	0,75
	8	6,82	6,5	0,86	0,70
	12	5,75	5,00	0,76	0,50
LSD 5%		1,09	1,22	0,072	0,063
Hilal Ahmar	4	13,42	13,50	1,05	0,90
	8	11,86	12,50	1,00	0,90
	12	8,78	8,50	0,84	0,75
LSD 5%		2,01	2,22	0,092	0,083
Jash Habash	4	7,86	8,5	1,12	1,00
	8	6,54	8,00	1,01	0,9
	12	5,65	6,00	0,91	0,8
LSD 5%		1,07	1,13	0,085	0,091

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"Effect of Vapor Gard and Some Preservatives" On the quality of Date Fruits (Zahdi cv.) at Rutab Stage During Cold Storage

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ABSTRACT

This study was carried in Agriculture and Water Resources Research Center, Department of Palm and Date. Date fruits (*Phoenix dactylifer*, L.) Zahdi cv. at rutab stage were treated with waxes and preservatives to extend their shelf life during cold storage.

The following treatments were undertaken:

- Vapor Gard (V.G.) which is a waxy material extracted from plants at 4% concentration.
- A mixture of equal weights of sodium benzoate and calcium propionate at 2% concentration.
- A mixture of equal weights of Vapor Gard, sodium benzoate and calcium propionate at 2% concentration.

The fruits were dipped in the solutions for 3 min., dried, placed in carton boxes, and stored in cold room at – 3°C (± 1°C) for a period of 5 months.

Physical and chemical characteristics of the treated and untreated fruits were determined. Fruits treated with V.G. were superior in keeping quality when compared with other treatments and untreated fruits. In the meantime, V.G. reduced the percentage of the defected and shrinked fruits.

INTRODUCTION

Fresh dates are popular among the people of the Near East, specially at "Rutab stage", they are usually consumed on season, they are less astringent in taste, delicate and distinctive in flavour. It has been understood that the major cause affecting date during Rutab stage is the relative contents of moisture, therefore in order to keep the fruits at this stage for longer period of time, it requires suitable physical and chemical conditions. There are several methods to preserve fruits including addition of chemical preservatives or physical means. This trial was conducted within a major research programme named "PROMOTION OF MARKETING IRAQI DATES AT RUTAB STAGE". Studying the suitability of microbioal preservatives alone and in combination with waxy compounds "Vapor gard" as moisture proofing. All the treatments carried on under refrigeration conditions. Attemputs were made earlier to prolong the shelf life of rutab through the application of low temperature either by refrigeration or frezing alone.

Preservation by refrigeration was not sufficient for storage of fresh dates as fungal attach was evident after few days of storage (14). Ammonia liquid was used by Rygg (13), who didn't observe any moulding symptoms on the stored rutab dates at the end of storage period. Mikki (10) indicated that potassium sorbate was most promising as antimicrobial agent when it was sued on dates at Rutab stage also was found to be successful for many dried fruits such as figs and prunes (9). Several trials were conducted to use other preservatives with different packaging materials, such as methyl bromide and nitrous oxide (5).

It was noticed that application of chemical and microbial preservatives such as calcium propionate, sodium benzoate, sulfur dioxide, and potassium sorbate in addition to acetic acid had direct and positive impact on keeping fruits at low temperature storage (1,6). Mark (11) stressed that yeast growth was controlled by using the ethylene oxide and methyl bromide, with high concentration and short time.

Waxy compounds have been applied widely in dried and semidried fruits and vegetables to prevent moisture losses, such as Vapor Gard.

MATERIALS AND METHODS

Random samples from 200kg of Zahdi variety at rutab stage, were harvested from one orchard, fruits were cleaned by tap water, dried by air, and then followed by chemical and physical analysis before entering the refrigerated compartments. Total samples were grouped into four batches for treatments:

1- Control: fruits were washed by tap water and dried.

2- Second Batch; Fruits were dipped in vapor-gard 4% for 3 minutes and liquid (supplied by Miller Chemical and Fertilizer Corporation –AN Alco Standard Company). It is a waxy material used as evaporation preventive side effect. The batch was dried at room temp and packed in special cartons containers.

3- Third batch: This batch was treated with mixture of 2% Sodium Benzoate and calcium propionate ca., dipping time 3 minutes, dried and packed in special cartons.

4- The fourth batch dipped in even mixture of 4% V.G. and 2% (sodium benzoate + colcium propionate) for 3 minutes. All fruit samples in the form of spadix fruits stalks, were arragned after treatments in 2 kg cartons, 20 box for each treatment, immediately refrigerated at –3°C (± I°C), and relative humidity 75% (± 5).

The physical and chemical properties were identified at the end of the storage period. Monthly changing pattern of the physical properties were registered:

1- External appearance: an identified parameters of Zahdi cultivar fruits were specified, as far as their physical deterioration or degree of changes from the original sturcture of the fruits at certain stage of rutab maturity.

2- Tensile strenght: It was measured by counting number of abscised fruits of each pack and the percentage was calculated accordingly.

3- Average fruits maturity: was calculated on the basis of increasing percentage of maturity at each stage of ripening up to the end of storage period. Spoiled fruits, shrivelled fruits and those having spot crystals were indicated by eye sight and the percentage was calculated. Eye sight practice was the basis to monitor the degree of changes in the color during storage period. Local and out-sider testers tasted the degree of changes in taste and flavor during storage period. Mold fermented fruits were tested personaly by smelling and absolute eyesight for moulding, binocular was used for detailed checking.

Chemical Characteristics:

1- Moisture determination: Vacuum oven of 60.4 ml/hg at 65°C was sued to follow the moisture content of, an overage of 3 samples, and was repeated monthly of up to the end of the storage period.

2- Soluble solids: random clear extract of dates, filtered and drops of the filtrate were used by ABBE refractometer for soluble solids determination.

3- Total Acidity: It was determined by usual titration with 0.01 normal solution of naoh.

4- PH: PH – meter 26 was used.

5- Total sugars, Reduced sugars and sucrose: were determined using Berlin method stated by (A.O.A.C.).

All results were analyzed statistically according to a complet randomized design, LSD applied at both levels 1% & 5%.

RESULTS AND DISCUSSION

I. Physical properties:

1- Wilting: Best results were achieved with treated samples with Vapor-Gard alone and it was significant at 1% & 5% LSD in comparison with the control. Chemical preservatives alone or with the V.G did not appear to be significant with with the control at any level. The reason due to the formation of thin layer covering the fruits which pevent moisture losses and also reduce gas exchange and subsequently inhibit metabolic activities, this agreed with the findings of Rygg (13). No wilted fruits could be found of Vapor Gard treated samples during the first month of refrigeration, while there was a slight increase toward the end of the storage period. On the other hand, others while were treated with preservatives affected from the first month continued to the second month and a severe increase was noticed at the beginning of the fot months. Table (1).

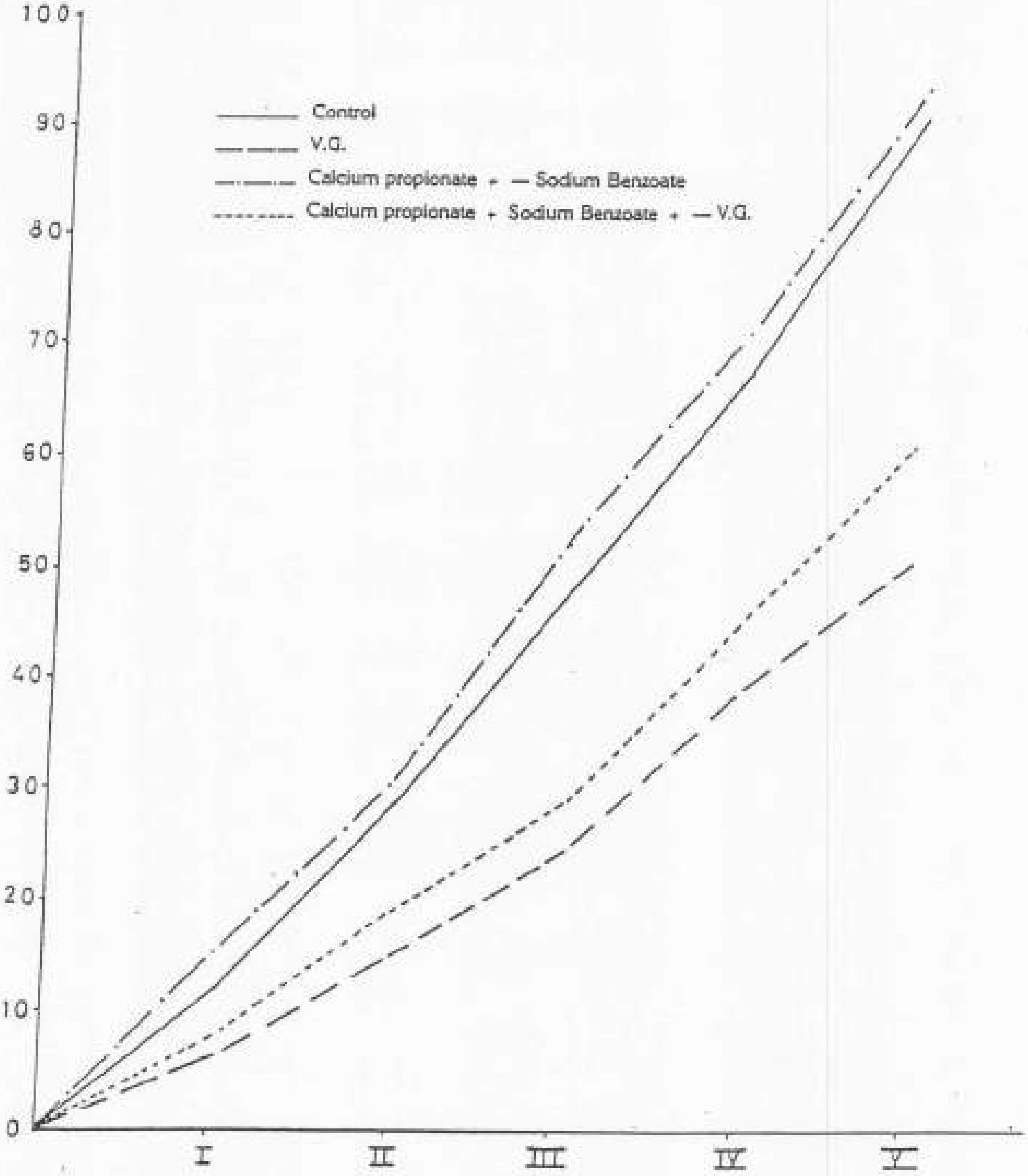
2- Maturity: Significant difference was observed between V.G treatment and the control, positive results were also obtained with mixture of V.G and the preservative, delaying in maturation of the V.G treated fruits obviously due to the functional impact of the synthetic layer of wax surrounding the fruits. Among all treatments including the control, the increase in the degree of maturity continued along with the progress of the storage.

3- Tensile strength: No significant difference was noticed among all treatments, this might be related to the high degree of T.S.S of the Zahdi

FIG (1): MONTHLY PATTERN OF WILTED FRUITS DURING STORAGE PERIOD

STORAGE PERIOD (Month)

FIG.(2)AVERAGE INCREASE OF FRUITS MATURTION DURING STORAGE PERIOD



STORAGE PERIOD (MONTHS)

variety. In general Vapor Gard had an excellect impact on the external appearance of Zahdi dates Fig. 2.

II- Chemical Properties:

1- Moisture: periodic examinations of chemical properties of date fruits during storage revealed significant differences among various treatments, as far as moisture contents and consequently of soluble solid contents of stored dates. As evident from Table (2). V.G treatment sample showed a minimum loss in moistre with significant figured 8.286%, as far as the monthly pattern lossed Fig (3), the greater loss occurred in the first month, and all treatment loss continued up to the third month, then stayed constant, except for V.G treated fruits was observed after the second month.

2- Soluble solids: (S.S) Naturally greater losses of moisture resulted in higher level of S.S. stored dates, of the control Fig (4) clearly indicated that steadily and continuous increase in S.S. of non treated fruits up to the end of the storage period, whereby wax treated samples revealed little increase of the first two months followed by tailing decrease in S.A. to the end of the storage period. This might be attributed to the inhibition of metabolic activities on carbohydrates (1), (2).

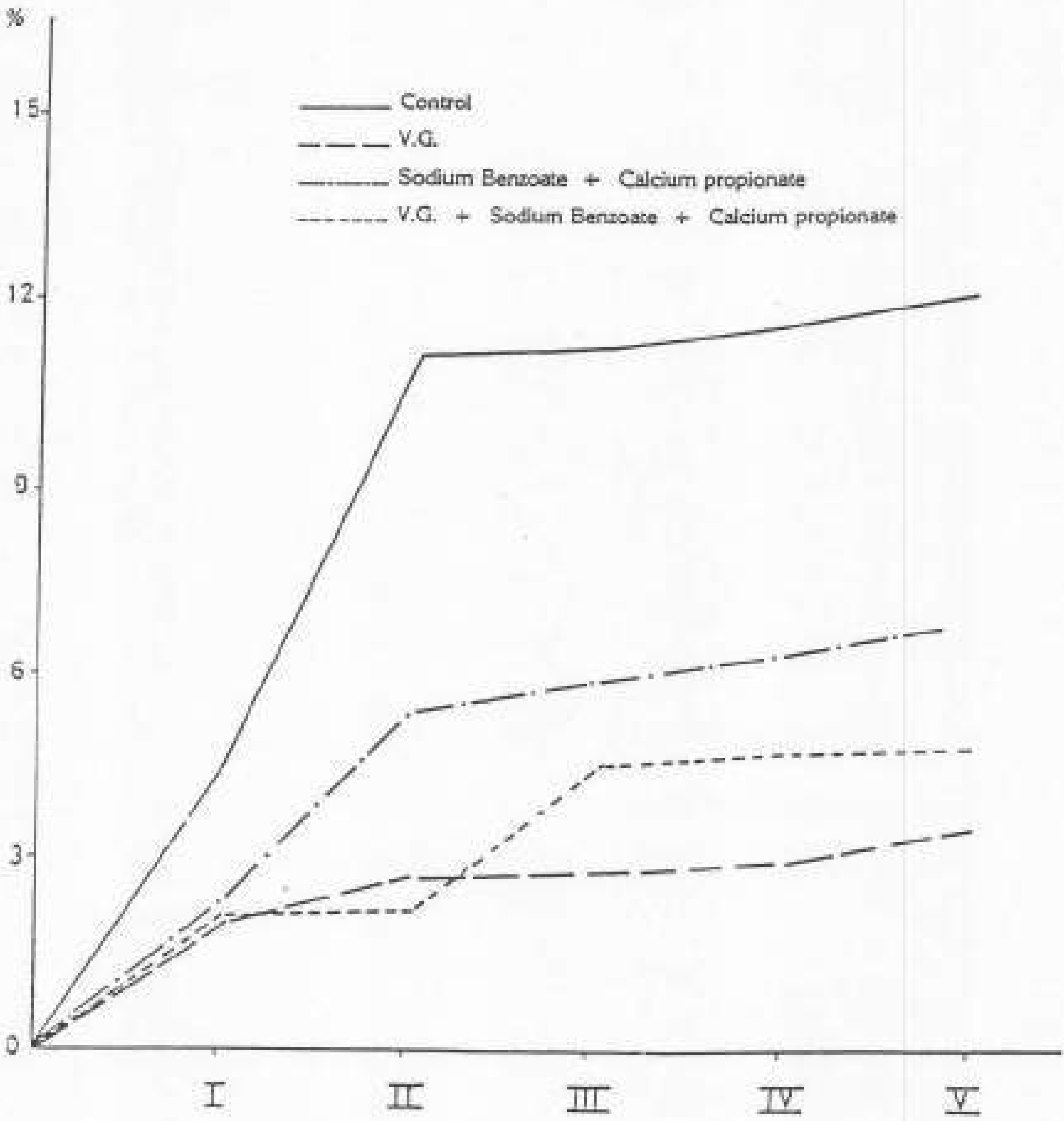
3- Total Acidity: In general all treatments were subjected to an increase in total acidity at the end of storage period, inspite of insignificancy of the data, except that of preservatives treatment, this due mainly to the inhibition effect at 5% level were noticed among treatments, Table (2).

4- Sugars: Aside from the control treatment which measured the highest level of total and reduced sugars, no significant difference were indicated between non treated samples and treated ones. On the other hand, clear decrease in all sugar contents were recorded with a mixture of V. G. and preservatives treated dates.

The final conclusion from the current findings support the application of waxy material such as Vapor Gard to maintain good quality of Zahdi variety at rutab stage under refrigeration for at least few months, having in consideration, there is no side effect of this material on humans. This trial will enhance dates exporting programs, especially Zahdi variety at desired stage (Rutab), as well as for domestic use.

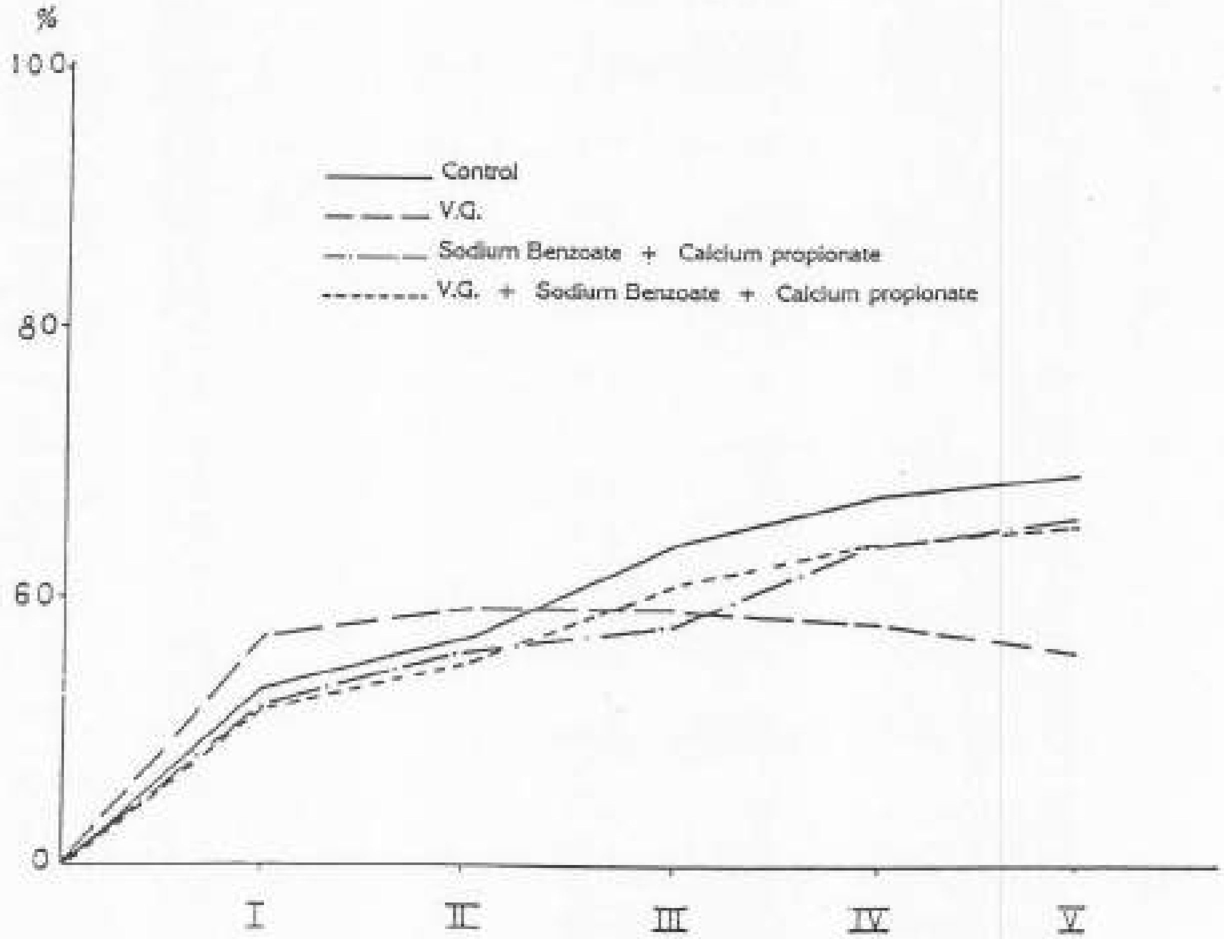
The authors suggest more research and detailed field studies to be Performance of other commercial varieties at different stages of maturity.

FIG.(3) MONTHLY PATTERN OF MOISTURE LOSS OF FRUITS DURING STORAGE PERIOD



STORAGE PERIOD (MONTHS)

FIG.(4) MONTHLY PATTERN OF SOLUBLE SOLIDS DURING STORAGE PERIOD



STORAGE PERIOD (MONTHS)

Table 1. Physical properties of stored dates

Crystallization	External appears	Taste & Flavuor	Colour	Deterioration %	Tensile strength %	Monthly Ripening %	Wilting %	Treatments
-	Medium	Natural	Brown	2.016	4.750	49.724	7.126	Control
-	Good	Natural	Brown	0.440	2.670	27.120	1.988	V.G.
-	Medium	Natural	Brown	1.650	4.050	52.840	9.330	Sodium Benzoate + Calcium Pproionate
-	Good	Natural	Brown	1.016	4.040	32.692	6.090	V.G. + Sodium Benzoate + Calcium Propionate
-	-	-	-	3.356	N.S	14.867+	3.696+	%1 LSD
-	-	-	-	2.393	N.S	10.604+	2.636+	%5 LSD

Table (2) Chemical properties of stored dates

Surose	Invert Sugars %	Total Sugars %	pH	Total Acidity	Soluble Solids	Loss in Moisture %	Tretments
13.101	68.519	81.620	6.630	0.023	62.60	10.158	Control
12.391	67.070	79.430	6.770	0.040	57.06	2.872	V.G.
12.511	65.470	77.980	6.0710	0.051	59.200	5.365	Sodium Benzoate + Calcium Propionate
8.806	65.540	74.340	6.770	0.041	59.700	4.122	V.G + Sodium Benzoate + Calcium Propionate
8.999-	2.793-	3.483-	3.978-	0.029-	2.382-	2.413+	%1 LSD
2.139-	1.992-	2.484-	2.837-	0.020-	1.699-	1.721+	%5 LSD

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EFFECT OF TEMPERATURE ON THE STORAGE OF RUTAB DATES HARVESTED AT DIFFERENT MATURITY STAGES

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ABSTRACT

Cold storage of dates at the rutab stage was found to be a successful method to preserve the dates in sound condition. Different temperatures had different effects on the fruit quality. The two stages of rutab (early and late rutab) responded positively to the storage temperatures. However the varietal difference for the storage was more noticeable than the stage of maturity.

INTRODUCTION

This paper describes investigations into long term cold storage of dates harvested at the rutab stage. Cold storage is the most widely used method in vegetable and fruit preservation (Thompson, 1996). Rutab is the maturity stage at which the soft varieties of dates are most commonly harvested (Al Bakr, 1972). At this stage the dates are highly perishable because they are soft, squashy and have a high moisture content (FAO, 1981). Rutab dates can be stored in different temperatures depending upon the length of the storage period required. Rygg and Furr(1953) recommended a storage temperature of -18°C for one year, -3°C for up to 6 months (FAO, 1981) and 0°C for 1 to 2 months (Snowdon, 1990). They can be stored loose in boxes (Benjamin 1976) or still attached to their stalks (Shabana, 1988). Dates are not subject to chilling injuries and have very low sensitivity to freezing injuries (Al Ani, 1985). According to Fennema et. al., (1973) the fruits which contain high soluble solids like dates (Booij et. al, 1995) exhibit low sensitivity to freezing injuries.

Freezing is defined as lowering the temperature, generally to -18°C or below, which results in the crystallization of water and sometimes solutes (Fennema et al., 1973). The main factor in the freezing process is the crystallization. The formation of crystals inside the fruit tissue depends mainly on the average speed of freezing. The speed in which the heat is removed from the fruit determines the size of the crystals in the fruit (Fennema et al., 1973). Quick freezing, in contrast to slow freezing, will form a relatively bigger number of crystal nuclei with smaller average size (Astrom, 1977). Recrystalliszation can occur around the crystallization nuclei in the tissue due to temperature fluctuations in the store. Recrystallization refers to any change in the number, size, shape, orientation or perfection of crystals following completion of initial solidification (Fennema et al., 1973). Ice crystals initially start forming in the extracellular regions. Under vapour pressure, the intracellular water will move toward the extracellular spaces. This process will make the ice crystal grow in size which will eventually puncture the cells surrounding the ice crystal. This process will make the thawed fruit softer than fresh ones (Fennema et al., 1973). While thawing, the punctured cells will bleed out some solutes creating a drip loss. Drip loss in some fruits is considered to be an indication of deterioration (Astrom, 1977).

Damage which might occur in fruits during the freeze thaw process can be traced to chemical or physical activity. There are various types of chemical activity like the oxidation of the phenolic compounds by the enzyme polyphenol oxidase and physical ones like the recrystalization (Fennema et al., 1973).

Another useful tool to describe the activity of the fruits under storage is the "water activity" (a_w). It is a useful expression used to describe the water relation to the microbial growth and enzymatic activity (Troller and Christion, 1978). Water activity for water is 1 at 0°C. It decreases at lower temperatures at -10°C (a_w) is 0.907 and at -20°C (a_w) is 0.864. This means that the microbial and enzymatic activities are greater at 0°C than at -10°C or -20°C. Water activity increases with higher moisture content and decreases with lower moisture content of the sample.

MATERIALS AND METHODOLOGY

Each date was weighed with a 4 digit balance and wrapped individually in pre-numbered polyethylene bags of 100 micron thickness and approximately 10x15 cm in size. All the bags were heat sealed to ensure air tightness. Then 30 dates from each treatment were selected randomly and put onto trays with the following design: 2 varieties x 2 harvest maturity x 6 replicates.

All the fruits were stored in temperature controlled cabinets at -20, -10, 0 and +5°C. Five analyses, at 54 days intervals were carried out in the nine month storage period. Other fruits of the same varieties and harvest maturity were stored at room temperature (+20°C) to serve as a control.

In each experiment, 9 parameters were studied. The chemical ones were moisture content, titratable acidity, total soluble solids and the pH. The organoleptic test investigated the texture, sweetness, acidity, astringency and off flavour.

There were three factors involved in this experiment. The first one was the temperature effect on the storage of the date fruit, in which there were four different temperature settings +5, 0, -10 and -20°C. The +5°C were totally infected after 45 days of storage and this part of the experiment was terminated.

The second factor was the cultivar, Khlas and Khnaize cultivars were used in this experiment. The third factor was the stage of maturity. Two stages were used, the early and the late rutab. Measurements of fruit quality were taken after 54, 108, 162, 216 and 270 days storage. From these five analyses only 54, 108, 162 and 270 are discussed in this paper. All the treatments were arranged in a completely randomize block design and each treatment was replicated 6 times. The data was analysed statistically by using ANOVA and of significant differences at P = 0.05. using the Mstat computer program.

Measurment of the TSS (%) value

A "Bellingham & Stainley Ltd. 40-85% sugar refractometer" was used to measure the TSS.

Measurment of the pH value

A "JENWAY 3020" pH meter was used to measure the pH of fruit juice. The meter was always calibrated by using standard 4 and 7 pH solutions before taking any measurements. The range of the pH meter reading was between 0-14.00 resolution was 0.01 and accuracy was ±0.02 pH as per the manual of the pH meter.

Measurment of the Moisture Content/(%)

Each single date was cut in two halves and one was spread on aluminium foil, then weighed with a four digit balance and dried in the oven until a constant weight was reached (after five days) at a temperature not exceeding 68°C. The final weight of the date was taken by using the same four digit balance. The percentage moisture content was calculated:

Titratable Acidity:

The titratable acidity was measured by weighting 5 grams of the date fruit flesh diluted in 20 ml of distilled water. The whole mixture was then filtered and a 5 ml sample titrated against 0.1N NaOH with phenolphthalein used as indicator. Titratable acidity was expressed as percent of tartaric acid:

Organoleptic test (Taste panel)

The taste panelists were mainly from Libya and occasionally others from Yemen and Saudi Arabia. It was important to choose the panelists from traditionally date palm growing countries. The same panelists were continuously used from the start of the experiment in August 1993 until the end of the experiments.

Organoleptic test (taste panel) scores table

	Nil or very low	*Low*	*Medium*	*Medium to high*	*High*
	0-1	*2*	*3*	*4*	*5*
Texture	*Soft*				*Firm*
Sweetness					
Acidity					
Astringency					
Off flavour					

RESULTS AND DISCUSSION

Effect of Temperature

Table 1 **.** Effects of temperature on the % weight loss of dates during storage*

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	% weight loss				
54 days	0.86	0.69	0.42	0.12	30.50
108 days	0.95	1.05	0.64	0.19	37.40
162 days	0.87	1.60	0.70	0.26	43.10
270 days	1	1.85	1.10	0.30	35.60

1 = Fruit discarded due to rotting.

* Each figure is a mean of two varieties, two stages of maturity and six replicates.

Table 2. Effect of temperature on the % moisture content during storage*

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	% moisture content				
54 days	41.17	35.00	40.63	1.38	4.2
162 days	41.40	39.00	39.40	1.65	4.9
270 days	1	37.90	40.13	1.54	4.8

1 fruit discarded due to rotting.

* Each figure is a mean of two varieties, two stages of maturity and 3 replicates.

Table 3. Effect of temperature on the % TSS value during storage*

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	% TSS				
54 days	55.12	54.42	56.80	1.12	3.5
108 days	57.00	55.70	56.10	0.70	2.2
162 days	54.87	55.80	57.40	0.73	2.3
270 days	1	54.70	53.80	0.77	2.4

1 fruit discarded due to rotting after 216 days storage

* Each figure is a mean of two varieties, two stages of maturity and six replicates.

Table 4. Effects of temperature on the pH value during storage*

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	pH value				
54 days	7.04	7.08	7.30	0.09	2.3
108 days	6.50	7.13	6.73	0.15	3.7
162 days	6.19	6.62	6.76	0.10	2.5

* Each figure is a meon of two cultivars, two stages of maturity and six replicates.

Table 5. Effect of temperature on the titratable acidity after 108 and 162 days of storage*

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	% acid				
108 days	0.15	0.13	0.09	0.015	15.1
162 days	0.14	0.12	0.13	0.014	13.1

* Each figure is a mean of two cultivars, two stages of maturity and 3 replicates.

Table 6. Effects of temperature on the texture during storage*

Temperature	*0°C*	*-10°C*	*-20°C*
Days in storage	texture (1= soft, 5 = firm)		
54 days	3.96	2.83	3.46
108 days	2.04	2.33	3.00
162 days	[1]	2.04	3.21
270 days	[1]	2.25	2.83

[1] fruit discarded due to rotting.

* Each figure is a mean of two cultivars, two stages of maturity and six replicates.

Table 7. Effects of temperature on the sweetness 54 days storage*

Temperature	*0°C*	*-10°C*	*-20°C*
Days in storage	sweetness (1= low, 5 = high)		
54 days	4.71	4.13	4.21

* Each figure is a mean of two cultivars, two stages of maturity and six replicates.

Varietal effects

Table 8. Varietal effect on the pH value during storage*.

Temperature	*Khlas*	*Khnaize*	*LSD at P = 0.05*	*CV %*
Days in storage	pH value			
162 days	6.60	6.50	0.08	2.5
270 days	7.18	7.61	0.12	2.9

* Each figure is a mean of two stages of maturity and six replicates.

Table 9. Varietal effect on the % TSS value during storage*.

Variety	*Khlas*	*Khnaize*	*LSD at P = 0.05*	*CV %*
Date in storage	% TSS			
Initial	53.70	55.83	1.16	2.5
54 days	53.60	57.31	1.12	3.5
108 days	54.83	57.70	0.58	2.2
162 days	54.70	57.30	0.60	2.3
270 days	52.20	56.30	0.77	2.4

* Each figure is a mean of two stages of maturity and six replicates.

Table 10. Varietal effect on the % moisture content during storage*.

Variety	*Khlas*	*Khnaize*	*LSD at P = 0.05*	*CV %*
Days in storage	% moisture content			
Initial (0 days)	36.80	35.55	*NS	8.3
54 days	40.45	37.44	1.14	4.2
108 days	41.20	38.50	1.10	4.0
162 days	41.70	38.11	1.34	4.9
270 days	40.30	37.74	1.54	4.8

* NS = Not significant

* Each figure is a mean of two stages of maturity and 3 replicates.

Table 11. Effects of cultivar on the texture during storage*.

Temperature	*Khlas*	*Khnaize*
Days in storage	texture (1= soft, 5 = firm)	
108 days	1.81	3.11
162 days	2.00	3.25
270 days	2.21	2.88

* Each figure is a mean of two stages of maturity and six replicates.

Table 12. Varietal effect on sweetness after 54 and 162 days storage*.

variety	*Khlas*	*Khnaize*
Days in storage	sweetness (1= low, 5 = high)	
Initial	4.58	4.00
54 days	4.53	4.17
162 days	5.00	4.60

* Each figure is a mean of two stages of maturity and six replicates.

Effects of Stage of maturity

Table 13. Effects of stage of maturity on the % weight loss of dates after 108 days storage*.

Stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Days in storage	% Weight loss			
108 days	0.80	0.97	0.16	37.4

*Each figure is a mean of two varieties and six replicates.

Table 14. Effect of stage of maturity on the pH value during storage*.

stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Days in storage	pH value			
162 days	6.60	6.50	0.08	2.5
270 days	7.46	7.32	0.12	2.9

* Each figure is a mean of two varieties and six replicates.

Table 15. Effect of stage of maturity on the % TSS value during storage*.

stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Days in storage	% TSS			
Initial (0 days)	53.92	55.60	1.16	2.5
54 days	53.80	57.10	0.92	3.5
108 days	55.80	56.72	0.58	2.2
162 days	55.20	56.83	0.60	2.3
270 days	52.90	55.54	0.77	2.4

* Each figure is a mean of two varieties and six replicates.

Table 16. Effect of stage of maturity on the % moisture content during storage**.

Stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Days in storage	% moisture content			
Initial (0 days)	38.13	34.21	*NS	8.3
54 days	39.84	38.05	1.14	4.2
108 days	40.80	38.90	1.1	4.0
162 days	40.80	39.10	1.30	4.9
270 days	40.60	37.43	1.54	4.8

*NS = Not significant

** Each figure is a mean of two varieties and 3 replicates.

Interaction between variety and stage of maturity

Table 17. Effect of the variety and stage of maturity on the pH value after 54 and 270 days storage*.

Days in storage	*Stage of maturity*	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
	Variety	pH value			
	Khlas	7.22	7.00		
54 days	Khnaize	7.15	7.21	0.11	2.3
	Khlas	7.35	7.00		
270 days	Khnaize	7.57	7.64	0.17	2.9

* Each figure is a mean of two stages of maturity and six replicates.

Table 18. Effect of the Interaction between variety and stage of maturity on the % TSS value after 54 days of storage*.

Stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Variety	% TSS			
Khlas	51.28	55.89		
Khnaize	56.33	58.28	1.3	3.5

* Each figure is a mean of six replicates.

Table 19. Effect of the Interaction between variety and stage of maturity on the titratable acidity after 270 days of storage*.

Stage of maturity	*stage 1*	*stage 2*	*LSD at P = 0.05*	*CV %*
Variety	% acid			
Khlas	0.17	0.15		
Khnaize	0.17	0.18	0.02	10.1

* Each figure is a mean of 3 replicates.

Interaction between variety and temperature:

Table 20. Effect of the Interaction between variety and temperature on the pH value during storage*.

	Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	Variety	pH value				
	Khlas	6.92	6.95	7.46		
54 days	Khnaize	7.15	7.21	7.18	0.13	2.3
	Khlas	6.14	6.73	6.88		
162 days	Khnaize	6.25	6.52	6.65	0.14	2.5
	Khlas	[1]	7.06	7.30		
270 days	Khnaize	[1]	7.64	7.58	0.17	2.9

[1] = Fruit discarded due to rotting.

* Each figure is the mean of two stages of maturity and six replicates.

Table 21. Effect of the Interaction between variety and temperature on the % TSS value of dates after 108 days of storage*.

Temperature		*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	variety	% TSS				
	Khlas	57.00	52.83	54.67		
108 days	Khnaize	56.90	58.60	57.60	0.98	2.2

* Each figure is the mean of two stages of maturity and six replicates.

Table 22. Effect of the Interaction between variety and temperature on the % moisture content after 108 days of storage*.

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Variety	% moisture content				
Khlas	41.60	41.90	40.10		
Khnaize	38.70	36.60	40.10	1.90	4.0

* Each figure is a mean of two stages of maturity and 3 replicates.

Table 23. Effect of the Interaction between variety and temperature on the titratable acidity after 54, 108 and 270 days of storage*.

Temperature		*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage	variety	% acid				
	Khlas	0.12	0.10	0.10		
54 days	Khnaize	0.10	0.16	0.10	0.037	27.50
	Khlas	0.16	0.13	0.08		
108 days	Khnaize	0.13	0.13	0.09	0.020	15.10
	Khlas	[1]	0.19	0.13		
270 days	Khnaize		0.15	0.19	0.020	10.10

[1] = Fruit discarded due to rotting.

* Each figure is a mean of two stages of maturity and 3 replicates.

Table 24. Effect of the Interaction between variety and temperature on the texture after 108 days of storage*.

Temperature	*Variety*	*0°C*	*-10°C*	*-20°C*
Days in storage		texture (1= soft, 5 = firm)		
	Khlas	1.83	1.33	2.25
108 days	Khnaize	2.25	3.33	3.75

* Each figure is the mean of two stages of maturity and six replicates.

Interaction between stage of maturity and temperature:

Table 25. Effect of the Interaction between stage of maturity and temperature on the % weight loss of dates after 54 days of storage*.

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
stage of maturity	% weight loss				
Stage 1	0.96	0.62	0.40		
Stage 2	0.77	0.76	0.45	0.16	30.5

* Each figure is a mean of two varieties and six replicates.

Table 26. Effect of the Interaction between stage of maturity and temperature on the % TSS value after 108 days of storage*.

Temperature	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Stage of maturity	% TSS				
Stage 1	56.80	54.70	55.90		
Stage 2	57.10	56.75	56.33	0.98	2.2

* Each figure is a mean of two varieties and six replicates.

Table 27. Effect of the Interaction between stage of maturity and temperature on the titratable acidity after 108 and 162 days of storage*.

Temperature	Stage of maturity	*0°C*	*-10°C*	*-20°C*	*LSD at P = 0.05*	*CV %*
Days in storage		% acid				
	Stage 1	0.16	0.11	0.09		
108 days	Stage 2	0.14	0.15	0.09	0.02	15.1
	Stage 1	0.14	0.12	0.12		
162 days	Stage 2	0.14	0.11	0.15	0.02	13.2

* Each figure is a mean of two varieties and 3 replicates.

RESULTS AND DISCUSSION

The weight loss was lower at the lower temperatures and higher at higher temperatures Table (1) which would be due to higher metabolic activity and higher respiration at higher temperatures (Thompson 1996). The lower weight loss at 0°C for 108 and 162 days of storage might have been caused by the humidity infiltration into the PE bags (Hardenburg and Watada1990) and it had high moisture content Table (2). The high moisture content at -20°C mirrored the low weight loss observed at the same temperature. The TSS values of the dates Table (3) between the treatments were too small to have a practical difference. The reduction of the TSS value at 0°C after 162 days storage might have been caused by the fungal attack, which has previously been shown to reduce the TSS value and the pH value Table (4) (Salam et al.,1991). The higher pH of the dates at lower temperatures Table (4) might have been caused by smaller metabolic changes at -20°C compared with -10°C (Fennema et al.,1973). The acid content decreased with the decrease in temperature Table (4), the same result was also found previously by (Fennema et al.,1973). The cell destruction at -20°C will be lower than at -10°C which will make the dates softer than at -20°C. The dates stored at 0°C Table (6) had the lowest textural firmness and that might have been caused by the higher enzymatic activity at elevated temperatures (Troller and Christian, 1978). The higher sweetness of the dates at 0°C Table (7) might have been caused by higher weight loss value at 0°C Table (1) and higher TSS value.

After 162 days of storage the dates were infected at 0°C. Infection caused the decrease of the pH value of the dates Table (8). After 270 days storage Khlas had lower pH value which might have been caused by a varietal difference. Khlas became softer and squishier than Khnaize during the storage period Table (11) which appears to be a varietal characteristic probably related to cell structure as has been shown for other fruit (Thompson 1996). This indicates that Khlas was closer to the late rutab stage which is characterised by a lower pH value. In all the analyses Table (9) Khnaize had higher TSS value than Khlas. Khnaize also had a lower moisture content as a maturity characteristic of dates Table (10). The TSS value of Khlas was lower than Khnaize Table (10), but the panelists Table (12) members chose Khlas to be of a higher sweetness. The same result was obtained at the initial test. This might have been caused by the sugar composition of each date variety (Ba Angood 1984).

The weight loss is usually higher at the first stage because of greater availability of moisture than the second stage (Al Ani 1982). The high weight loss at stage two might have been caused by the differences in the samples since the two stages under study are of one maturity stage which was the rutab Table (13). Jarrah (1983) stated that the pH value of dates increased even up to the tamr stage, but Rouhani and Bassiri (1976) indicated that the pH decreased toward the tamr stage. From the current experiment it seems that the pH decreases Table (14). The dates increase in sugar content and decrease in moisture content during maturation Tables (15 and 16).

The interaction between variety and stage of maturity on the pH value showed that Khlas had lower pH value at the second stage, while Khnaize had a lower one. The difference of the pH value of the two varieties at stage 2 could have been caused by a varietal difference Table (17). Since each variety has its own sugar-acid ratio (Benjamin et al., 1985). The same difference was also found for the TSS value of the dates between the stages and varieties. Khlas had a lower TSS value in both stages than Khnaize for both stages too Table (18). The varietal difference of the sugar-acid ratio (Thompson 1996) of each date variety (Benjamin et al., 1985), might have decreased the titratable acidity of Khlas at stage 2 and increased for Khnaize Table (19).

Both varieties did not show consistency of the pH value, Khnaize had lower pH value than Khlas after 162 days storage at -10°C. However, after 270 days storage Khnaize had higher pH value Table (20). The interaction between variety and stage of maturity on the pH value showed that the pH value of Khlas decreased from stage 1 to stage 2, while Khnaize increased its pH value as a maturity characteristic of different varieties of dates Table (17). The effect of the varietal difference on TSS of two varieties was very clear at -10°C and -20°C, where Khlas was lower in TSS than

Khnaize Table (21). However, this difference did not mirror the moisture content of both varieties. The moisture content might have changed because of high humidity infiltration into the dates flesh and the lower metabolic activity of the dates at -20°C Table (22). The titratable acidity was decreased toward lower temperatures in all the treatments except with that of -10°c for khnaize after 54 days of storage (Table 23), which agrees with previously published work (Fennema et al., 1973). The texture was firmer at -20°C and less firmer at -10°C and softer than the others at 0°C. Khnaize

[redacted]

It can be concluded that the variety Khnaize is more suitable for storage because it can keep its physical properties such as 'firmness' and chemical ones such as 'pH, TSS ' value better than Khlas. Both the storage temperatures -10°C and -20°C could be used without greatly affecting the quality of the dates 'except the colour at -10°C was darker and the texture was softer than -20°C (see figures 3-1 to 4). Also both maturity stages (early and middle of the rutab) could be used since they did not greatly differ in their physical or chemical characteristics. The PE wrapping could have increased the storage period from the usual 2 months at 0°C and 94% relative humidity to more than 3 months.

Figure 1 First stage Khlas stored at -20°C for 270 days.

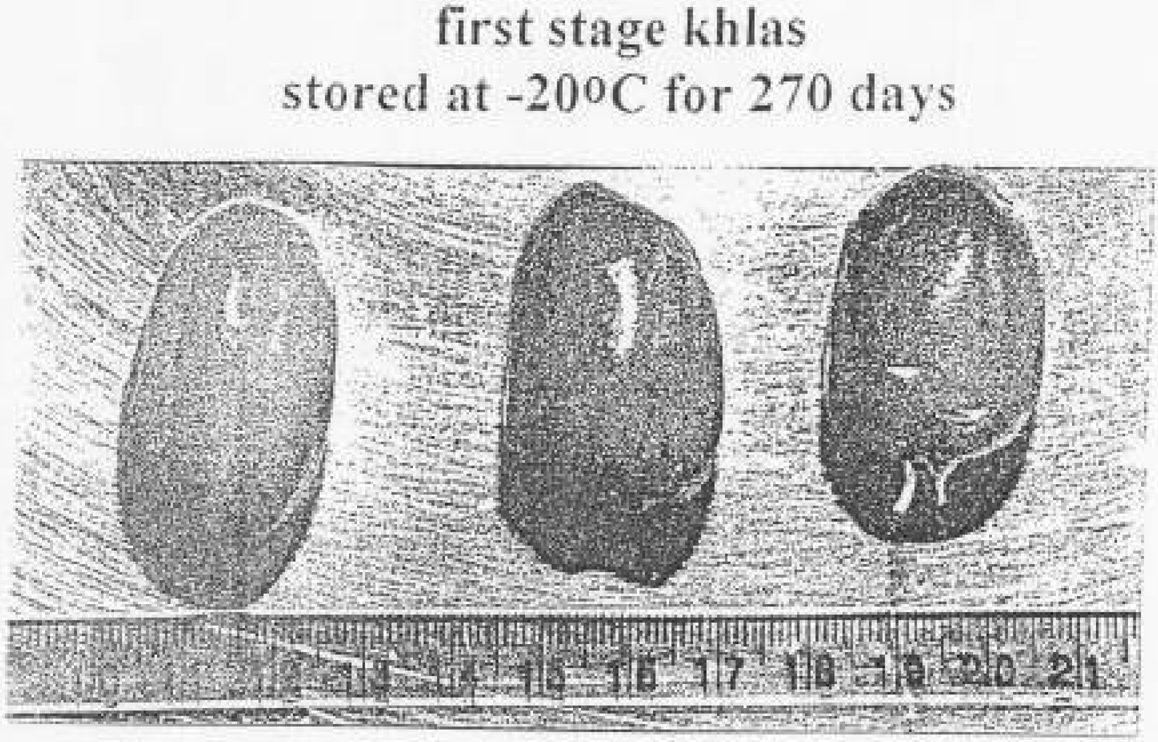


Figure 2 First stage Khlas stored at -10°C for 270 days.

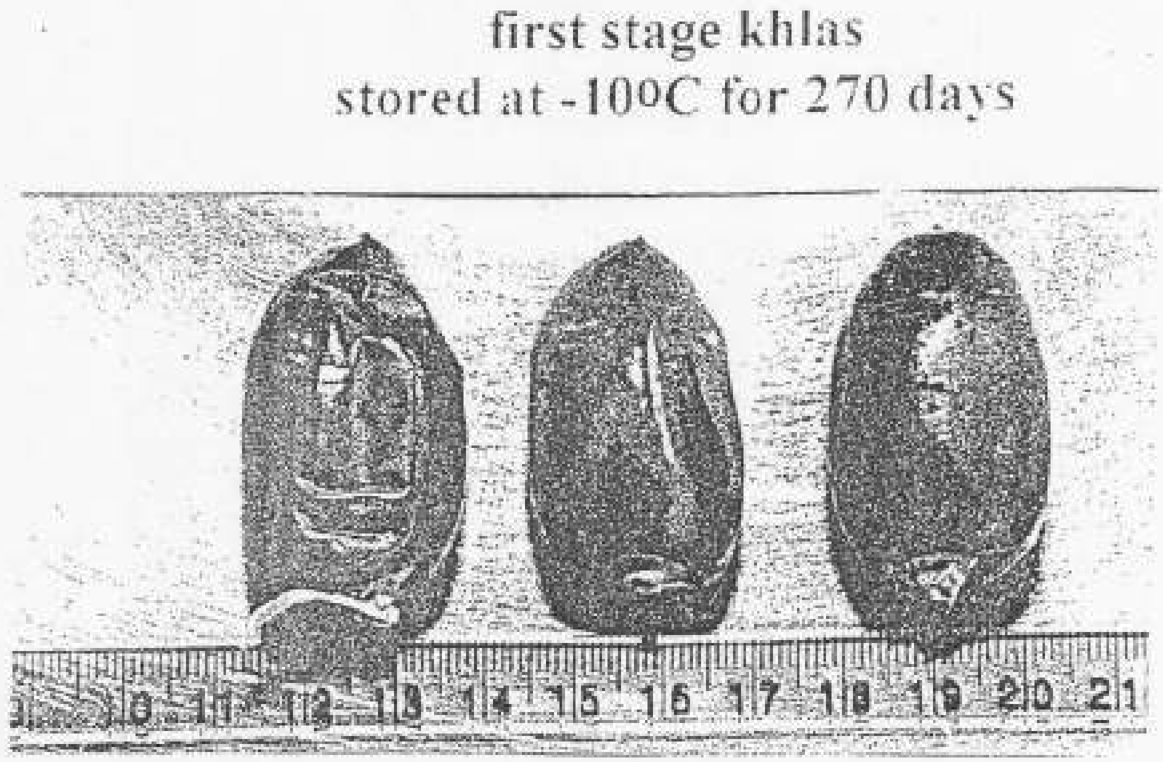


Figure 3 First stage Khnaize stored at -20°C for 270 days.

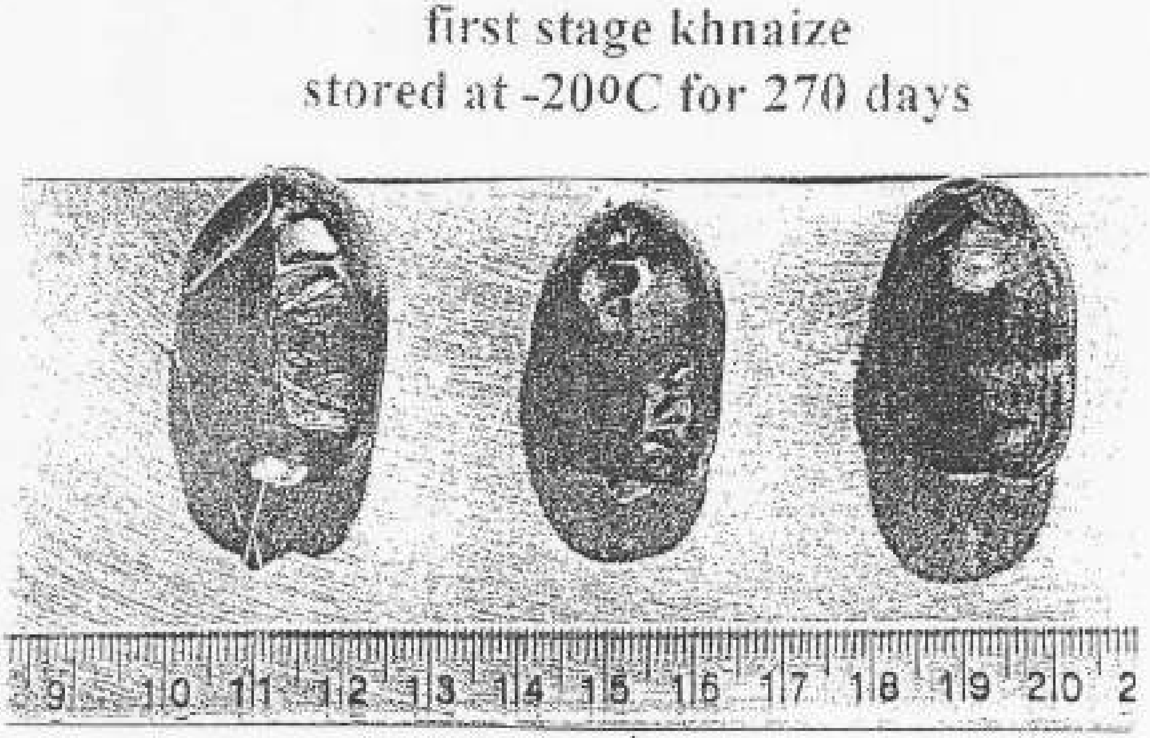
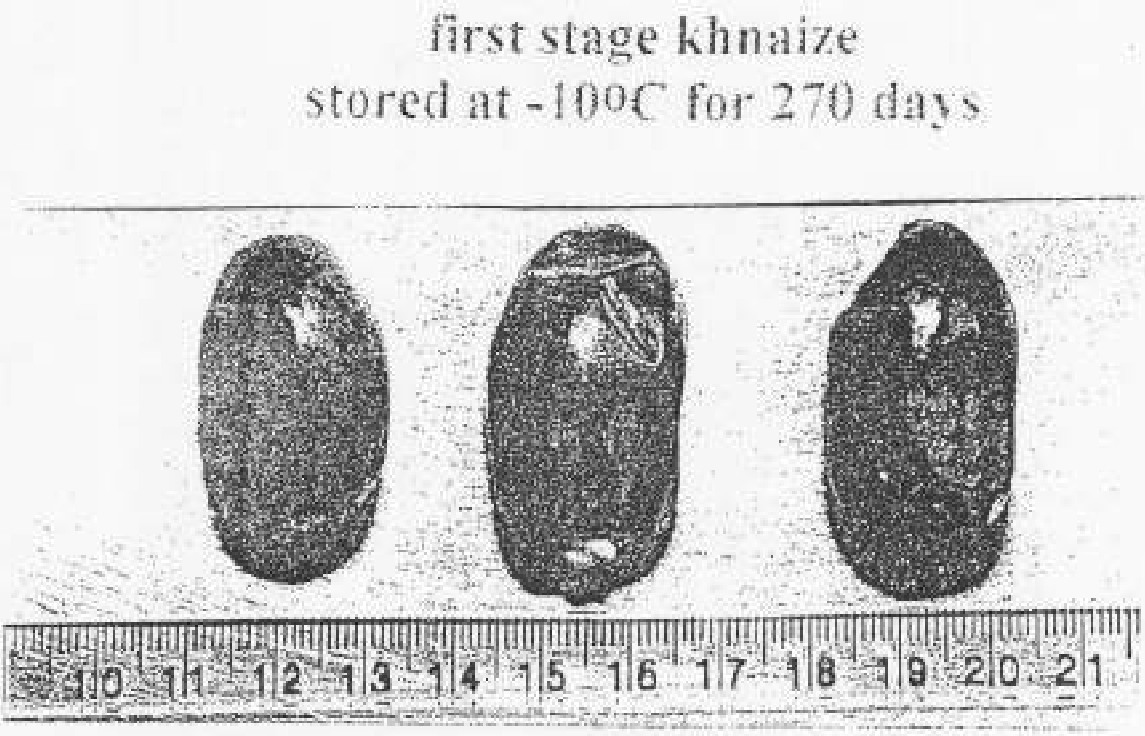


Figure 4 First stage Khnaize stored at -10°C for 270 days.



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DEVELOPMENT TO THE RUTAB STAGE WITHOUT ACCOMPANIED FRUIT SOFTENING OF ZAGHLOUL DATES BY SOME POSTHARVEST TREATMENTS.

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ABSTRACT

Zaghloul dates are demanded in the Egyptian and many foreign markets. This cultivar is consumed at the khalal stage but rapidly develop to the rutab stage. Since extending the khalal stage is accompanied by shriveling, this study takes the approach of obtaining rutab fruits without softening or tissue breakdown after many days on the shelf. Fruits were dipped in one of the treatment solutions for 15 min after harvest in two consecutive seasons 1994 and 1995. Treatments were : putrescine at 1.0 and 2.0 mM, ascorbic acid (0.5%, w/v), citric acid (0.5%, w/v), benzoic acid (0.5%, w/v), potassium permanganate (0.05, 0.1%, w/v), and salicylic acid (0.25, 0.5%, w/v). Putrescine (2.0 mM) or potassium permanganate (0.1%) resulted in significantly lower tissue softening or breakdown as compared to the control. The electrical conductivity (EC) of fruit tissue after 6 days at room temperature was significantly lower than that of the water control for both treatments. Benzoic acid, however, led to higher EC than the control. All treatments did not retard the development to the rutab stage. They caused a significant reduction in juice acidity, except with putrescine (1.0 mM) or potassium permanganate (0.1%). This study provided evidence that either putrescine or potassium permanganate at certain concentration has the potential to retard tissue softening of Zaghloul dates after harvest and improve the fruit marketability.

Additional Index Words: date palm, senescence, shelf life, antioxidants, polyamine, potassium permanganate, salicylic acid, marketability, firmness.

INTRODUCTION

Zaghloul dates are demanded in the Egyptian and many foreign markets. A great amount of the crop is harvested in a relatively, short period of times. Rain in autumn increases the possibility of infection by pathogens and fruit softening and abscission. Since the fruits are harvested at the khalal stage, they develop to the Rutab stage either at the storage facility or in the market. This conversion is usually accompanied by softening of the fruit tissue that affects its marketability and accelerates its spoilage. Most researchers have been focusing on the approach of extending the khalal stage (Hussein et al, 1993) with varying degrees of success. Date palm producers, however, still lack a commercially accepted method that could be adopted to achieve this goal. Another approach to increase the marketability and the shelf life of dates after harvest is to retard the tissue softening or senescence. This means obtaining fruits at the rutab stage after several days on the shelf but keeping a firm texture for the tissue.

Furthermore, prolonging the khalal stage with some chemical treatments such as calcium solutions still result in badly shriveled fruits when left on the shelf at room temperature after the treatment, thus, an acceptable appearance is still needed. On the other hand, a rutab but not soft fruit could be a major consumer preference in many areas of the world.

The goal of this study is to obtain a rutab Zaghloul dates that have a firm texture and acceptable appearance after several days on the shelf at room temperature.

Materials & Methods:

Mature Zaghloul dates at the khalal stage were harvested from the same tree from a commercial orchard near kafr El-Dawar, Beheira. The orchard was under standard agricultural practices, and the soil was clay- loamy. Pest management was well maintained. Fruits were transferred to the laboratory for further treatments at the same day. Fruits were thoroughly washed with water, surface sterilized with sodium hypochlorite for 3 min (0.5% of 5% stock solution), then washed again in distilled water and left for air drying. Uniform and free of defects fruits were divided into random groups, each group contained 6 fruits that represented one replication. Three replications were used with each treatment. Fruits were treated by dipping for 15 min in each treatment solution on Nov.14 and 12 in both 1994, 1995, seasons respectively. After air drying, fruits were kept at $22^0 \pm 2^0C$ for 6 days. Water loss and rutab percentage were daily monitored for each fruit individually according to an established score as follow: (No rutab = 1; >0 - < 25% rutab =2; >25-<50% rutab =3; >50-<75% rutab=4; >75-<100% rutab =5; 100%rutab=6).

At the end of the experiment, the following measurements were taken: final weight (gram), rutab percentage for each fruit as the above mentioned score. Total soluble solids using hand refractometer, titratable acidity of the juice against 0.01 N NaOH, and electrical conductivity (EC) of the flesh tissue using a conductivity meter. The ratio of EC was calculated by taking the electrolyte leakage of the flesh tissue before killing, then killing the tissue by deep freezing and taking another measurement after killing (to represent the total leakage of electrolytes). Each fruit was cut into two halves, then each half was cut into four pieces. Two pieces were randomly taken from each fruit pieces to give 12 pieces for each replication to measure the EC as mentioned above. The experiment was completely randomized and treatment means were compared by using the least significant difference (LSD) at 5% level. Analysis of variance for the data was obtained using Mstat computer program.

Results & Discussion

The data indicated (Table 1) that putrescine at 2.0 mM resulted in retarding the softening of fruit tissue after 6 days on the shelf. The electrolyte leakage of putrescine (2.0 mM) treated fruits was significantly less than the control in both seasons. Moreover, putrescine at 1.0 mM led to preserving the tissue firmness in both seasons. The difference between this treatment and the control was significant, especially during the second season. The use of the antioxidants citric and ascorbic acids tended to reduce electrolyte leakage as compared to the control, but the difference was not statistically significant, except with the citric acid treatment during the second season. Benzoic acid, however, caused a significant increase in fruit softening when compared with the control, as indicated by the electrolyte leakage values in both seasons. Fruit treatment with potassium permanganate at 0.1%, w/v resulted in less electrolyte leakage than the control during both seasons. Furthermore, potassium permanganate at 0.05%, w/v caused a significant reduction of electrolyte leakage only during the second season when compared with the control (Table 1).

The treatments that resulted in a consistent reduction in electrolyte leakage (Putrescine at 2.0 mM or potassium permanganate at 0.1%,w/v) were not significantly different when compared with each other. Salicylic acid tended to reduce leakage of electrolytes from fruit tissues at both concentrations, this reduction, however was significant during the second season as compared with the control.

With regard to total soluble solids, the data showed that there was a significant reduction by all treatments when compared with the control. However, there were some variations between these treatments. For example, potassium permanganate (0.1%) treatment gave a higher TSS value than putrescine at 1.0 mM., or salicylic acid at 0.5,w/v. the second season (Table 1).

Titratable acidity after 6 days on the shelf was also reduced by all treatments. This general trend was consistent in both seasons. However, the significant reduction was achieved by benzoic acid as compared with the control in both seasons. The difference among treatments were not statistically significant, except between benzoic acid and salicylic ucid (0.5% treatment in the 2^{nd} season, (Table 1).

The data also provided evidence that either benzoic acid or citric acid was able to increase TSS/acid ratio after 6 days on the shelf when compared with the control. There was a trend of higher TSS/acidity values as result of putrescine treatment at 2.0mM. the difference between putrescine at this concentration and the control was only significant during the second season. Putrescine at 1.0 mM did not cause a significant difference in higher TSS/acid ratio when compared with the control. Benzoic acid treatment also gave TSS/Acid ratio than that obtained with citric or ascorbic acid (Table 1).

The effect of various treatments on water loss after 6 days on the shelf is shown in table 1. The data indicated that there was no significant difference between the control and all other treatments except with salicylie acid at 0.5%. This acid treatment led to significantly higher water loss during both seasons as compared with the control. However, putrescine (1.0 mM) treated fruits had significantly lower values of water loss in both seasons when compared with ascorbic acid, benzoic acid, and salicylic acid at 0.5%. Moreover, putrescine (at 1.0 mM) treated fruits had significantly lower water loss than putrescine (2.0 mM) and salicylic acid (0.25%) during the second season, and potassium permanganate (0.05%) at the first season. Furthermore, potassium permanganate (0.1%) treated fruits after 6 days on the shelf had significantly lower values of water loss when compared with salicylic acid treated fruits at 0.5% during both seasons. In terms of rutab score (table 1), fruits of all treatments tended to have lower values of rutab score when compared with the control. However, this difference was significant only during the first season between the control and putrescine (2.0 mM), ascorbic acid, citric acid, and potassium permanganate (0.1%). Values of water loss during both seasons with benzoic acid were higher than the control with regard to water loss.

With regard to the interaction for 1994 season, (Table 2) it was found that benzoic acid treated fruit had higher values of water loss than putrescine (2.0 mM), ascorbic acid, citric acid, potassium permanganate, and salicylic acid (0.25%) after two days of the treatment. Control fruits had similar values of water loss after 2 days to that of putrescine (1.0 and 2.0 mM) and both concentrations of potassium permanganate. After 3 days of the treatment, progress of water loss from control fruits was still similar to all other treatments except benzoic acid and ascorbic acid which lost more water than the control. The interaction between the treatment and time showed that after 6 days of the treatment, benzoic acid treated fruits had higher values of water loss than the control. Similar results were obtained with ascorbic and salicylic acid (0.5%) after 6 days which lost significant amount of water greater than the control.

For the interaction between treatment and time in 1995 season, (Table 2), similar trend was found for the progress of water loss. The data indicated that benzoic acid treated fruits started to lose water in a higher rate than other treatments. The highest values of water loss appeared after 2 days of the treatment with benzoic acid or salicylic acid (0.5%). After 6 days of the treatment, it was evident again that benzoic acid or salicylic acid (0.5%) treated fruits lost significantly more water than the control (Table 2), potassium permanganate at both concentrations, putrescine (1.0 mM), citric acid, and salicylic acid (0.25%).

The interaction between treatment and time for rutab development in 1994 season (Table 3) showed that the significant difference appeared after 3 days with the use of benzoic or ascorbic acid when compared with the control. The rutab score with both acids was also higher than that for potassium permanganate (0.05%) treated fruits. Benzoic acid treated fruits maintained their higher values of rutab score after 4 days on the shelf when compared with other treatments except ascorbic acid. However, the difference in rutab development between putrescine (1.0 mM) or potassium permanganate (0.05%) and the control was not significant. By the end of the experiment, all treated fruits had higher rutab score than the control. Similar trend was obtained for the interaction during 1995 season. The significant difference between benzoic or ascorbic acid and the control appeared in rutab score after 4 days on the shelf. Similarly, benzoic acid treated fruits had the highest rutab score value. After 6 days on shelf, all treatments except putrescine (1.0 mM) and potassium permanganate (0.1%) had higher rutab score than the control (Table 3).

This study provides evidence that it is possible to obtain a rutab fruit but with a firm texture through keeping the membranes integrity as the electrolyte leakage indicated. Putrescine (2.0 mM) or potassium permanganate (0.1 %) significantly reduced electrolyte leakage of the fruit tissue by the end of the experiment. The antiethylene effect of the polyamine, putrescine, was reported (Arteca, 1996). Thus putrescine was able to retard fruit tissue senescence. In a similar way, calcium was used to keep tissue integrity and retard rutab development (Husein, et al. 1993) but extending the khalal stage by such treatment is accompanied by shriveling. Potassium permanganate was found to extend the shelf life of another climacteric fruit, namely avocado (Nwufo, et al. 1994) which agrees with our finding. Salicylic acid which was reported as a new growth regulator (Raskin, 1992) that antagonizes ethylene effects, was not able to preserve the date fruit texture in this study. Furthermore, the use of the antioxidants, citric or ascorbic acids, were not able to hold the progress toward senescence (rutab development and tissue breakdown). This study also indicated that there is a potential to improve the Zaghloul dates marketability even after the development of the rutab stage.

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Table 1. Some fruit characteristics of Zaghloul dates after 6 days on the shelf as influenced by antioxidants, an ethylene absorbent, and an antiethylene compound during 1994 and 1995 seasons.

Treatments	Electrolyte Leakage (%)		TSS (%)		Acidity (%)		TSS/Acidity		Water loss %		Rutab score	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Control	25.38	25.68	30.73	27.60	0.60	0.55	51.89	50.18	12.96	13.55	2.50	3.05
Putrescine(1.0 mM)	19.45	15.88	19.87	20.53	0.46	0.48	43.68	45.12	11.80	11.37	4.17	3.67
Putrescine(2.0 mM)	16.82	12.80	26.40	20.13	0.42	0.36	63.72	61.00	12.91	15.19	4.72	4.56
Ascorbic acid	20.93	19.31	21.87	22.67	0.40	0.46	55.06	50.43	14.85	14.47	4.72	4.39
Benzoic acid	45.24	43.73	18.93	26.40	0.25	0.26	81.32	112.33	15.95	16.16	5.33	5.00
Citric acid	21.13	16.95	23.60	21.60	0.34	0.33	70.78	68.36	13.25	12.87	4.50	4.22
K.Permanganate (0.05 %)	25.67	16.55	21.60	16.93	0.37	0.36	61.61	48.75	15.61	14.35	3.67	4.45
K. Permanganate (0.1%)	16.89	14.78	24.00	24.40	0.53	0.36	47.19	70.72	12.42	13.17	4.50	3.72
Salicylic acid (0.25%)	22.98	18.24	22.93	22.27	0.37	0.40	62.07	56.78	13.17	14.76*	4.11	4.33
Salicylic acid (0.5%)	21.83	18.56	20.13	15.33	0.38	0.50	58.65	31.67	16.06	17.89*	3.89	4.50
LSD	7.15	5.90	4.13	2.34	0.34	0.23	14.30	9.17	3.01	3.05	1.76	1.58

Initial values for fruit characteristics were: 13.78, 14.11 for. EC; 30.33, 30.60 for TSS. 1.07, 1.30 for acidity; 30.23, 24.53 for TSS/ Acidity; 25.64, 23.97 for fruit weight; and 1.0,1.0 for rutab score during 1994 and 1995 respectively.

Table 2. Progress of water loss from Zaghloul dates following the treatments for 6 days during 1994 and 1995 seasons

Treatments	1994 Season						Mean	1995 Season						Mean
	Days after treatment							Days after treatment						
	0	1	2	3	4	6		0	1	2	3	4	6	
Control	0.0	2.63	5.12	7.43	9.31	12.96	6.24	0.0	2.80	5.32	7.65	9.89	13.55	6.54
Putrescine(1.0 mM)	0.0	2.47	5.69	7.75	9.62	11.80	6.22	0.0	1.22	3.39	5.33	7.46	11.37	4.80
Putrescine(2.0 mM)	0.0	2.49	4.93	7.12	9.95	12.91	6.23	0.0	4.17	5.77	8.00	11.11	15.19	7.37
Ascorbic acid	0.0	2.79	4.61	9.52	11.20	14.85	7.16	0.0	2.78	5.32	7.88	10.25	14.47	6.78
Benzoic acid	0.0	3.13	6.44	9.49	11.92	15.95	7.82	0.0	2.96	5.96	8.81	12.01	16.16	7.65
Citric acid	0.0	2.24	4.58	6.91	9.68	13.25	6.11	0.0	2.47	4.77	6.93	9.04	12.87	6.01
K.Permanganate (0.05 %)	0.0	2.40	5.01	7.41	9.52	15.61	6.66	0.0	4.07	5.83	8.23	10.25	14.35	7.12
K. Permanganate (0.1%)	0.0	2.71	4.99	6.43	8.31	12.42	5.81	0.0	2.46	4.94	7.38	10.42	13.17	6.40
Salicylic acid (0.25%)	0.0	2.07	4.78	7.26	9.30	13.17	6.10	0.0	2.58	5.21	7.72	10.06	14.76	6.72
Salicylic acid (0.5%)	0.0	2.86	5.96	8.82	11.19	16.06	7.48	0.0	3.35	6.53	9.80	12.54	17.89	8.37
Mean	0.0	2.58	5.21	7.81	10.00	13.90	6.58	0.0	2.89	5.31	7.77	10.30	14.38	6.78
LSD		Treatment	1.04					1.89						
		Time	18.39					15.30						
		interaction	1.45					1.19						

Table 3. Progress of rutab development (as indicated by rutab score) of Zaghloul dates following the treatments for 6 days during 1994 and 1995 seasons.

Treatments	1994 Season						Mean	1995 Season						Mean
	Days after treatment							Days after treatment						
	0	1	2	3	4	6		0	1	2	3	4	6	
Control	1.0	1.0	1.0	1.0	1.05	2.50	1.26	1.0	1.05	1.05	1.05	1.05	3.05	1.38
Putrescine(1.0 mM)	1.0	1.0	1.0	1.11	1.72	4.17	1.67	1.0	1.0	1.0	1.05	1.89	3.67	1.60
Putrescine(2.0 mM)	1.0	1.05	1.16	1.33	2.50	4.72	1.96	1.0	1.0	1.11	1.44	2.78	4.56	1.98
Ascorbic acid	1.0	1.0	1.05	1.95	2.94	4.72	2.11	1.0	1.05	1.11	1.83	2.84	4.39	2.04
Benzoic acid	1.0	1.22	1.44	1.94	3.78	5.33	2.45	1.0	1.22	1.28	1.72	3.28	5.0	2.25
Citric acid	1.0	1.0	1.0	1.33	2.06	4.50	1.82	1.0	1.0	1.05	1.05	1.56	4.22	1.65
K.Permanganate (0.05 %)	1.0	1.0	1.0	1.0	1.17	3.67	1.47	1.0	1.0	1.16	1.55	2.78	4.45	1.99
K. Permanganate (0.1%)	1.0	1.0	1.05	1.22	2.05	4.50	1.80	1.0	1.0	1.0	1.0	2.39	3.72	1.69
Salicylic acid (0.25%)	1.0	1.05	1.11	1.33	1.55	4.11	1.69	1.0	1.0	1.05	1.33	1.83	4.33	1.76
Salicylic acid (0.5%)	1.0	1.0	1.11	1.22	2.50	3.89	1.79	1.0	1.0	1.05	2.0	2.89	4.50	2.07
Mean	1.0	1.03	1.09	1.34	2.13	4.21	1.80	1.0	1.03	1.09	1.40	2.33	4.19	1.84
LSD	Treatment	0.50						0.51						
	Time	0.25						0.28						
	Interaction	0.80						0.89						

DETERMINATION OF MATURITY STANDARDS OF DATES

M.S.Fageria[1], R.S.Dhaka[2] and N.L.Chaudhary[3]

ABSTRACT

The harvesting stage influenced the fruit weight, acidity, T.S.S., organoleptic rating and spoilage percentage. The weight of fruits in all the cultivars increased upto doka stage and then slightly decreased at dang stage. The total soluble solids in all the cultivars increased from gandora to dang stage whereas acidity decreased. This study revealed that for raw consumption of dates as well as for its better keeping quality, fruits should be harvested at doka stage. A positive correlation was observed between T.S.S. and organoleptic rating, hence, it is suggested that T.S.S. may be taken as an index of maturity of dates.

Additional index words: cultivars, stages, gandora, doka, dang, storage, maturity index, correlation.

INTRODUCTION

India is one of the horticulturally rich countries of the world. It is unfortunate that fruits and vegetables produced in India are not enough to meet out the basic requirement of ever increasing population. There is a considerable gap between gross production and net availability of fruits and vegetables due to heavy post harvest losses (approximately 30 per cent). The post harvest losses in date palm fruits in India are as high as 30 to 40 per cent due to heavy rains during its fruit maturity. The post harvest losses in date palm fruits can be minimised to a great extent by harvesting of date palm fruits at right stage. Determining the maturity standards of different varieties of dates is therefore, important for proper management,. handling, harvesting, drying, packaging and storage. Work done on the physico-chemical changes during fruit development and maturation of various date cultivars has been reported by many workers (El-Azzouni et al, 1975, Hussein, 1970, Sawaya and Khalil, 1986 and Chandra, 1994).

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The maturity of dates varies among genotypes, from climate to climate and region to region. Therefore, in view of this the present study was undertaken to determine the maturity standards for different cultivars of date palm, under semi arid conditions of Rajasthan.

MATERIALS AND METHODS

The experiment was conducted at Department of Horticulture, S K N College of Agriculture, Jobner (Jaipur), India. The fruits of eight cultivars of date palm were procured from plantation of date palm research centre, Bikaner. The fruits were harvested at Gandora (Kimri), doka (khalal) and Dang (Rutab) stages. Fruits could not reach pind (tamar) stage because the ripening time always coincided with onset of rains in the region and fruits got spoiled by rotting. The trial was laid out in factorial randomised block design with three replications. The fruits were harvested from 8 trees at different sites of plantation. The average of 20 fruits selected randomly were taken for recording of different observations. For keeping quality study, the fruits of all the cultivars were stored under ordinary room temperature for 6 days. Acidity was determined by titration method as suggested by AOAC (1980). The total soluble solids was determined by hand refractometer. The organoleptic rating was done by a panel of five experts on the basis of 0-10 point hedonic scale.

RESULTS AND DISCUSSION

The sufficient variability for fruit weight, T.S.S., acidity, organoleptic rating and shelf life was observed among genotypes (Table 1). The weight of the fruits in all the cultivars increased upto doka (khalal) stage and then slightly decreased at Dang (Rutab) stage (Table 2). Similar results were also reported by Siddiqui and Gupta (1994).

The maximum organoleptic rating for fresh fruits was noticed at Dang stage very closely followed by gandora stage. Whereas on the 6^{th} day of storage the highest organoleptic rating and minimum spoilage percentage in all the cultivars was observedat doka stage. Similar to it, Chandra et al (1994) also reported that for eating of dates as a raw fruit, the fruits in most of date palm cultivars must be harvested at full doka stage.

A significant positive correlation was observed between total soluble solids and organoleptic rating (Table 3). Hence, T.S.S. may be taken as an index of maturity in dates.

This study revealed that for raw consumption of dates as well as for its better keeping quality, fruits from most of cultivars should be harvested at doka stage.

The days taken from pollination to different stages of maturity and heat summation from spathe opening to maturity are also some important considerations for judging maturity in dates.

There is also an urgent need to develop/screen an early maturing variety of dates so that its fruits may reach to pind (tamar) stage before onset of monsoon.

ACKNOWLEDGEMENTS

The senior author is grateful to Dr.M.S.Manohar, Director Research for providing the research facilities, Dr. J.R.Mathur, Director (P&M) Rajasthan Agricultural University, Bikaner for providing financial assistance for presenting this paper at UAEU, United Arab Emirates.

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Table 1. Physico-chemical changes during various developmental stages and during storage of date palm fruits.

Cultivar	Stage	Fruit weight (g)	T.S.S. (°Brix)	Acidity (mg/100g)	Organoleptic rating (10 points)	Organoleptic rating (6th day)	Spoilage (%)
Jagool	Gandora	5.17	17.00	240.00	3.00	4.33	14.17
	Doka	6.07	21.67	180.00	6.50	6.27	10.67
	Dang	5.70	25.00	108.33	6.83	4.17	19.83
	Mean	5.64	21.22	176.11	5.44	4.92	14.69
Khadrawi	Gandora	6.30	15.83	211.67	2.57	3.60	12.50
	Doka	9.77	20.83	125.00	6.83	6.07	9.40
	Dang	7.77	29.00	81.67	7.23	4.97	16.23
	Mean	7.94	21.89	139.44	5.54	4.88	12.71
Medjool	Gandora	9.83	18.83	218.67	2.40	3.07	12.00
	Doka	13.10	22.83	155.00	5.87	5.93	10.90
	Dang	11.90	28.83	75.00	7.07	4.83	15.70
	Mean	11.61	23.50	149.56	5.11	4.61	12.87
Shamran	Gandora	5.25	24.00	199.33	3.07	4.17	10.33
	Doka	6.10	34.17	141.67	6.90	6.23	9.07
	Dang	5.67	39.00	74.33	6.97	4.50	14.40
	Mean	5.67	32.39	136.44	5.64	4.97	11.27
Halawy	Gandora	7.77	24.00	243.33	2.50	3.17	10.43
	Doka	9.23	32.33	225.00	8.07	6.97	9.33
	Dang	8.97	35.00	155.00	8.20	5.67	14.97
	Mean	8.66	30.44	207.78	6.26	5.27	11.58
Barbee	Gandora	7.37	14.00	151.67	2.83	3.90	8.30
	Doka	8.47	20.17	135.00	7.37	7.00	7.73
	Dang	7.53	21.67	84.33	7.63	5.87	14.80
	Mean	7.79	18.61	123.67	5.94	5.59	10.28
Khunezi	Gandora	8.57	26.67	202.00	3.30	4.07	8.27
	Doka	10.17	45.00	165.00	7.30	6.07	8.10
	Dang	9.33	46.33	120.67	7.43	4.17	16.30
	Mean	9.36	39.33	162.56	6.01	4.77	10.89
Khelas	Gandora	8.90	23.33	147.67	2.63	3.20	8.17
	Doka	10.83	34.67	126.00	6.43	6.43	7.47
	Dang	9.83	36.67	75.33	6.53	4.33	15.17
	Mean	9.86	31.56	116.33	5.20	4.66	10.27
C.D.at 5%	Culitvars	0.331	1.033	11.129	0.324	0.360	0.640
	Stages	0.203	0.632	6.814	0.198	0.221	0.392
	Cultivar X stages	0.574	1.789	19.276	0.562	0.624	1.109

Table 2. Means of different characters at different stages of harvest

Stage	Fruit weight (g)	Acidity (mg/100)	T.S.S. (°Brix)	Organoleptic test (10 marks) fresh fruit	Organoleptic test (10 marks) (6th day of storage)	Spoilage (%) 6th day of storage
Gandora	7.39	201.01	20.45	2.79	3.69	10.52
Doka	9.22	156.58	28.96	6.91	6.37	9.01
Dang	8.34	96.83	32.69	7.23	4.81	15.93
SEm	0.072	2.409	0.223	0.070	0.078	0.138
C.D.	0.203	6.815	0.632	0.198	0.221	0.392

Table 3. Phenotypic correlation coefficients among six characters of date palm

Character	Acidity (mg/100g)	T.S.S. (°Brix)	Organoleptic rating of fresh fruits (10 point scale)	Organoleptic rating on 6th day of storage (10 point scale)	spoilage (%) on 6th day of storage
Fruit weight (g)	-0.195	0.2516	0.2501	0.2316	-0.1673
Acidity (mg/100g)		-0.3745	-0.6181	-0.2083	-0.4290
T.S.S. (°Brix)			0.5971**	0.2384	0.1676
Organoleptic rating of fresh fruits (10 point scale)				0.7551**	0.2842
Organoleptic rating on 6th day of storage (10 point scale)					-0.2814

** significant at p= 0.01

EFFECT OF THE GLUCOSE SYRUP COATING ON THE QUALITY

OF THE TUNISIAN DATES DURING STORAGE

Achour M.[1], Hamdi S.[2] and Hamdi M.[1]

This work consists of simulating the coating of the Tunisian dates type Deglet Nour with the glucose syrup and studying its effect on the storage stability and the moisture equilibrium of these dates. The sorption isotherms of corresponding to the natural and coated dates have been experimentally established, compared and used to validate the appropriate theoretical adsorption models. The results have shown that in presence of a relative humidity above 50%, the hydration of the coated dates is less pronounced than that of the natural dates. Below 50% relative humidity, the natural dates have experienced a higher degree of dehydration. In both cases, the glucose syrup has played the role of a physical barrier to the water vapor. Such effect has been quantified for two types of Deglet Nour, dry and semi-dry. The experimentally established adsorption isotherms were compared and used to validate and characterize the B.E.T., G.A.B. and Henderson adsorption models over a wide range of a relative humidity. The validity of the BET model was found restricted to water activities below 0.5. The predictions from the other two models showed a great coherence with the experimentally generated data.

Additional Index Words: Isotherms, adsorption, BET model, GAB model, moisture content

INTRODUCTION

Tunisian dates, ranked third among the exported agricultural products, constitute an area of great expansion. The dates type Deglet Nour are of a high grade quality and a considerable commercial value; they constitute the main parts of the exports. In fact, this type of dates has covered over 40% of the European Union demands in dates (Utica, 1995). The high quality of such dates necessitates a good grasp and control of the conservation and storage techniques.

Moreover, when stored at some specific conditions, the dates could be subject to various quality degradation phenomena such as: crystallization sugar at the surface of the dates, drying of soft dates,

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hydration, fermentation or surface color change and biological alterations due to the development of micro-organisms.

Therefore, the choice of humidity and temperature conditions during storage becomes crucial and must be taken based on full knowledge of the equilibrium state between the storage ambient air and the moisture content of the dates. In order to overcome the degradation effects listed above, the usage of glucose syrup as a coating could prohibit or limit the extent of such degradation. Its presence at the surface constitutes an anti-crystallization effect (Gauthier, et al., 1978) and will certainly limit the mass transfer occurring between the air and the dates. Such limiting factor could be quantified through the establishment of the adsorption isotherms for the system (Cheftel and Chefteh 1976). These isotherms will determine the amount of water gained or lost by the dates stored at some specific conditions.

The goal behind this work is to master the conservation and the coating techniques of dates using the glucose syrup. The main objectives are to study: the sorption isotherms for natural and coated dates type Deglet Nour; the effect of glucose syrup coating on the moisture equilibrium of the dates; the comparative behavior of dry and semi-dry dates during storage and to validate the theoretical adsorption models applied to natural and treated dates.

MATERIALS AND METHODS

The experimental work is based on the establishment of the equilibrium between the dates and their storing atmosphere having a constant relative humidity. Such equilibrium is obtained by placing the samples in hermetically sealed containers at a specific temperature and maintaining a constant humidity through the experiment. Five different saturated salt solutions are chosen in order to maintain a constant ambient relative humidity at 25°C (table 1). These solutions allow to control and regulate the partial pressure of water vapor in the ambient air at saturation.

Table 1. Relative humidities of the saturated salt solutions at 25°C

Saturated Solution	Relative Humidity (%)
K_2SO_4	97.3
NaCl	75.2
$Na_2\ Cr_2\ O_7\ (2H_2O)$	53.9
K_2CO_3	43.2
$MgCL_2$ (6H2O)	33.0
NaOH	8.24

The samples of dates used are of the following type: Deglet Nour type Dry: moisture content is equal to 17.33 g/100 g dry matter (D.M.) and Deglet Nour type Semi-Dry: moisture content is equal to 18.67 g/100 g D.M.

These samples, previously picked and calibrated, are immersed in a 40% glucose syrup solution a 37% dextrose equivalent at a pH of 5.46. Samples of 60 grams of each type of dates both treated and natural are placed in the sealed containers having different constant relative humidity. The weight of each sample is followed as a function of time (each 5 days) until the weight becomes constant; and therefore the equilibrium state is achieved. The final moisture content of the samples are then determined and used to characterize the equilibrium state.

RESULTS AND DISCUSSION

Data processing and effect of the glucose syrup coating

The analysis of the crude experimental results (tables 2 and 3) shows that the moisture content of the dates increases with an increasing relative humidity of the ambient environment. Such phenomenon is also observed for treated dates both dry and semi-dry; this is due to the gradient of the vapor pressure present between the dates and the ambient atmosphere.

Table 2. Moisture content of semi-dry dates (in g/100 g. Dry Matter)

($X_i = 18.67$)

Relative Humidity (%)	Natural dates	Treated dates
8.24	6.00	8.01
33	11,43	12.11
43	16,43	17.17
53.9	20.19	18.88
75.9	21.59	18.89
97.3	26.49	22.20
100	38.25	32.61

Table 3. Moisture content of dry dates (in g/100 g. Dry Matter)

($X_i = 17.33$)

Relative Humidity (%)	Natural dates	Treated dates
8.24	5.24	8.75
33	7.17	10.97
43	13.39	14.38
53.9	19.02	17.96
75.9	19.61	18.21
97.3	26.18	21.31
100	31.60	24.65

The same results are presented in tables 4 and 5 in terms of gains (+) and losses (-) of water by the dates as a function of the storing environment. These tables facilitate the comprehension of the glucose syrup coating effects. The protective role of the coating against the hydration and the dehydration phenomena is illustrated through the comparison of columns 2 and 3 of each table. Containing a higher percentages of total and reducing sugar (Dawson, 1963), the semi-dry dates allow a higher affinity to water than the dry dates. As such, at high relative humidities the adsorption rates are in general higher for semi-dry dates than for the dry type.

Table 4. Hydration and (+) dehydration (-) percentages of semi-dry dates

Relative Humidity (%)	Natural dates	Treated dates
8.24	- 67.9	- 57.1
33	- 38.8	- 35.1
43	- 12.0	- 8.0
53.9	+ 8.1	+ 1.1
75.9	+ 15.6	+ 1.2
97.3	+ 41.9	+ 18.9
100	+ 104.9	+ 74.7

Table 5. Hydration (+) and dehydration (-) percentages of dry dates

Relative Humidity (%)	Natural dates	Treated dates
8.24	- 69.8	- 8.58
33	- 58.6	- 6.36
43	- 22.7	- 2.95
53.9	+ 9.3	+ 3.6
75.9	+ 13.2	+ 5.1
97.3	+ 51.1	+ 23.0
100	+ 82.3	+ 42.2

Following the coating process, the glucose syrup constitutes essentially the surface layer of the dates, which is directly exposed to the surrounding relative humidities. The behavior of the dates in terms of hydration and dehydration rates is influenced by the presence of the glucose layer, the ambient relative humidity and the initial moisture content of the dates. Taking into consideration all these criteria and based on the obtained results and the mass transfer principles, two phenomena have been ovserved:

First behavior: at high relative humidities (RH > 50%), the two types of dates are exposed to increasing hydration effects with an increasing relative humidity. However, the treated dates are subjected to a lower hydration rate due to the presence of the glucose layer playing a role of a physical barrier to water transfer from the air to the dates. The hydration phenomenon takes place in three steps:

i) water vapor transfer at equilibrium from the air to the surface of the dates

ii) water adsorption on the surface yielding to migration into the pores;

iii) internal water transfer by diffusion

Second phenomena: at low relative humidities (RH < 50%), both types of dates experience a decreasing dehydration rate with an increasing relative humidity. However, the treated dates are subject to a lower dehydration rate due to the following factors: the physical barrier provided by the glucose syrup against water vapor transfer and the lower moisture gradient present between the coated surface and the inside of the dates compared to the case of a bare surface. This lower gradient is caused by the affinity of the glucose syrup to water, therefore yielding to a higher moisture content at the coated surface than at the bare surface. In fact, the glucose syrup tends to dry within this relative humidity range.

Establishment of adsorption isotherms

The adsorption isotherms are defined as the graphical representation of the moisture content (MS) as a function of the water activity (AW) in a food product. The water activity is the ratio of the equilibrium vapor pressure and that corresponding to the pure liquid at the same temperature; it is simply equal to the relative humidity in equilibrium with the dates divided by 100. Figures 1 and 2 show the isotherms corresponding to the two types of the dates both natural and treated by the glucose syrup. The positive effect of the glucose coating is more pronounced in the case of the hydration than the dehydration due to the above explanation. Such isotherms are very useful in predicting the gain or loss of moisture of these types of dates during storage. Such information will allow to control this equilibrium behavior and therefore limit the deterioration of the dates quality in case of hydration (ex. multiplication of micro-organisms, etc.) or of dehydration (ex. migration of sugar to the surface, color change, etc.).

Figure 1. Adsorption Isotherms- Natural and treated Dry dates

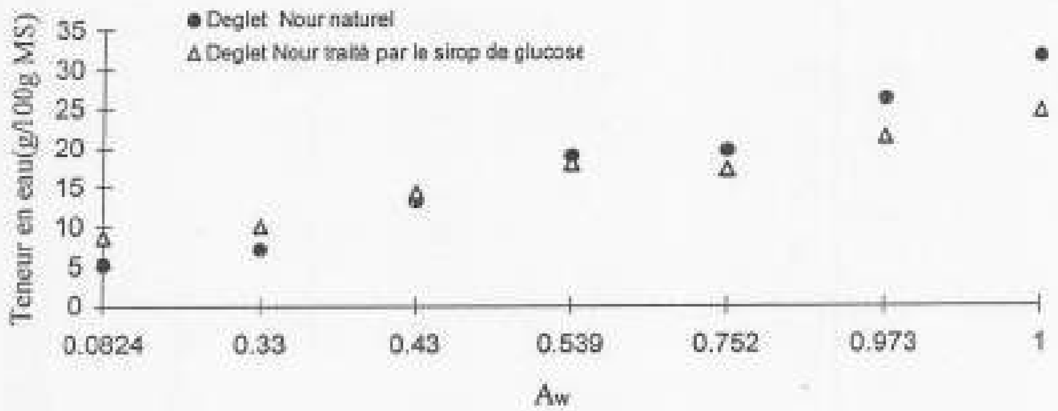
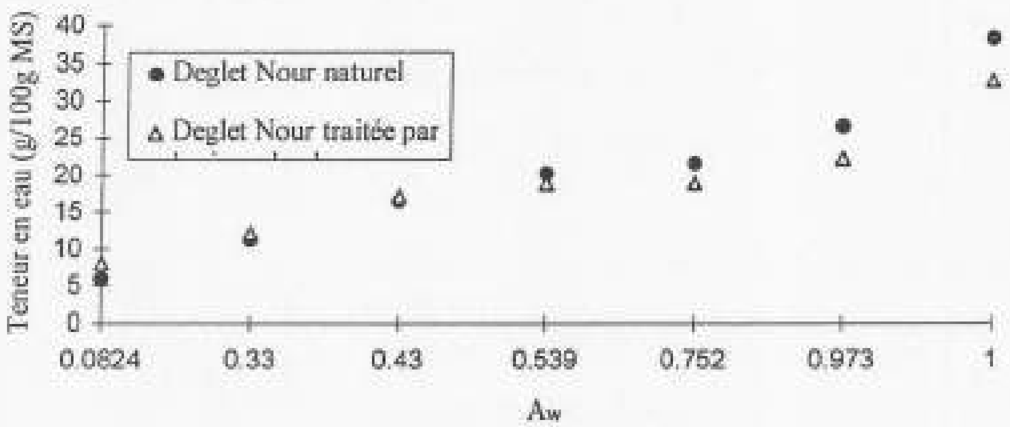


Figure 2. Adsorption Isotherms- Natural and treated Semi-dry dates



Theoretical sorption models

Using the experimentally established isotherms, several common theoretical sorption models are tested and validated for these types of dates in both natural and treated state. The more common models are those of BET, GAB and Henderson:

Brunauer Emet and Teller: $M = (M_0*C*A_w) / [(1-A_w)+(C-1)(1-A_w)A_w]$

Guggenheim Anderson de Boer: $M = (C*K*M_0*A_w) / [(1-K*A_w)(1 K*A_w+C*K*A_w)]$

Henderson : $A_w = 1-\exp(A*T*M^b)$

Where:

A_w............. water activity

M.............. water amount adsorbed at equilibrium (g/100 g. D.M.)

M_0............ water content corresponding to mono-molecular layer

A, B, C, K.. constants (specific to the models)

T............... absolute temperature in °K

These models are used to express the amount of water present in a food product as a function of its water activity. The models have been tested for the experimentally collected data of the equilibrium moisture content and the water activity. The BET model fits well except for activities higher than 0,5, whereas the GAB model is valid for the whole range of water activities. Once validated, the parameters of the various models have been determined and could be used to predict the amount of water gain or loss by stored dates in absence of adsorption isotherms. The following table presents such characterization:

Table 6. Characterization of the adsorption models of BET, GAB and Henderson for dry dates

Model	Parameters natural dates	Parameters treated dates
- B.E.T.	. M_0= 9.98 . C= 41.45 . R^2= 0.92	. M_0= 9.06 . C= 45.81 . R^2= 0.98
- G.A.B.	. M_0= 18.25 . C= 11.79 . K= 0.40 . R^2= 0.88	. M_0= 17.05 . C= 27.51 . K= 0.31 . R^2= 0.99
- Henderson	. A= -4.95×10^{-6} . b= 2.23 . R^2= 0.93	. A= -0.42×10^{-6} . b= 3.14 . R^2= 0.89

CONCLUSION

This experimental work has allowed to establish the adsorption isotherms of the Tunisian dates type Deglet Nour both natural and treated with the glucose syrup. These isotherms could be used to master and control the effects of storing conditions on the quality degradation of such dates during storage, in particular in terms of hydration and drying or dehydration phenomena. The comparison of the isotherms corresponding to the natural and treated dates has allowed to detect and quantify the protective role of the glucose syrup coating against gains and losses of moisture by the dates. The validation of the common theoretical sorption models has been performed using the experimental data. Their parameters have been estimated for the considered dates both natural and coated with the glucose syrup.

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PHOENIX DACTYLIFERA IN THE UNITED ARAB EMIRATES

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ABSTRACT

M.H. Otier, 1997. *Phoenix dactylifera* in the United Arab Emirates. Re-printed with permission. *Principes,* 41(1), pp. 29-35.

The United Arab Emirates was founded in 1971. At that time, there were about 1.5 million date palms in the region. Slightly more than two decades later, generous government subsidies and technical assistance to date palm farmers have enabled *Phoenix dactylifera* to proliferate to cat 18 million date palms. The U.A.E. government has an active agenda to increase the number of date palms in the region. Together with research projects that are in progress at the Ministry of Agriculture and other institutes, like the Faculty of Agricultural Sciences, United Arab Emirates University, the U.A.E. could soon become a global center for the cultivation and propagation of *Phoenix dactylifera.* This paper investigates the current status of date palms in the United Arab Emirates. A brief review of some of the research and projects that are in progress will be reviewed, such as: artificial pollination; basic date palm maintenance services that are provided by governmental entities; a cursory outline of The Date Palm Project and a review of clonal propagation techniques at the Al-Ain Date Palm Development Research Unit. This paper also explores ethno-cultural practices related to date palms. The ethno-cultural perspective gives a colorful portrayal of Al-Ain's marketplace, including the market trade of local date varieties and date palm inflorescence trade.

Additional Index Words

Khodrey, Sikkah, Khalas, Barhi, Khanazi, Khadravi, Sultana, Nabtat Saif, falaj, Pseudophilus testaceous, organogenesis, ethno-cultural, artificial pollination, The Date Palm Project.

INTRODUCTION

From the manicured date palm orchards among the golden hills of California to the oases in the Al-Hasa region of Saudi Arabia, *Phoenix dactylifera* has a well-established presence in traditional and hi-tech commercial settings. The United Arab Emirates is rapidly raising the degree of international recognition of this region as a future standard-bearer in the cultivation of *Phoenix dactylifera.* With particular zeal the U.A.E. is promoting higher quality date harvests via scientific research and aid to farmers.

The United Arab Emirates was founded in 1971. At that time, there were about 1.5 million date palms in the region. Slightly more than two decades later, generous government subsidies and technical assistance to date palm farmers have enabled *Phoenix dactylifera* to proliferate to ca. 18 million date palms (MAF 1994). The U.A.E. government has an active agenda to increase the number of date palms in the region. Together with research projects that are in progress at the Ministry of Agriculture and Fisheries and other institutes, the United Arab Emirates could soon become a global center for the cultivation and propagation of *Phoenix dactylifera.*

The trend in the U.A.E. is to modernize date palm operations, but some traditional sectors of date palm cultivation will remain intact. One domain is the conservation of water sources for irrigation by maintaining *falajes,* which are traditional and environmentally friendly irrigation systems. Another area is the preservation of some major oases, like the Al-Ain oasis in Abu Dhabi.

With a location of 55.5° longitude and 24.4° latitude, Al-Ain lies 165 kilometers inland from coastal Abu Dhabi, which is the capital of the United Arab Emirates. The area of Al-Ain borders Oman, and it is only a three-hour drive from the fringe of the expansive Rub Al-Khali desert, i.e. the Empty Quarter. The United Arab Emirates University's Faculty of Agricultural Sciences, which is the region's hub for research into the propagation and cultivation of *Phoenix dactylifera, is* also located in Al-Ain.

FALAJES AND OASES

Although Al-Ain has some *falajes,* its more mountainous neighbor, Oman, has a larger network of *falajal* irrigation. The typical sources of water for *falajes* are subterranean water tables from which water seeps to the surface along valley river beds and the rainwater reservoirs inside mountains. Horizontal drilling into a mountain accesses its water reserves and an irrigation system that may be several kilometers long is constructed to hydrate date plantations at lower levels by the gravity flow of the water. As long as rain replenishes the mountain's water reserves, the farmer always has a reliable water source.

In contrast, wells that have been established through vertical drilling require pumps to raise the water to the surface. In the long-term, pumps might extract water quicker than it can be naturally restored and lower the water table below the reach of the palm's tap root. Some of the abandoned date plantations are testimony to this event. Oman's government is keenly aware of the advantages of *falajes.* Consequently, the Ministry of Water and Electricity there maintains a few hundred *falajal* irrigation systems.

The Al-Ain oasis represents a site which operates in the same traditional manner as it has for centuries. Although urban development has encroached on this oasis of cultivated date palms, cat four square kilometers remain preserved. Its close proximity to the city offers the city dwellers who visit it a respite from the busy urban life. The oasis also presents visitors a glimpse into date palm cultivation and the idyllic lifestyle of the farmers who live there.

The residents of the oasis live in a seemingly planned community. Upon entering the oasis through a lintel-style gate, one finds a network of cobblestone roads meandering through the oasis which occasionally branch off to provide access lanes to the gates of privately owned date farms. Old-fashioned mud-brick walls line the roads and define farm boundaries. Sprawling palm fronds of five to ten-meter high date trees shade the road, which provide the pedestrians with a welcomed relief from the baking summer daytime temperatures that average 110-120° F.

The irrigation systems in the oasis not only supply water to the date palms, but they also provide local bathing areas. The dammed sections of the irrigation system create bathing pools that are accessible from the road. These discreetly located areas allow residents to cool or bathe themselves in clear, clean irrigation water. Although the inhabitants of the oasis lead a provincial lifestyle, their community is within walking distance of the city center.

AL-AIN MARKETPLACE & ETHNO-CULTURAL PRACTICES

Upon exiting the oasis, it is a mere five-minute walk to Al-Ain's most popular outside vegetable and fruit market. It is hardly surprising that besides the typical fare of fresh vegetables and fruit, dates are also available. Vendors offer an astonishing plethora of date varieties. Local Al-Ain favorites are Khalas, Barhi, Faradh, Raziz, and Shishi. Additional Emirati dates like Hilali, Khasab, Lulu and others are among the commercially available dates in the United Arab Emirates.

Not all the dates that are found in the market are locally grown. Consumer preference and targeted usage of the dates are factors that contribute to date imports. Certain preferred date varieties grow outside the Emirates. The Deglet Noor, which is a worldwide favorite, is primarily grown in Tunisia and Algeria. Moreover, climatic conditions outside the U.A.E. are more opportune for the cultivation of particular varieties. Usually, the U.A.E. has hot, humid summers. Most dates that are used in confectionery require dry summer weather. All of these factors contribute to annual date imports.

The date stalls at the market attract customers with enticing aromas and an array of colors which range from golden-yellow to chocolate-brown to red. And these dates are available for longer periods now. The use of naphthalene acetic acid to delay ripening and etheral to promote early ripening have extended the date season . Customers can buy dates in various stages of ripeness, which range from khalal to jubseh.

The date season begins with the arrival of fresh dates in the khalal stage at the marketplace. These yellow or rose-colored dates are crunchy and slightly astringent. The kimri stage precedes khalal, but these young, green-colored dates with their high tannin content are insufficiently mature to market. In the next two stages of ripeness, i.e. rutab and tamar, the Khalas date is the Emirate's favorite. This translucent-amber to chocolate-colored date with its ample, soft flesh and small pit is the queen of Emirati dates. The Khalas is best enjoyed with a cup of coffee and it is often offered to hotel guests at the reception desk. Typically, rutab dates are brown or black and are fully-ripened dates. Amazingly, some varieties, like Barhi, can simultaneously share the rutab and khalal stage. This results in a date that is half-brown and half-yellow with a respective sweet and astringent taste. Tamar represents an advanced stage of ripeness; similar to the raisin-state of a grape. A reduced moisture content of 15-20% in this stage concentrates minerals and vitamins. Customers have preferences for particular dates at a certain stage in ripeness and they must be familiar with them since different dates vary in the time they remain in a stage or skip certain stages of ripeness altogether (FAO 1962).

In the jubseh stage, which is colloquially known as "balah jaff" in the Emirates, the date is mummified and has a sandy-beige color. "Concentrated sweetness" best describes the gustatory experience of eating one of these dates. The word "jubseh" is derived from the Arabic word for gypsum. True to its etymological source, it is rock-hard. Dates in this stage can be eaten dry or soaked in water first to soften them. Eating a date in the jubseh stage is reminiscent of the jarring experience of eating jaw-breaker candy. In Saudi Arabia, jubseh dates are selected based on their city of origin, like jubseh Medina or jubseh Najran.

Jubseh dates are especially rich in minerals and are the Arab equivalents to hi-energy bars. Portable and nutritious, jubseh dates quickly restore nutrients that are lost during the performance of physically demanding activities. Women sometimes eat jubseh or other dates to replenish their strength following childbirth. Jubseh dates are also valued since they can be stored for years and serve as a valuable source of nutrients when the date season has passed. The date stalls at Al-Ain's outside market offer a plentiful variety of dates to satisfy customers' preferences. Certainly, the flurry of activity of vendors and buyers negotiating purchases reflects the importance of dates as a food staple in the Emirates.

Each year, between mid-February and early April, farm workers set up stalls beside the date vendors to enjoy some brisk business with the trade of male date palm inflorescences. In addition to customers who visit the stalls to purchase inflorescences for pollinating date palms, some residents visit the stalls to indulge themselves in a seasonal treat. Men will occasionally crumble an inflorescence and mix it with crushed, dried fish which are also available from nearby vendors. They eat this concoction and purport to benefit from increased energy and a strengthened libido. Dr. Haffar, Associate Professor of Agricultural Engineering at the United Arab University's Faculty of Agricultural Sciences in Al-Ain, readily shared his insight into these local practices and other facets of the inflorescence trade. He frequents the vegetable market at this time of year to collect specimens of inflorescences for his pollen research at the university.

Residents who have their own date gardens and local farmers often require a source of pollen. The inflorescence trade at the market helps to satisfy this demand. Date farm workers begin to inspect spathes of inflorescences from male trees soon after sunrise. The spathes must be harvested before they open. Upon opening, they release a burst of pollen which benefits nearby female date trees, but renders them useless for the inflorescence trade at the market. The workers test the spathes for ripeness by squeezing the end of the spathe. When the tip crackles this indicates the spathe will swell and open later in the afternoon and is ready to be collected for the morning market. By seven or eight a.m., the inflorescence traders are at the marketplace. To display the closed bunches of flowers for inspection, the vendors make length-wise, parallel cuts down the spathe, back this wooden tab of spathe. Besides scrutinizing the condition of the closed flowers, the prospective buyers also smell the inflorescence to detect the particular aroma that indicates a fresh, ripe inflorescence. The inflorescence trade concludes by eleven o'clock in the morning. The farmers require sufficient time to return to their date palm orchards and pollinate before the flowers fully open and eject their pollen. Although the market provides a limited supply of pollen, the general demand for pollen has risen so greatly that alternative sources of viable pollen are necessary to sustain the increase of date production in the region.

ARTIFICIAL POLLINATION

Pollen collection has emerged as a significant element in establishing pollen reserves, especially for use in artificial pollination. The Ministry of Agriculture and Fisheries has established Pollen Extraction and Distribution Centers in the United Arab Emirates with its main lab for date palms located in Hamraniyyah, in the Emirate of Ras Al-Khaima. These facilities collect, store and distribute pollen to farmers.

Khodrey and *Sikkah* are the typical male offshoots of date palms in the U.A.E. whose inflorescences are used as a main source of pollen. Vacuum collectors and vibratory shaking methods are used for pollen extraction, although the latter is more predominant. In the vibratory shaking process, the spathe covering the inflorescence is removed and the inflorescence is hanged to dry for 2-3 days in humidity and temperature controlled open rooms. Afterwards, the inflorescences are placed inside a vibrating shaker for pollen extraction.

The vibrating shaker generally yields 10-20 grams of pollen per inflorescence, depending on the cultivar. One "super" spathe Dr. Haffar viewed during a visit to a local farm weighed eight kilograms. This mega-inflorescence had the potential to produce 40 grams of pollen which would have been sufficient to pollinate 25-30 date bunches.

The drying time of the flowers along with the intensity and duration of vibratory shaking all influence the optimum extraction of pollen. Since increased moisture holds pollen grains together and requires a longer shaking period, properly dried flowers more readily release their pollen. On the other hand, prolonged shaking of adequately dried flowers causes too much debris, e.g. bits of inflorescence, to mix with the pollen which reduces the amount of usable pollen.

Staff members from the U.A.E. University's Faculty of Agricultural Sciences have conducted experiments to investigate the most suitable combination of drying time of the flowers, together with the intensity and duration of vibratory shaking to maximize pollen extraction from a number of date palm cultivars (Haffar, et al 1995. Vibratory Date Palm Pollen Collection in Relation to Variety and Mechanical Extraction Variables. Paper presented at the International Symposium on Date Palm Cultivation and Oasis Agriculture in Mediterranean Countries. Elche, Spain.). This university team's research is contributing significantly to making vibratory shaking an effective means of pollen extraction. A readily available source of pollen will enhance mechanized pollination and help increase date production in the United Arab Emirates.

Since the number of date palms has greatly increased, there is an insufficient pool of skilled workers to manually pollinate the date palms. The Ministry of Agriculture and Fisheries and the U.A.E. University's Faculty of Agricultural Sciences have worked intensively to develop and improve mechanized means of pollination. As a result, hand dusters are available to pollinate palms 4-5 meters high, while power dusters can be used for date palms up to ten meters. Maximum efficiency in pollinating the date palms is attained by dusting them 3-6 times with a mixture of fresh pollen and free-flowing wheat flour at a ratio of 1:10. Mechanized pollen extraction and pollination are a few components of a national program for integrated date palm mechanization systems.

DATE PALM MAINTENANCE AND RESEARCH

The Ministry of Agriculture and Fisheries, each Emirate's Department of Agriculture and municipalities promote date cultivation by providing a core of basic services that range from land preparation which includes sand dune removal and land leveling, to crop establishment, harvesting, post-harvest management and crop maintenance/management. Pest control, which lies within the rubric of crop management, offers some challenges in maintaining the health of *Phoenix dactylifera.* The most obvious damage by an especially harmful pest can be readily observed during a walk through the local oases. Date palm trunks with round, insect-emergence holes, which appear to have been excavated by ravenous woodpeckers, are telltale signs of the palm-stem borer, *Pseudophilus testaceous* (FAO 1982). This beetle is one of the primary pests in this region that can have an adverse impact on the cultivation of *Phoenix dactylifera.* Researchers at the U.A.E. University are investigating pest control and numerous other issues which are related to the cultivation and propagation of *Phoenix dactylifera* in the United Arab Emirates.

The U.A.E. University's support of research in the cultivation of *Phoenix dactylifera is* highlighted by a generous grant it awarded to the Faculty of Agricultural Sciences for The Date Palm Project. This U.S. $160,000 grant is being allocated over four years to advance research into a myriad of projects, such as: using dates as animal feed for camels and fish; date palm protection from disease and pests; utilizing dates to manufacture jam and syrup; studying the water requirements of date palms; and investigating cultural practices and production issues of

Phoenix dactylifera, which range from the effect of low temperature on the storage capability of dates to chemical fertilization and its effect on the productivity and fruit characteristics of date palm cultivars. The holistic benefit from the research that is conducted in The Date Palm Project should be reflected in an economically efficient approach to improving the cultivation/propagation of *Phoenix dactylifera* and the increased productivity of date palms.

The Ministry of Agriculture and Fisheries has also mobilized its resources to promote date palm propagation. In 1989, the Ministry of Agriculture and Fisheries in collaboration with the U.A.E. University established the Al-Ain Date Palm Development Research Unit. Originally, the Tissue Culture Laboratory there had the capacity to produce 120,000 date palm plantlets per year. As a result of their success in tissue culture technique and the rising demand for vast quantities of superior date palm cultivars throughout the Emirates, the facilities were expanded in 1994, and currently have the lab capacity to propagate 1,000,000 plantlets, annually.

Clonal propagation at the tissue culture lab is performed by organogenesis (Rhiss et al. 1979, and Almai 1977, Poulain et al. 1979 a.). This method of propagation, which has the benefit of producing mutation-free clones, has become the preferred date palm tissue culture method in the Emirates. Primarily, the date palm tissue culture lab propagates popular cultivars, such as Khalas, Barhi, Khanazi, Khadravi and even Sultana and Nabtat Saif, which are elite cultivars from Saudi Arabia.

Dr. Rhiss, Director of the Date Palm Development Research Unit, recently gave the author a tour of the tissue culture lab and reviewed the stages of clonal propagation by organogenesis. The explants that are cultured in organogenesis are obtained from the date palm heart. Then, the palm heart is dissected and the apical tip and surrounding tissue are cut into 20-30 sections of $2mm^3$. These explants are cultured in vitro in a solid medium that contains nutrients and growth hormones that are modified for each particular stage in the process. In the first stage, which occurs in a dark room, the sections of explant are cultured to produce and multiply organogenesitic tissue. This initial step takes 8-12 months, depending on the cultivar. Not all of the explants produce tissue and these are discarded.

Stages two through four take place in fluorescent-lighted and temperature-controlled growth chambers, which are maintained at 28°-30°C. Stage two, and each subsequent stage, takes one month to complete. In the second stage, the organogenesitic tissue is cultivated to produce and multiply buds. The tissue that is cultured from the initial 20-30 sections is sufficient to produce 10,000 buds. With a 2.5x rate of multiplication, these buds, in turn, will multiply to 25,000 buds. Generally, 15,000 of these buds continue to stage three, while 10,000 buds are retained for additional multiplication. Surprisingly, as long as the nutrients and growth hormones are replenished each month, the buds can be used to reproduce for as long as five years.

Bud elongation occurs in stage three. When the buds elongate to 10-12 cm., they are ready for stage four, which results in root formation. Upon completion of this final stage in the lab, the combined length of the root and leaf is cat 14 cm. and the plantlets are ready to be transplanted. Acclimatization of the newly transplanted plantlets follows in growth tunnels, which are regulated to provide an environment with 80% humidity and a temperature of 28°-30°C. After one month, the plantlets are transferred to a humidity-controlled greenhouse. Once the plantlets have acclimatized, their cultivation can continue outside.

Presently, the national rate of date consumption in the U.A.E. has outstripped the country's resources of date palms to satisfy it. The Al-Ain Tissue Culture Laboratory is a good example of the country's effort to increase its stock of date palms. In the future, clonal propagation of premium cultivars should help meet the consumers' demand for this food staple.

DISCUSSION

Since its founding twenty-five years ago, the U.A.E. has made noteworthy progress in the areas of date palm research, technology transfer to farmers and date palm propagation and cultivation. The international date palm community should surely benefit from the corpus of scientific information that will be generated from ongoing projects. In the near future, the United Arab Emirates could very well position itself to become a worldwide center for the cultivation and propagation of *Phoenix dactylifera* .

ACKNOWLEDGMENTS

The author would like to thank Dr. Imad Haffar and Dr. Hameed Al-Juburi at the U.A.E. University's Faculty of Agricultural Sciences for sharing their research and personal experiences with *Phoenix dactylifera.* Appreciation is also extended to Dr. Ali Rhiss for the tour of the Al-Ain Tissue Culture Laboratory and his comments on organogenesis.

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Production and Protection of Date Palms in Sudan

By

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ABSTRACT

Date palm is still grown in Sudan at a conventional method without attention to irrigation, fertilization, or other cultivation practices.

Date palm is vulnerable to attack by variety of pests, mainly the date palm green scale insect asterolecanium phoenicis (Rao), the termite odontotermis classicus (sjostedt), the white scale parlatoria blanchardii Targ. Occasionally date palms are being infested by the mite obligonychus paratinsis banks, greater date moth arenipsis sabella hampsim, store pests such as the raisin moth ephestia sp., the saw green beetle oryzaephilus surinamensis L. other vertebrates birds such as house sparrow passer domesticus arbreus, and bulbul pycnonotus brbatus arsionoe, and rats namely Nile rat Arvicanthis nilotica, house mouse Mus musculus, roof rat Rattus rattus, multimammate rat Mastomys natalensis, and Gerbils Tetera robusta.

Survey in the Northern State has shown manifestation of various plant diseases on date palms such as false Bayoud, slow decline and white tip die back. Virus or virus like symptoms were encountered. But the causal organism not yet accurately know. Mycoflora of date palm was determined, fungi associated with some pathological symptoms were defined as fusarium moniliforme, Mauginiella scaette, Thiolaviopsis paradoxa, Aspergillus sp. And Helminthosporium sp., Some species of plant parasitic nematodes were extracted from soil taken from plant rhizosphere. Bustard head or physiological disorders were observed.

Insect pests are always controlled through integrated pest management starting with cultural practices or sanitary measures, supplemented with chemical control and other natural enemies together with plant quarantine legislations.

1. Introduction:

The date palm, *Phoenix dactylifera* L., is cultivated in the Northern State along the banks of the River Nile over a distance of about 700 Kms. The total number of trees is in the order of five to seven million. The date is the most important agricultural crop in the area and provides food and income to the majority of the inhabitants. It ranks first among all the crops due to its high nutritional and economic value. The annual income of the dates is estimated to be around $ 200 million in the Northern, and Nile States, representing not less than 26% and 20% respectively, of the total agricultural income, respectively.

As far as date industry is concerned it is known that most varieties are of dry types not relevant for international competition. Only a native alcoholic beverages are made of fruits.

As by products also woods are made of stems, and fronds are widely used for thatching, buildings, braiding and basketry (Household utensils).

2. Agronomy:

Varieties Grown and Their Geographical Distribution:

Through the years and as result of practicing the date palm production in the Northern province we came to develop good quality dates which are being handled from generation to another. Out of the total amounts of dates produced in the Northern region about 75% are dry dates, the other 25% soft or semi dry. This encouraged by the hot and dry spells during the summer period which encourages dry dates production (May to September). Thus dry dates produced are characterized by their high stability and can withstand varied techniques of handling and packing with minimum losses or damages.

The varieties grown include local names:

Dry Dates	**Soft Dates**
BARAKAWI	MISHRIG/WAD LAGGAI Nile province.
GONDALLA	MISHRIG/WAD KHATEEB,
BIT TAMOUD	MEDINA.

KULMA	DIGLAT Nour.
ABDELRAHIM	JAW/Nile Province & Khartoum.
TUNISI	GORAIR (North Province).
JAW	Northern Region,

It is uncertain whether the Sudanese date cultivars originated endogenously or were introduced as such; however, it is most likely that Barakawi, Gondaila, and Tamoda originated within the geographical zone covering Southern Egypt and Northern Sudan. Other cultivars such as Mishrig Wad Khateeb, Mishrig Wad Lagai and Gorair are of indigenous origin, where as Medina as the name indicates might have been introduced from Saudi Arabia, and Tunisi from Tunisia.

Yield:

The total production of dry and soft dates is not exactly known, but a figure of about 182000 Tons of annual production is normally encountered in the literature with an average of 26-30 Kilograms per tree which is very low. However in areas where good cultural practices prevail, the average per tree jumps up to 100 kilograms per tree.

Selection and Breed:

There is nothing particular to report, however this is subject to like and dislike or other criteria of favourite taste of pomaceous fruit.

Propagation Technologies:

Date palm propagation is chiefly achieved through seeds or offshoots and airlayering (offshoots rooting), and tissue culture. The later is still at its infancy stage, since it needs special trained calibre.

Few farmers tend to raise seedlings of date palms from seeds because this practice results in new and heterogenous varieties known collectively as, JAW. Very few of these Jaw varieties prove themselves as bearers of good quality dates. Generally the method is very limited and very unpopular. In this case, seeds are planted in a nursery or in the field, with sev6ral seeds per hole, but more commonly they are allowed to develop to the flowering stage. At this time any male trees may be removed.

Regarding offshoots and airlayering, it is perfectly recognized that most date palm cultivars tend to bear some offshoots at the base of the trunks above soil level. Offshoots are being cut at suitable size from the parent plant and directly planted in the soil, but owing to the poor survival rate, they are encouraged to root while still attached to the parent palm by surrounding the bases of offshoots with damp soil in a bottomless container (Empty Kerosene tin), After root formation, the offshoots are excised from the parent palm and planted out. Planting of already rooted offshoots greatly increases the survival of the young date palm replants.

Both seedlings and offshoots are used to fill spacing in existiny plantations or to establish new plantations. Offshoots method produces palms of exactly the same genetic constitution as their parents, and it is the preferred method of propagating quality cash crop varieties.

Spacing:

Formerly offshoots cut from the parent palm or seedlings from seeds are usually planted 3-4 meters apart, with one male for every 50 female trees.

Irrigation:.

The young palms are irrigated initially fortnightly, then monthly for 1-2 years until establishment. On the banks of the Nile irrigation is seldom continued for more than tow years, but further inland, several irrigations per year are provided for the first ten years, On the upper terraces, monthly irrigation may be required throughout the life of the palm.

Intercropping:

Farmers intercrop young palm with bean, alfalfa, vegetables, herbs, spices, condiments and other crops ensuring that the palms receive some irrigation, fertilization and additional nitrogen from leguminous plants,

Intercropping ceases after 3-10 years and the palms receive little further attention. Irrigation is minimal, no fertilizer is applied and offshoots are allowed to grow unchecked, resulting in multi-stemmed palms.

Pollination:

The date palms is dioecious, bearing male and female flowers on different palms. The growers climb the trees during the flowering season to carry pollen by hand from male to the female. No mechanical method is applied such as hand operated machine from ground level. Artificial pollination is effected by collecting male spathes before they burst or shortly after wards, One to four male strands are made into small bundles and each inserted into female inflorescence. If dry pollen is to be used it is normally dusted on cotton balls which are then placed in the center of the female cluster in the same manner. Pollens are selected from males blooming at about the same time with the females to provide fresh pollen in order to get successful fruit setting.

The pollination is usually made early in the morning as soon as the first break in the spathe is observed. Storage of pollen or the practice of keeping pollen from one year to another is not practised in the Sudan. On selecting a male palm the only character of significance is the number of inflorescence produced by a male plant.

Bunch Management:

To obtain good quality fruits, care has to be taken for the bunches during all their developing stage, to protect them against hazards such as extreme, low or high temperatures, rain, insects, or birds. But in Sudan very little attention is given to bunch management. This usually results in sizable losses and lowering of fruit quality.

Fruit Thinning:

This is the practice of removing some of the fruits for the purpose of improving the quality of the rest and the productivity of the tree in general. In most countries where commercial date culture is well developed some kind of fruit thinning is normally practised, But in Sudan, thinning is not practised. Preliminary findings at Hudeiba research station in Northern Province showed that thinning is necessary in many cultivars to avoid alternate bearing, Unthinned bunches of Zaglul and Madina some times shrivel and dry out.

Generally speaking, it is reasonable to say that palms are of major socioeconomic and social importance in the Northern State, but date palm is still grown in Sudan at a convential method without attention to irrigation, fertilization, or other cultivation practices. It becomes clear that date palm production and plantations considerably deteriorated in the last decade of this century. Fluctuation in climatical and environmental conditions had its role in spread of insect pests and plant diseases. Consequently, these factors contributed to poor yield and low productivity of palms in the Northern Province of Sudan.

3. Major Posts (Subject to Control Programme):

Arthopod posts:

One of the most serious problems facing date palm production in the Northern Province is the infestation by pests listed below.

A- Green Scale Insect (*Asterolocanium phoonicis* Rao):

Homoptera : Coccidae,

This insect was introduced about 10 years ago in Golid area through illegal importation of one infested offshoot from Saudia Arabia. Because of lack of natural biological control agents in Sudan, it assumed serious pest status.

Extension of Infestation and Development:

To date the infestation encompasses about 4500 ha (i.e. 40000 trees and 200 000 offshoots and young trees) in Golid area. However, it might have managed to infiltrate to small spots elsewhere, inspite of the strict plant quarantine measures.

Injury of Economic Implication:

The insect attacks the leaflets, leaf rachis and fruits. It causes chlorosis, degeneration of the leaves, malformation of fruits before maturity, and leading to losses in productivity from 26-30 Kg. to 5 Kg. per tree, Death of trees occurs in the end.

Control:

Studies have been conducted on the biology and population development of the pest, its seasonal abundance, susceptibility of date palm varieties, losses caused by the pest, and on control method.

An eradication program was attempted based on pruning, local quarantine, and both aerial and ground insecticide application.

Insecticide applied, at volumes 100 litres of water, were Diazinone 60 EC (340 ml), Roger 32% EC (225 ml), and Folimat 80% (200 ml); each including 2 litres of 80% Albolinium summer oil. A 96.4 control rate was achieved, thus lowering the infestation within the targeted area drastically to 3.6% and ended nearly in curtailing apparently its infiltration outside the hot area. The infestation had flared back to more than 50 % in less than one year.

We feel certain that eradication of insect was doomed to failure. Attempts to locate a biological control agent are in progress.

B- Termites or white ants particularly the species *Odonotezmes classicus* (Sjostedt):

Isoptera: Termitidae,

Termite damage to date palms in the Northern Region of Sudan has been recorded since the 1920s and has been recognized as a serious problem by several authorities (Harris, 1958; Schmutterer, 1969; Wood & Kambal, 1984; Logan & Bakri, 1990). The united states Department of Agriculture (1962, 1963) reported that 60% of date palms in Northern Sudan were attacked and that 35% were seriously affected. Wood and Kambal(1984) found up to 100% of trees in a plantation attacked and estimated an annual loss of 1-2% of trees.

Odonote.rmes classicus mostly observed in all parts of the Northern province. Termites primarily attacks the dry plant parts which include the fibre and the leaf axis, This infestation usually starts from the soil surface and goes as high as 20-30 feet along the stems of some palms (Nixon, 1967). Severe termite infestation may gradually weaken the stem and result in complete destruction,

Control:

It was recommended by Nixon (1967) that old leaf should be cut out close to the trunk at least four or five feet above the ground.

With regards to chemical control it has been practised in very small and confined area using Dildrin and Chlordane which are banned and no longer recommended due to the hazards which they present to both environment and human health, So investigation into an appropriate cost effective measures are required.

Marshal suscon 10g. and Furidan 5g. now under trial. First results proved to be promising, but more trials have to be conducted before release,

Natural Enemies:

After leaving the nests the winged forms are preyed on by lizards, frogs, birds, bats and certain other animals, Among the insects several ant species e,g, *oecophylla longinoda* (Latr) and *Paltothy.reus tarsatus* (F) are most effective predators.

C- White Date Scale, *Parlatoria blanchardii* (Targ):

Homoptera: Diaspididae.

Parlatoria date scale is found wherever date palm is grown in Sudan. But it causes severe damage in the southern parts of the Northern province and in the Nile province.

It mainly infests the leaves, and damage occurs from the nymph sucking action which may finally be all covered with white scalesr and the leaves dry out. In heavy outbreaks, fruits may be attacked and fall off before maturity.

Varietal Resistance:

According to Mohamed (1991), varietal susceptibility experiments showed that Mishrig and Gondaila were the most susceptible varieties. The infestation on the varieties Brakawi and Jaw were moderate, and on Tamoda was the least affected variety.

Control:

Some work has been carried out by Siddig (1975). He reported that removal of infested lower leaves of date palm was found to be an effective means of decreasing infestation of the insect. Spraying with petroleum oil plus Dimethoate (Roger) also resulted in significant control.

Natural Enemies:

Recent survey in Northern province has proved that populations of *Parlatoria blancharidii* (Targ). Are normally kept at tolerable levels by indigenous natural enemies such as larvae and adults of a brownish lady bird *Pharosscymnus sp,* (coccinellidae), *Cybocephalus dudiclri* (Nititulidae), *Crysoperla carnea* (Chrysopidae), *Archenomus arabicus* (Aphelmidae), and some unidentified mites.

An introduced predator, lady bird, *Chilocorves bipusrulatus var. irgnsis* author was applied also to control the pest but with little success due to unsuitability of climatical conditions or some other ecological reasons.

4. Minor Pests (Not Subject to Control Programmes):

A- Store Pest:

The raisin or stone moth *Ephestia sp,:* Lepidoptera.

The saw grain beetle *Coleoptenu oryzaephilus surinamensis L*

According to winter (1955), the infestation of store pests sets in shortly after harvest and by the following year as much as 50 percent of the stored dates are completely destroyed and the remainder are hardly fit for consumption.

Control:

Dates are protected by early harvest, clean Packing, never avoidance of mixing of the fruit drops with any harvest, and immediate fumigation. Fumigation is usually effective by use of phostoxin tablets.

B- Date mites *(Ob2igonychus pratensis* **Banks):**

The date mite is observed on palm all over the country. Occasionally serious damages are found in palm under close spacing at or where mixed plantings with citruses or mangoes.

The mite usually feeds on the fruit at kalal and rutab stages resulting in a rough silvery surfaces. Severe infested fruits stop expanding and do not mature properly.

Control:

Dusting with sulphur towards the end of May or the first week in June is recommended.

C- Greater Date Moth (*Arenipses sabella* **Hampsim**):

Lopidoptera: Pyralidae.

Few incidence were reported from Gorair area in the Northern Province. The insect was controlled by dusting with Sevin 85% successfully, Dusting carried out on tops of trees during flowering and very early after setting while dates are green mature.

5. Vertebrates:

It includes frugivorous birds and rats.

A- Frugivorous Birds:

House sparrow, *Passer riomesticus arbrous.*

White vented bulbul ***Pycnonotus barbatus arsinoe*** **(Light).**

Passeriformes: Pycnonotidae.

These species feed on sweet fruits in many shady gardens and causing nuisance and some damage, It is controlled by protection of ripening fruits by bags made of muslin or cloth, early picking and destruction of the rest and fledglings to reduce their populations or by traps.

B- <u>Rats</u>:

Nile rat *Arvicanthis niloticus*

White bellied house mouse (um sis), *Mus musculus*.

Roof Rat: *Rattus rattus rodentia*: Muridae.

Occasionally they reach importance as crop pests and cause considerable damages in the stores.

They are chemically controlled by use of anticoagulant rodenticide, such as Killrat, Storm and Racomin.

Multimammate rat, *Mastomes natalensis:*

Geribils (garbouh), *Totera robusta*:

These species together with Nile rat are found in the fields and some times are encountered in orchards climbing date palm trees.

Control of these rats is carried out by baiting. The baits consists of crushed sorghum as a carrier to which a rat poison is added with adhesive. The common rodenticide used is Zinc Phosphide. Baits are prepared at the rate of 1% one Kg Zink Phosphide + lKg food oil + 98 **Kg** crushed sorghum,

6. Plant Diseases Situation:

Up to present time little has been formally published regarding diseases of the date palm in Sudan. In 1987 survey of date palm diseases was conducted by the Plant Pathology Department of the Plant Protection Directorate - Khartoum North. Then another survey was done jointly with the help of FAO expert with same Department.

Survey revealed the presence of the following diseases along the banks of the Nile, between Dongla, Marawi and Karima.

False Bayoud:

Similar symptoms to Bayoud disease (False Bayoud) is whitening of the middle crown leaves, most of leaves take the albino white colour while the rachis of affected frond remains green. This phenomenon occurred sporadically in some locations.

Slow Decline:

The disease is characterized by yellowing followed by drying and death of leaflets tips. Pineae die at the tips of leaves and tips of pineae die along the rachis for about 1/2 - 2/3 length from outer and giving a palm a ragged appearance. White chlorotic or brown streaks frequently extended longitudinally down side of rachis. The disease is dominant all over the region and most serious because it is lethal.

White Tip Die Back:

This might be pattern of slow decline.

Bustard Head, Deformed Reduced Green Leaves:

The causal organism for these diseases not yet verified because Koch's postulates have not been fulfilled. However investigation at Rothamstead Research Laboratory in the U. K.

Showed particles of virus-like organism (Mycoplasma) for both slow decline and white tip die back, It has been assumed to be particles similar to what found in yellow disease of coconut.

Mycoflora of Date Palm:

Simultaneously, mycoflora of date palm was determined in Northern State of Sudan. Fungi associated with some pathological symptoms were defined as follows:

1.	*Fusarium moniliforme*	Known to	cause inflorescence rot.
2.	*Mauginiella scaette*	Known to	cause inflorescence rot.
3.	*Thiolaviopsis paradoxa*	Known to	cause Majnon disease.
4,	*Aspergillus sp.*	Known to	causefruit rot.
5.	*Alte-rnaria sp.*	Known to	cause fruit rot.
6.	*Helminthospor-ium sp.*	Known to	cause fruit rot.

Viral Symptoms:

A viral symptoms, Fletrissment occurring in Tunisia was suspected to be prevalent in Sudan in some places in the Northern Province.

Nematodes:

Eight genera of plant parasitic nematodes were extracted from the soil taken from the palm rhizosphere. These were: *Psilenchus sp., Tylenchus sp., Tylenchorynchus sp., Paratylenchus sp., Tylenchulus semipenetrans, Trichodorus SP., Longidorus sp., Xiphinema sp.*

The later three nematodes are well known to be vectors of plant viruses. In views of the above, further research should be taken into account.

7. Environmental and Agronomic Conditions Enhancing Pests Development:

It should be noted that date palm grown was impaired by close spacing, lack of proper and regular pruning, nonfertilization, improper irrigation, water stress and water logging. This was due to drought spells which wiped out the region early in 1980 's followed by effects of flooding for prolonged time (1-2 month in 1985-1988-199) and this might have changed the ecosystem of plant growth and rendered them to be sensitive to different pests and diseases as appeared now.

8. Integrated production & Protection:

Extension materials are inadequate. Financial support is a handicap at the present time to launch any program for integrated production and protection in date palm. Perhaps with assistance of some internationl organizations we can bridge this gap. Still there is lack in qualified staff in agronomy and extension services. We recognize the need to update our staff on the latest technologies of integrated pest management and other agricultural sciences soonest.

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PRESENT STATUS AND FUTURE PROSPECTS OF DATES AND DATES PALM INDUSTRIES IN SAUDI ARABIA

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ABSTRACT

The paper highlights the present status of the dates business, in terms of industry structure and its attractiveness. Problems encountered by the various modern packaging and processing plants were summarized. Hindrances related to plant machinery and the special nature of the date fruit were given. Future prospects of dates and date palm industries in the Kingdom of Saudi Arabia and the role of government in setting strategies and incentives for the development and promotion of the dates and date palm industries have been also included. Strategic option to generate high profit revenues by these plant have been recommended. Such strategies include the importance for these industries to attain cost leadership through high production volume, competitive sourcing of raw materials, marketing differentiation by branding, advertising, good distribution and continuous market research. Supplementation of the existing plants with downstream products to avoid the seasonality of dates in the market by manufacturing dates derivatives round the year were also advised. Products including date paste, date syrup and vinegar were recommended. Promising technologies for utilization of dates palm residues such as arabesque manufacture from palm fronds, paper pulp industries and cottage industries e.g. handicrafts for rural development have been included. For

efficient utilization of research findings, the study finally illustrates the importance of cooperation and coordination of the existing date processing plants with research centers and universities involved in conducting research on various aspects of dates processing and date palm residues.

1- Introduction

Dates are reckoned to be the most oldest fruit tree and important crop in Saudi Arabia. They have been the main food in the past and are widely considered to be strategic source of food security. The tree, as described in the Holy Quraan, is a blessed plant having its roots in the earth and its branches in the skies.. It has been said about dates that they are food for the poor, sweets for the rich and food that a traveler packs for his trips (Zad). They are healthy and regarded as high energy food and basic raw material for many food products. Dates contain most of the dietary elements essential for the human body in the form of easily digested Sugars, mainly glucose and fructose, Proteins, Fats and considered to be a good source of minerals. Medical research has linked regular dates eating by Bedouins with low level of cancer cases. No wonder it is called the "Heaven's Fruit" and a source of good health and wealth to those who consume it and grow it.

In Saudi Arabia, although socio-economic changes had a negative effect on traditional date palm cultivation, it did not lead to a gradual disappearance of the date palm. On the contrary, the country's progress created the impetus and means to find new ways to adapt modern techniques in agricultural practices, quality standards and processing methods. Presently, date palm development is a governmental concern, while projects implementation a concern of the private sector. Ambitious expansion development programmes for new date palm plantation are in progress. The overall picture is now a continuous new endeavor aimed at improving the date growing areas through introduction of labor savings methods in cultivation and modern irrigation system, improved packaging, industrialization of dates and diversification of date palm products by better utilization of ligno-cellulusic residues of the palm tree.

2- Dates palm production

According to FAO statistics[1], the total world production of dates during 1996 touched a new record of 4,492,000 tons with almost 21.4% production growth since 1991 (Figure-1). The Kingdom of Saudi Arabia is ranked as third world producer of dates. Iran has emerged as the World's largest producer followed by Egypt (Figure 2).

Dates production in the Kingdom has been showing a steady growth for the last ten years, with an average of 1.9% every year (Figure 3).

Figure-1. Dates World Production during the Period 1989-1995

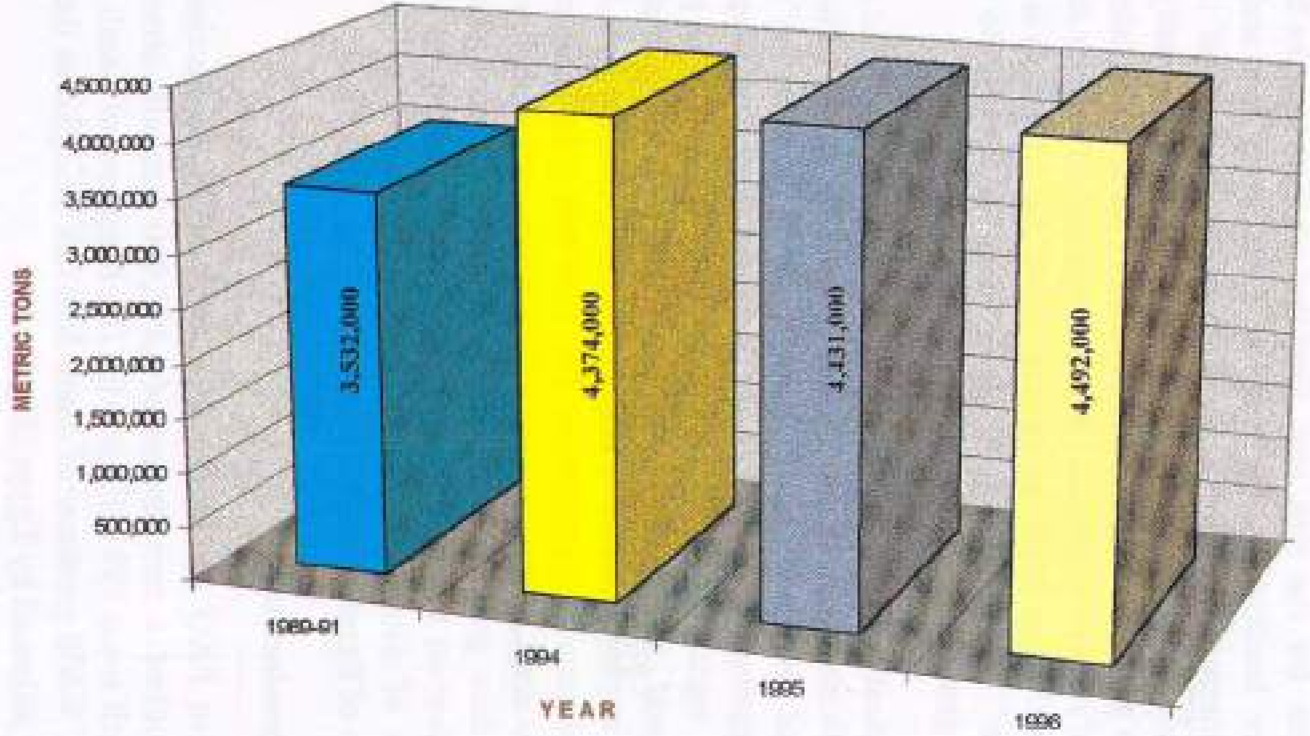
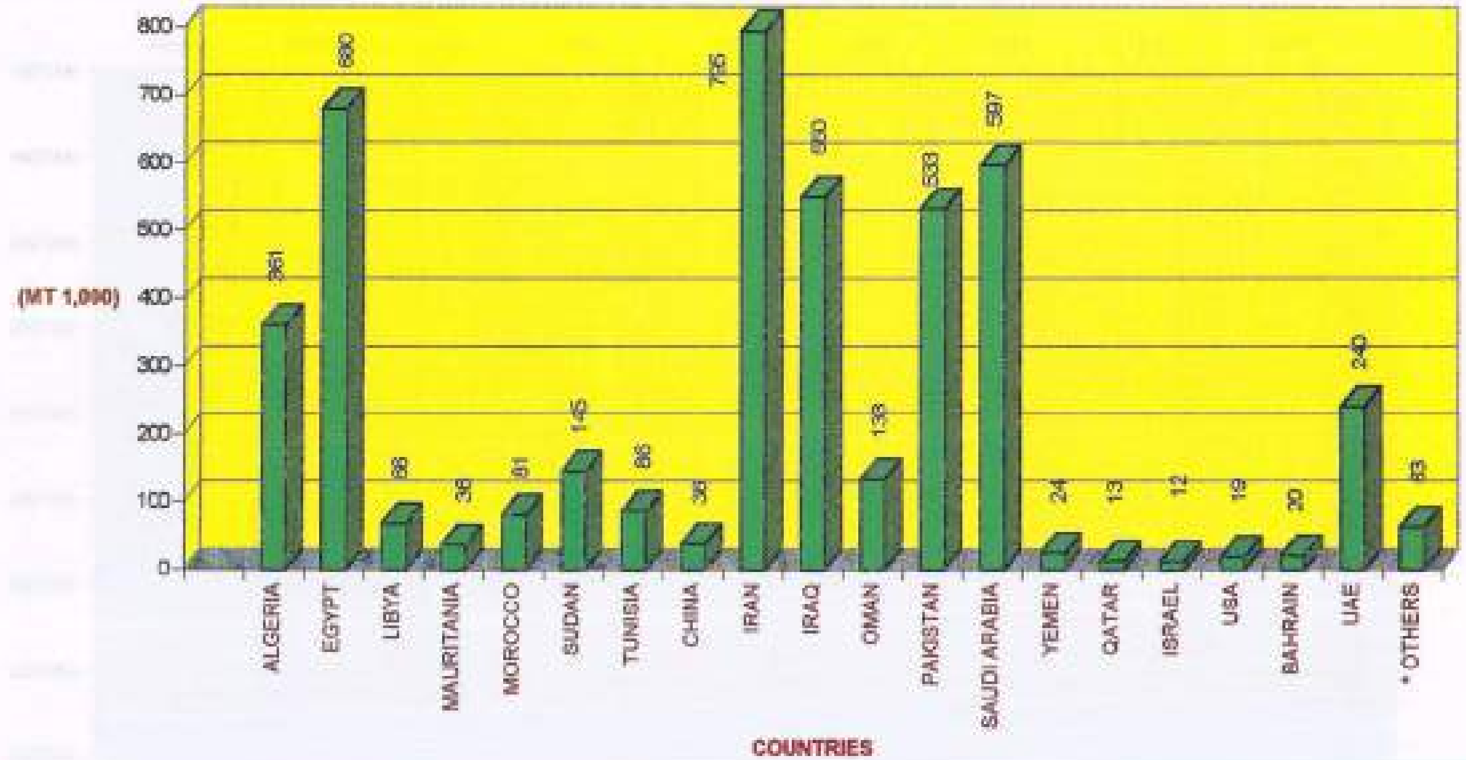
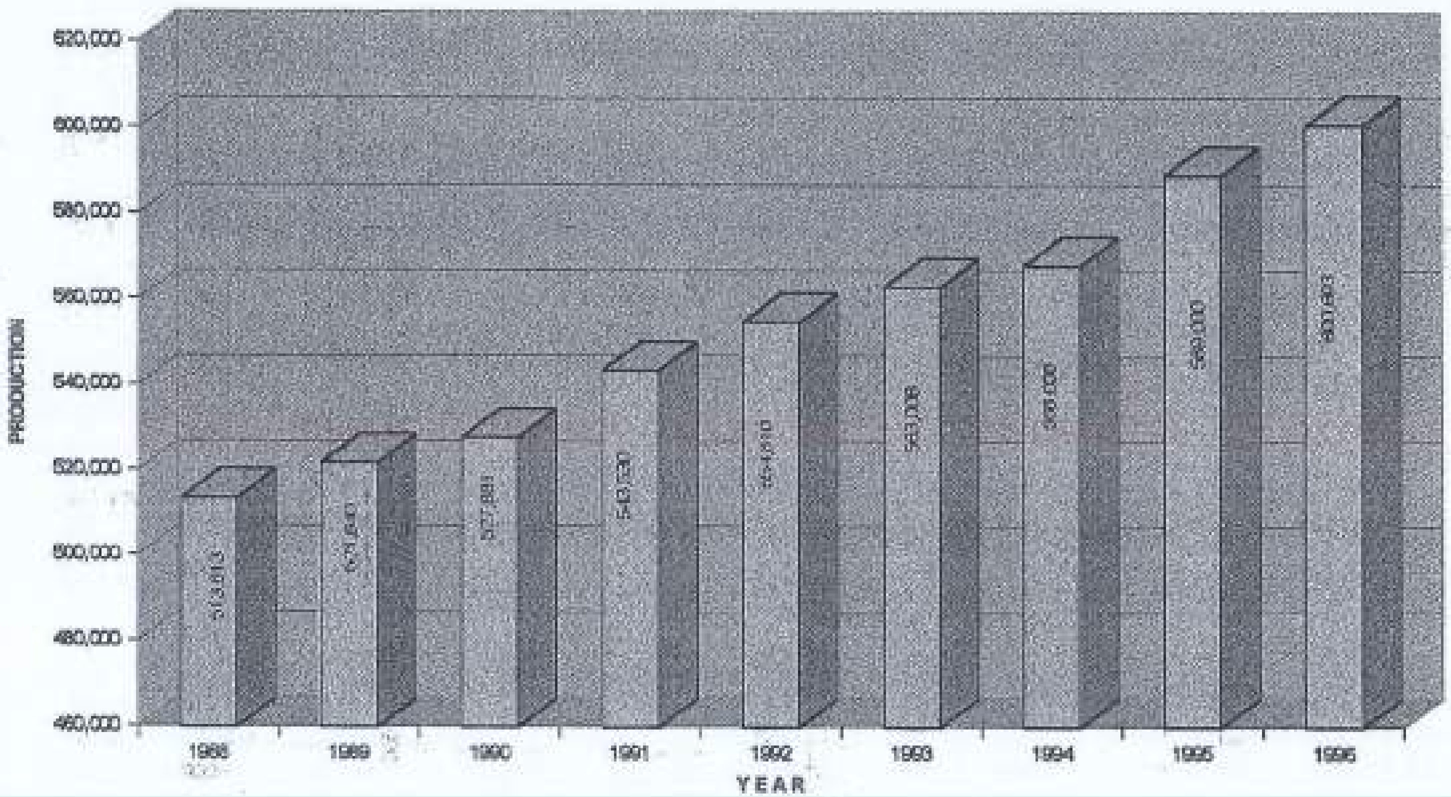


Figure-2. **Total World Product of Dates During 1996**



* Others represent Benin, Chad, Kenya, Niger, Somalia, Mexico, Gaza Strip, Jordan, Kuwait, Turkey and Spain

Figure-3. Dates Production Increase in Saudi Arabia for the Period 1988 - 1996



AVERAGE GROWTH RATE 1.9%

According to the latest government information[2], the Kingdom of Saudi Arabia dates production during 1996 is hitting a record over 600,000 ton. In terms of value, dates come in the second place after wheat crop. Date farming continue to thrive, boosted by generous government subsidies to farmers which involve a SR 50 as assistance per each off-shoot of good variety being planted, SR 0.25 for 1 kg dates produced and buying of the crop for the government dates packing plant at a supportive price of SR 3/kg. On top of all subsidies, the government also dispurse free interest loans through agricultural banks.

The date palm orchards are distributed in various Emarahs in the Kingdom (Figure 4) with a total land area of 95,345 hectares. (Table 1). Riyadh in the Central Region is considered the highest producer of Dates (28.96%) followed by the Eastern region (Al-Hassa and Qatif) which represent 13.98%. While there are over 400 dates cultivars produced in four main regions in the Kingdom, only about 50 to 60 varieties have commercial value[3], (Table 2).

3- Dates function in food and its nutritive value

Dates are high in quality due to their microbiological integrity. They are free from pathogenic organisms, due to their low water activity and moisture content. Hence, they are easily incorporated in food industry like dairy, bakery and other confectioneries. The following are some of potential uses and functions of dates:

- Normally dates are free from pesticide contamination, and will not form any health hazard. On this ground dates may be marketed and certified as organic fruit.
- They have desirable high sugar to acid ratio. This attribute will give fruity sweet taste and unique flavor enhancing characteristics.
- Dates act as humectants due to the presence of the reducing sugar. Fructose helps in extending the shelf-life and freshness of snack food and chocolate bars. When mixed with the dough it keeps the softness quality of the loaf.
- Dates paste is a natural extrudable product and can easily be incorporated as filler in bakery products. It performs valuable function in the manufacture of food products by displacing the need for artificial preservatives and additives.

Figure-4. Production of Dates by Emarahs in the Kingdom During 1996

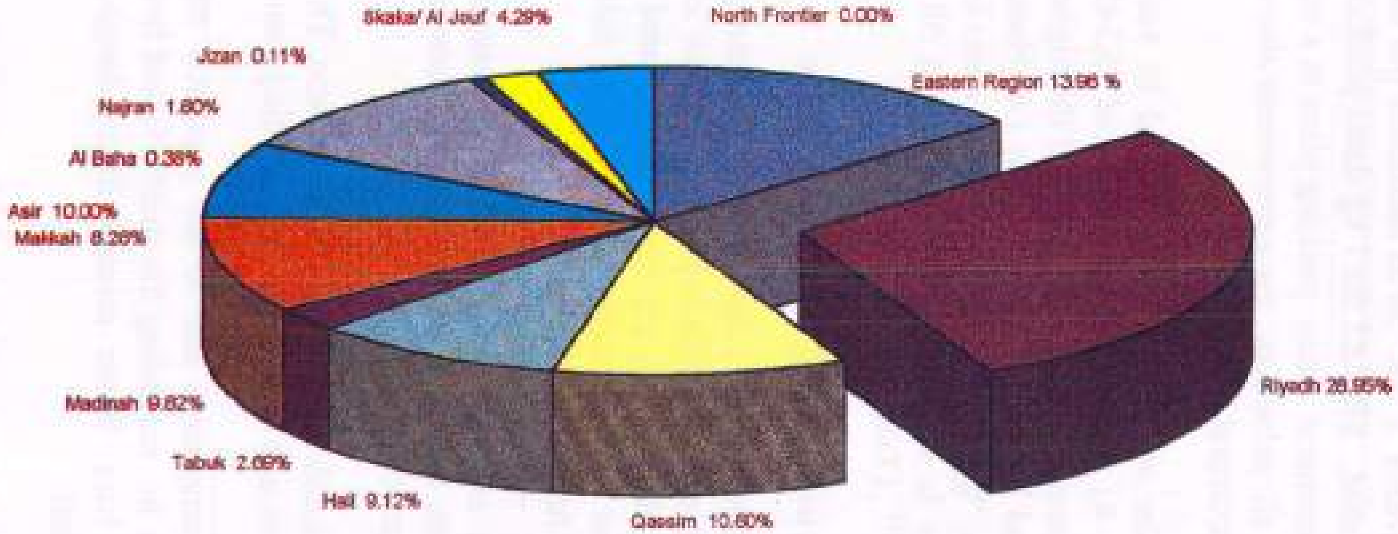


Table 1. Estimated Area and Production of Dates by Emarahs in the Kingdom during 1996

Principal Emarahas	*Area (hectare)*	*Production (Ton)*	*Percentage*
Eastern Region	11,565	83,955	13.98
Riyadh	29,597	173,894	28.95
Qassim	10,645	63,694	10.60
Hail	8,375	54,759	9.12
Tabuk	3,332	16,132	2.69
Madinah	10,446	58,963	9.82
Makkah	8,596	49,635	8.26
Asir	8,150	60,179	10.00
Al Baha	257	2,258	0.38
Jizan	364	673	0.11
Najran	1,787	10,773	1.80
Skaka/Al Jouf	2,223	25,744	4.29
North Frontier	8	34	0.00
Kingdom	95,345	600,693	100.00

Table 2. Main Date Cultivars in Saudi Arabia

Region	Sub Region	Variety	Distribution %
Central Region	Riyadh	Khudri	50
		Naboot Al Saif	10
		Others are Sellaj,Sukkari,	40
		Maktomi, Sultana	
	Qassim	Shagra	60
		Sukkari	10
		Others are Imm Al Kashab	30
		Miskani, Maktomi,Nabtat Ali	
Western Region	Madina Munawara	Al -Ola	
		Barni	30
		Rabiaa	20
		Safawi	15
		Shalabi	10
		Others are Ajwa,Anbara	25
		Shalabi, Hulwa,Baid,	
		Sukkarat Al-Shark	
Eastern Region	Qatif	Kuneizi	60
		Bukeira	15
		Izzat	5
		Others are Ruzaiz,Kholas,	20
		Merziban, Hallaw	
	Al-Hassa (Hofuf)	Ruzaiz	55
		Kholas	15
		Shbibi	5
		Shishi	5
		Others are Hilali,Tayar,	20
		Wesali,Shahl,Ghurr	
South West Region	Bisha	Sefri	80-90
		Others are Barni,Makfizi	10-20
		Shukal	

- Paste extruded from dates can easily be shaped and bind ingredients together like nuts, grains and other constituents in snack bar and chocolate coated bars.

- Dates are self-preserved fruit and can therefore be successfully used in emergencies, natural catastrophes, hospitals, health care institutions, army, etc.

- Saudi Dates varieties contain about 70% reducing sugars with almost equal quantities of glucose and fructose. Liquid sugar obtained will have more sweetening power than sucrose and will be an ideal replacer to refined sugar in various formulations such as softdrinks, chewing gums and other confections due to high sweetening power of its fructose moiety.

- Dates fulfill the need of today consumers who are asking for snacking instead of eating breakfast or lunch.

- Because of their low moisture content, excellent skin integrity, dates may be incorporated in crisp breads and crispy wafer, as they provide textural contrast.

- Dates like other dried fruits family (Figure 5) are rich in Magnesium and Potassium, and thus are good source to persons with mineral deficiency.

- Dates are almost free from sodium which is considered a potential source for hypertension.

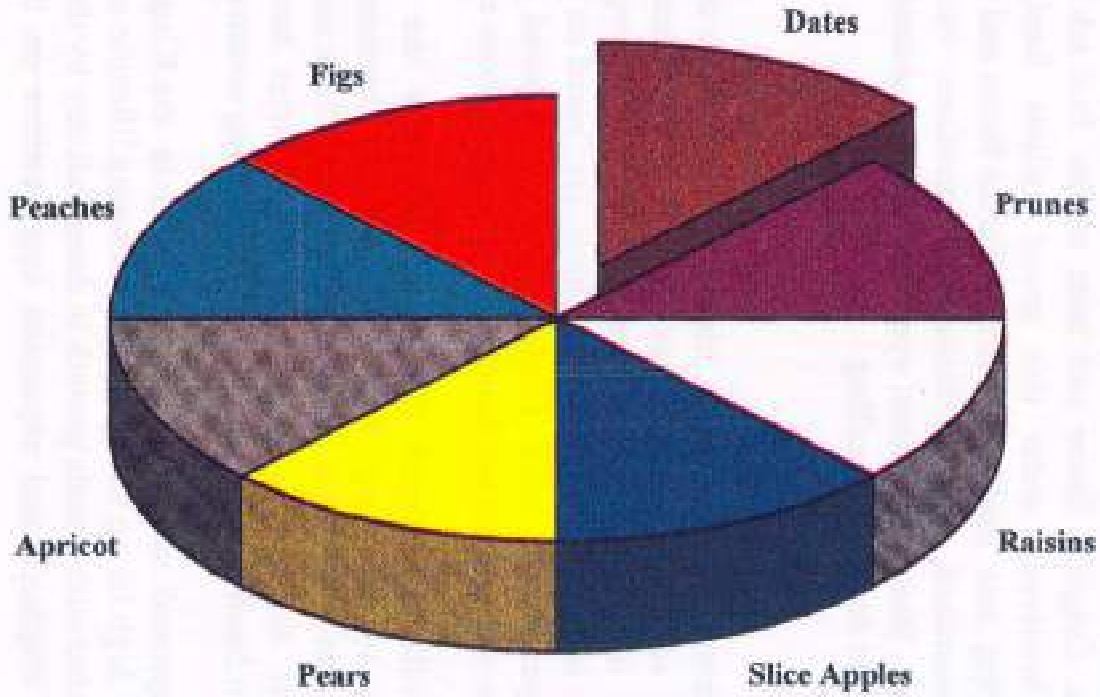
- Good energy supplement for athletes and runners during race games. The date juice may cope with the new trend for sport drinks like snapple drink to supply energy, electrolytes (minerals) and vitamins.

- Dates are eaten and enjoyed as natural fruit but not dried as some believe.

- They are natural desserts with minimum acidity and pleasant taste. This mild blend of attributes does not over power salad and fruit dishes.

- Syrup extracted from dates and their fibres would fit under the group of health foods. The natural syrup and fibres may be introduced in capsules or one of the ingredients in natural candies to control weight like the new branded products currently available in the health stores under the name of Come Alive and Slime Alive[4] .

Figure-5. Dry Fruits Family



4- Status of the industry

In general, the processes involved for the dates finished products can be divided into two main distinguished categories :

- Group 1

Where the indentity of the date fruit are kept unaltered by packing whole dates. Original flavor and taste of the fruit are kept unchanged. Processes involved under this group include fumigation, sorting, washing/drying and packing dates in different forms and styles. Products include vacuumized, pressed, loose or thermoform vacuum or nitrogen flushed dates. Basic additional operations may be sometimes included to the process like destoning/stuffing.

- Group 2

By altering completely the identity of the fruit for the production of more value added products. Dates paste, shredded dates, dates syrup, vinegar and liquid sugar are examples. Machineries required for syrups and vinegar industries for these products are based on juice extraction, destoning, partial or ultra filtration. The prepared juice is further channeled for specialized machineries to produce various end products.

The following figure (Chart 1) illustrates the possible dates derivatives which may be obtained on commercial scale by industrialization of surplus low priced dates and have strong potential as being import substitute. Some of these industries have been already established in Saudi Arabia or other date producing countries.

The improved socio-economic changes in the Kingdom which was reflected in high living standards and changing lifestyle of the Saudis has been coincided with drastic growth in dates industry by the private sector, with more emphasis and expansion opportunities on dates packaging plants.

Over forty two licenses were awarded in various locations all over the Kingdom, majority of these plants were licensed for packaging. Some of the basic processing operations which involve destoning, stuffing or dates paste making is also performed by these plants. According to the information of the Ministry of Industry, above twenty one factories are in actual production with their total licensed capacity exceeding 83,120 ton/year (Table-3). Small date packing houses owned by farms owners or date traders are also established in various locations. Such plants operate mainly during the harvest season and produce dates in plastic packs or tins in different styles.

Chart - 1. Flowchart for Dates Consumption Channels, Processed Products and Various Derived Dates Products

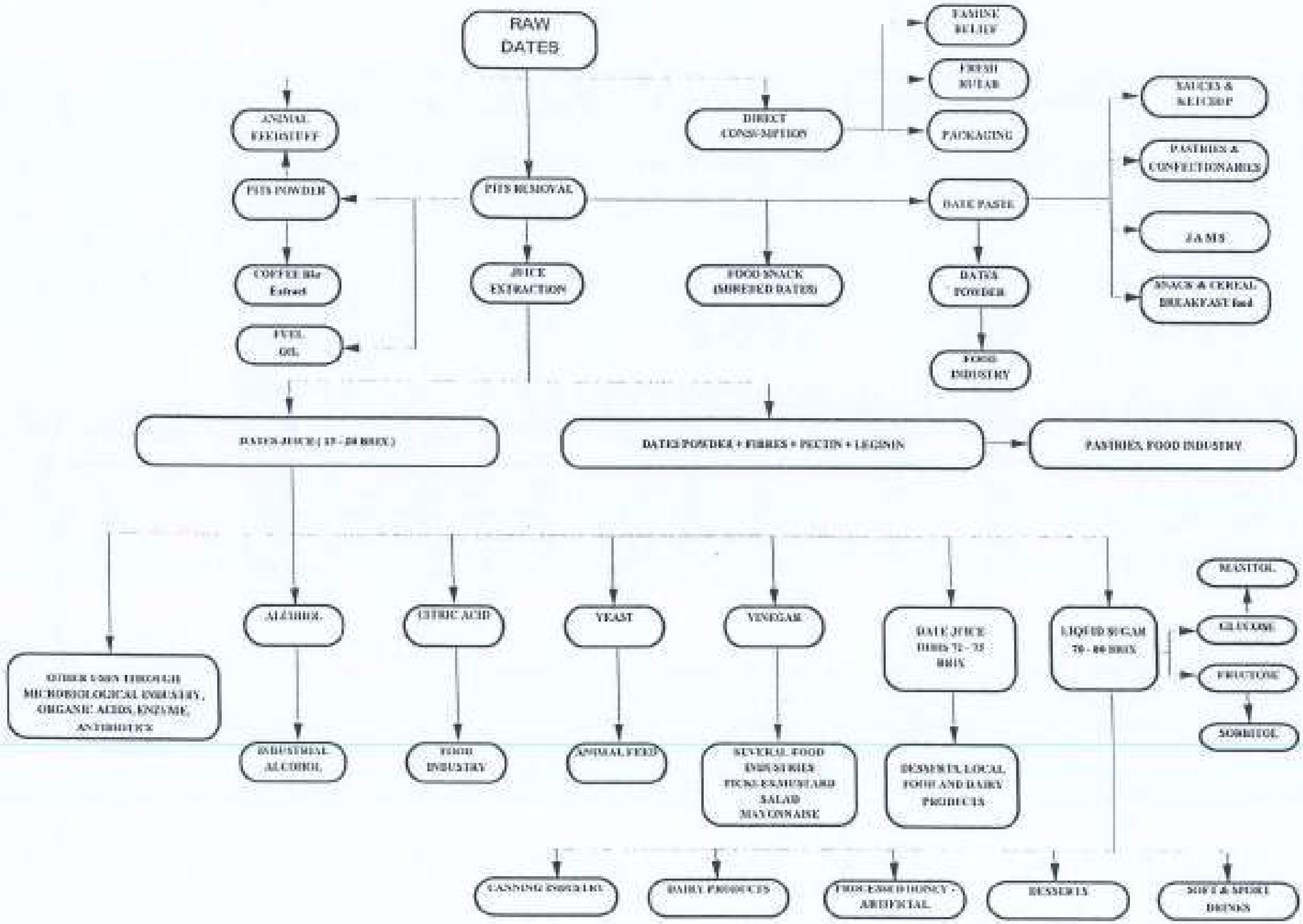


Table 3. **Estimated Quantities of Various Dates Products and Their Derivatives from Dates Packaging and Processing Industries in Saudi Arabia during 1997**

No.	DATES FACTORY	CAPACITY (TON)	PRODUCTION TYPE	BY PRODUCT TYPE	Qty/Ton
01	Al - Hassa Governent Plant, Hofuf	" 20,000	Bulk Dates (20kg) in corrugated cartons	Cull dates, defected dates calyxes	400
02	NADEC Plant, Hofuf	2,500	Packaged dates of different styles and sizes, paste	Stones, cull and defected dates and calyxes	120
03	Al - Barrak Plant, Hofuf	1,000	Packaged dates of various sizes and styles, paste	Stones and culls, defected dates and calyxes	50
04	Al-Hassa Development Co., Dates Factory, Hofuf	2,900	Initial commercial production for dates packaging, paste, syrup and Vinegar	Stones, culls, defected dates	50
05	Wadi Hanifa Dates Factory, Kharj	2,000	Packaged dates of different weights and styles, paste, date syrup line	Stones, defected dates,calyxes, press cake	60
06	Savola Dates Factory,Jeddah	20,000	Fancy packages of different sizes and style loose, depitted, pressed, shredded. Dates activities are presently focused for Syrup Vinegar and animal feed production.	Stones, defected dates,calyxes	250
07	Qassim Dates Factory Badayeh, Qassim	3,000	Packaged dates of different sizes, loose or pressed in blocks, Paste	Stones, defected dates,calyxes	60
08	Al-Qassim Agricultural Co., Dates Factory, Buraiydah, Qassim	5,000	Packaged dates, pressed, loose of different sizes and styles, paste dates syrup is presently under consideration	Stones, defected dates,calyxes	100
09	National Ideal Dates Packaging Factory, Madinah	3,000	Packaged dates in different sizes and styles, paste	Stones, defected dates,calyxes	50

No.	DATES FACTORY	CAPACITY (TON)	PRODUCTION TYPE	BY PRODUCT * TYPE	Qty/Ton
10	National Organization For Dates Processing, Madinah	160	Packaged dates, 250g , 500g , 1000g pitted and depitted	Stones, defected dates	10
11	National Factory For Dates Packing, Madinah	150	Packaged dates, 250g , 500g , 1000g	Stones, defected dates	10
12	Ali Hallabah Factory For Dates Packing, Madinah	3,250	Packaged dates in different sizes and weights, paste	Stones, defected dates,calyxes	100
13	Al-Awfi Dates Factory, Madinah	1,550	Packaged dates of different sizes and weights, paste	Stones, defected dates	50
14	Al-Madinah Modern Dates Packing Factory, Madinah	3,000	Packaged dates of different sizes and weights, paste	Stones, defected dates	70
15	Al-Dewely Dates Factory, Madinah	1,500	Packaged dates of different sizes and weights	Stones, defected dates	---
16	Bin Jaffar Dates Factory, Taif	1,200	Packaged dates of different sizes and styles, paste	Stones, defected dates	50
17	Al-Fakhyrah Dates Factory, Al Ghat	1,000	Fancy dates packaging of various sizes and styles, loose, pressed, stuffed dates, paste, date syrup base carbonated beverage,Date syrup under investigation	Cull dates, defected dates, calyxes	50
18	Al-Kharj Dates Factory	800	Paste Pressed Dates	Cull dates, defected dates, calyxes	50
19	Bisha Dates Factory, Bisha	5,000	Dates in tins	Cull dates, defected dates	----
20	Al Mohammadia Dates Factory, Al - Kharj	2,000	Dates packed in different packaging material and sizes. Packs include thermoform packing, vacuum packs, pressed & loose etc, and paste for food industries	Stones, cull and defected dates	150
21	Food Products Co. Al-Kharj (WAFRA)	10,000	Date juice concentrate (Dibis), vinegar, jams, animal feed	Presscake, stones	1,500
	Other small packing Houses, bakery and confectionery industries	5,000	Dates in PE bag, or in large 20 kg tins, Semi automatical scale for paste manufacture	stones, cull, defected dates	100
		83,120		TOTAL	3,820

* Current selling price is SR 150 - 200/TON

** Production delivered to World Food Programme (WFP) as donation to poor countries

In addition, the Government has a modern dates packaging plant in Hofuf, which has a capacity of about 20,000 ton/year. All its bulk production is being sent abroad as donations to poor nations. However, the total dates quantities which find their way to these factories do not exceed 14% of the Kingdom's total production.

The dates processing facilities, where derived dates products are produced are still in full progress. Date paste production has shown tremendous increase, with estimated production capacity of 10,000 ton which represents paste from packaging and processing factories and home made paste (unpublished data). The paste is used successfully in bakeries and other confectionaries. On the other hand very recently dates syrup, jam, vinegar and animal feed from processing waste have seen commercial debut in two large scale dates processing plants in Riyadh and Al-Hassa[5]. As being new branded products, marketing campaigns are needed to promote these industries.

5- Dates Consumption

The Kingdom has passed drastic changes affected the lifestyle and trend of dates consumption pattern of the Saudis. Socio-economic changes included improvement in living standard, the development and modernization of large supermarkets, changes in eating habits, continuous urban drift and tendency toward living within small size family. The wide availability of alternative competitive confectionaries and other fruits all over the year aggravated the problem. Consumers with the new younger generation in particular presently call for the need to improve the existing unhygenic cottage date packing industry to cope with their demand.

The average annual per capita consumption of dates is 25kg. Total population including expatriates has reached 16,929,294 with Saudis (12,304,835) representing 72.7%[6]. The Kingdom annual growth rate has been reported to be 4.4%[7]. Annual local consumption of dates reached 307,620 ton. Based on total Saudi production of dates, a surplus of more than 300,000 tons which represent 50% of the annual production goes as a waste or for animal feed. Such quantities are expected to be utilized for industrialization into more value added products. Such surplus is also considered a good potential for export market.

Out of annual dates consumption figures, 40% are consumed as fresh dates "Bisr" i.e. premature yellow or red color stage or as "Rutab", a squashy, fully mature high moisture dates. Around 90% of the annual consumption is being absorbed by cottage packing industry. The packing process is unhygenic and primitive methods are used for handling and packing the date harvest. Dates are oftenly washed in used water followed by manual packing in polyethylene bags or square re-used tins of 25 kg without fumigation. the upper lid sides are hammered across the top surface to ensure the tin closes absolutely air tight. The produced dates of high infestation are marketed at the prevailing high temperature which would impair its quality.

6- Present Status and Major Problems Facing Dates Industries.

Dates packaging and processing plants in the Kingdom are showing continuous increase for the last ten years as no barrier to new entrants. There are a yearly average of two to three new entries of modern dates plants or small unbranded packaging facilities. In spite of establishment of these plants, the industry is facing various production and marketing problems hindering their progress. A summary of these constrains may be categorized into the following groups:

6.1 Marketing

Dates Manufacturers in K.S.A. are currently facing the following major marketing problems:

- Low growth potential of dates business due to changes in life-styles of the Saudis and availability all over the year of locally produced or imported other fresh fruits.
- Strong competition in the peak season from low priced unbranded dates of initially high infestation packed by farm owners, or wholesalers. Their production cost is minimum, and consumers differentiation is based on dates variety and price, while packaging usually plays a secondary role. This would obviously result in small sales volume of branded dates.
- High cost of dates as raw material especially the good popular varieties. Examples are Sukkary of Kassim, Kholas of Al-Hassa, Anbara of Medina.
- Not enough marketing and ads campaigns are launched by dates manufacturers due to high cost involved.

- The presence of high percentage of live or dead infestation in the finished packs of many branded or unbranded dates exceeding Saudi standards of 7% which would impair their quality.

- No market usage and attitude (U & A) research to explore the real needs of the consumer in terms of varieties, packaging style, pack size, etc.

- Limited exports due to high infestation and lack of market research studies which can identify quantity and quality and levels of actual demand for dates in international markets.

6.2 Packaging and Processing Plants

- High cost of machinery, spare parts, maintenance and imported packaging materials.

- No strong links between dates farmers and manufacturers and absence of loyality of those farmers to the importance of delivery of good quality dates as laid down for raw material specifications for packing and processing industry.

- No coordination or cooperation among dates manufacturers themselves, and absence of dates packer's association or administration board to look after their interests and needs.

6.3 Production and Dates Machinery Problems

Advanced research and technology for packaging and processing dates machineries is unfortunately not well progressed. Problems related to international machine manufacturers and suppliers are described in the following :

6.3.1 Special nature of the date fruit:

The presence of large number of date cultivars would create wide variation in their physico-chemical characteristics. Such variation also exist among dates of the same variety. Examples are their degree of hardness, fruit weight, stone to flesh ratio, specific gravity, relative composition such as sugars, fibre content, polyphenols and moisture content. Morphological variation also exist among these cultivars like size, shape, texture, color ,skin integrity and firmness (smoothness, wrinkled, crackness, detachment, brittleness etc.) Based on these differences it becomes difficult to machinery manufacturers to design a common and proper machines to suit all varieties with same performance. Degree of efficiency in processing operation and consequently the final quality of the date products will evidently be affected as a result of differences in their adaptability to those processes.

Dates fruit contribute good sweet taste and mouth feel due to its relatively high flesh sugar consistency and fibrous texture but its contribution to flavor is poor. The fruit identity once transformed to new products as liquid sugar, or vinegar will lose its pronounced texture and taste. Industrialization pattern of dates should be thus encouraged only to those products and derivatives which would keep same or all of their original quality characteristics.

Dates do not lend themselves easily to modern industrial processing. High sugar content create various stickiness problems during packing of whole dates or during their processing to various derivatives and even byproducts. Fruits received by date packers are often lumpy and not free flowing. A situation would result in accumulation of sugars debris followed by feeding problems and difficulty in passing them through the conveyors for washing. Due to its hygroscopicity nature, the fruit will rapidly absorb moisture and turn massy and clumpy. Such problems are often faced during automatic weighing of cleaned dates for pouch packing in the Form - Fill Seal (FFS) machine and during processing for discharge conveyors of the packing lines for paste making. The fiber and moisture content of the date flesh varies from variety to another and degree of adherence of the flesh fibres with the stone and the shape, size of the stone itself due to variety variation may all affect the destoning and maceration process while passing through the macerator rollers. Paste is characterized of being highly viscous food with comparatively low moisture content (18-20%). High viscosity will impair its flowability during processing and create feeding and packaging problems during automatic packing. The presence of high polythenols, sugars in the finished paste may result in a rapid darkening during storage due to high rate of Millard and condensation reactions. Diced or extruded dates are coated with anticaking agents to keep them free flowing otherwise they will turn into lumps.

In automatic block formation of pressed dates, variation in moisture content, ripening stage and specific gravity of dates varieties create problems in accommodating same weightment but different volume capacities when the plant is packing different varieties. Such situation may result in the difficulty of building a common die with same size dimension to suit all such differences.

Differences in fruit shape and volume from one variety to another is an obstacle for machinery and equipment suppliers to improve appropriate common technology and systems for grading/sizing lines for each type of dates. Mechanical sorting on commercial scale and automatic sorting or camera computer system for sorting is not successful so far on commercial scale, picking rejected dates due to various defects in the inspection line is still not visualized.

Destoning machines presently available are designed and fabricated mainly for destoning of cherries, apricot, plums or olive but are supplied to date packers after little modification. Date pitters are provided with cups (holes) in a rotating belt in which dates are positioned, while special needles push the pits downward leaving the longitudinally flesh intact. The uniformity of fruit shape and volume, which apparently varies from cultivar to another, its overall shape and proper positioning in the cups are most important criteria to define the performance of the needle in the pitter. Available machines are designed for limited number of varieties, like Sayer, Zadhi, Halawi of Iraq and Deglet Noor of Tunisia.

The peculiar nature in date fruit is that during its ripening process on the bunch the whole fruit intact will not ripen evenly. Consequently, the moisture content, size, color and weight of the fruit of the date harvest of one variety will be varied from one fruit to another. This situation may create difficulty by the date packers in producing a uniform quality packs. Sun drying or tunnel dehydration of high moisture dates before washing to avoid dates of uniform dryness may be necessary to avoid fermentation or fungal spoilage.

As date packers deal with dates of different moisture contents, attention should be given for hydration/dehydration process. Dry fruits need to be hydrated in the conditioning tunnel. Optimum time/temperature relationship and degree of steam hydration should be standardized for each variety and each batch. High moisture dates should be dried to moisture content below 20% to avoid spoilage. Moderate temperature of 50-60°C should be used to avoid browning reactions.

6.3.2 Constrains Related to Machinery Manufacturers and Suppliers

Advanced research in engineering design and experience gained by machinery manufacturers in modifying the technology to suit dates processing requirement are still beyond our expectation due to the following:

Machinery suppliers for date packing industry in general and the more sophisticated date processing technology in particular are limited worldwide.

High cost involved in buying packaging & processing lines from abroad. Meantime, the availability of limited and less experienced local workshops to perform the needs of dates investors would aggravate this problem. Non - frequent orders and lack of information on machine specification from buyers for dates processing machineries, and irregular requests result in a poor response of suppliers in modifying the existing technology and lack of interest to continue investigations and attempts for machinery improvement. Machine modification and new design will be based on little experience on dates, time availability and convenience of machine manufacturers.

Machines R & D is a tedious and expensive process to be carried out alone by foreign machinery designers. Uncertainty of the machinery manufacturers on the actual needs, seriousness and real intention of the buyers make them feel not enthusiastic to carry out further modification or develop special prototype machines to tailor customer needs.

National research centers in the date growing regions are not carrying active research toward improving the existing technology in date processing industry due to lack of expertise. Co-ordination with the foreign suppliers or manufacturers on actual requirements in dates technology is not existing in its real sense.

6.4 Others

The dates packaging and processing industry is suffering from discontinuity of the technical expatriates. The industry is lacking well trained and experienced national manpower with special emphasis to the recent availability of more sophisticated vinegar and date juice concentrate industries. Lack of production experience for proper monitoring of the vinegar process during fermentation/acidification would result in poor yield and quality. Proper activation of the microhial strains as starters and control of their growth environment would result in poor quality. With same token, the extraction, filtration and vacuum concentration processes of date syrup if not well controlled will result in sedimentation of cellulosic and gummy substances and a poor quality product.

Absence of specific standards for the numerous date products presently available. The present Saudi Arabian Standards Organization (SASO) specification for packaged dates should be upgraded to suit all available type of packs available in the market as to cover, pressed, loose and vacuumized, thermoform packs. New specifications should be laid down by SASO for date paste, vinegar, date juice concentrate, and animal feed to have stability in quality.

7- Market Segmentation

The local dates market is currently a commodity type market. The industry in general is fragmented and lack market leaders with highly competent technical and business development team. It also lacks sophistication with newly emerged branding, but no intensive programs for an advertising.

As shown in Chart-2 the Saudi market is presently showing three main segments and sub-segments:

7.1 Prestige/Gifts Segment

This high priced segment represents the prestige/gifts of luxurious packaging with value added products. It constitutes a little share of the market products sell mainly through specialty outlets in the major cities like Kingdom dates, Bateel, Ajwa, Nadheed, Mohammadia outlets, Al - Fakhyra, Dates World, Maknoose, and Al - Dewan Stores. Estimated volume is 1500 tons.

7.2 Medium Priced Segment

The medium priced segment consists of the main bulk dates (Pressed and Loose) subsegment and the convenience packs subsegment which include consumer packs produced by modern dates packaging plants and dates packers.

7.2.1 Pressed and Loose Sub-segment

Which is being handled through central dates markets and amounts to 55,000 M.T./Year. Most bulk pressed dates are sold in 25 kg. Tins which are too big for an average family. Cans are sometimes cut into half and sold as 10 kg. Portions. Segmentation of this market into 5 kg., 10 kg., and 20 kg tins is possible and needed. Most loose dates are sold bulk by kilo. This subsegment can be developed into a convenience type by attractive packaging in 1kg & 1/2 kg cartons which can be used to serve guests directly and pouch bags for family consumption. New individual consumer oriented snack size packs of pitted loose dates would have good potentials for Omra visitors and pilgrims in Mekka.

Chart-2. Dates Market Segmentation in Saudi Arabia, 1996

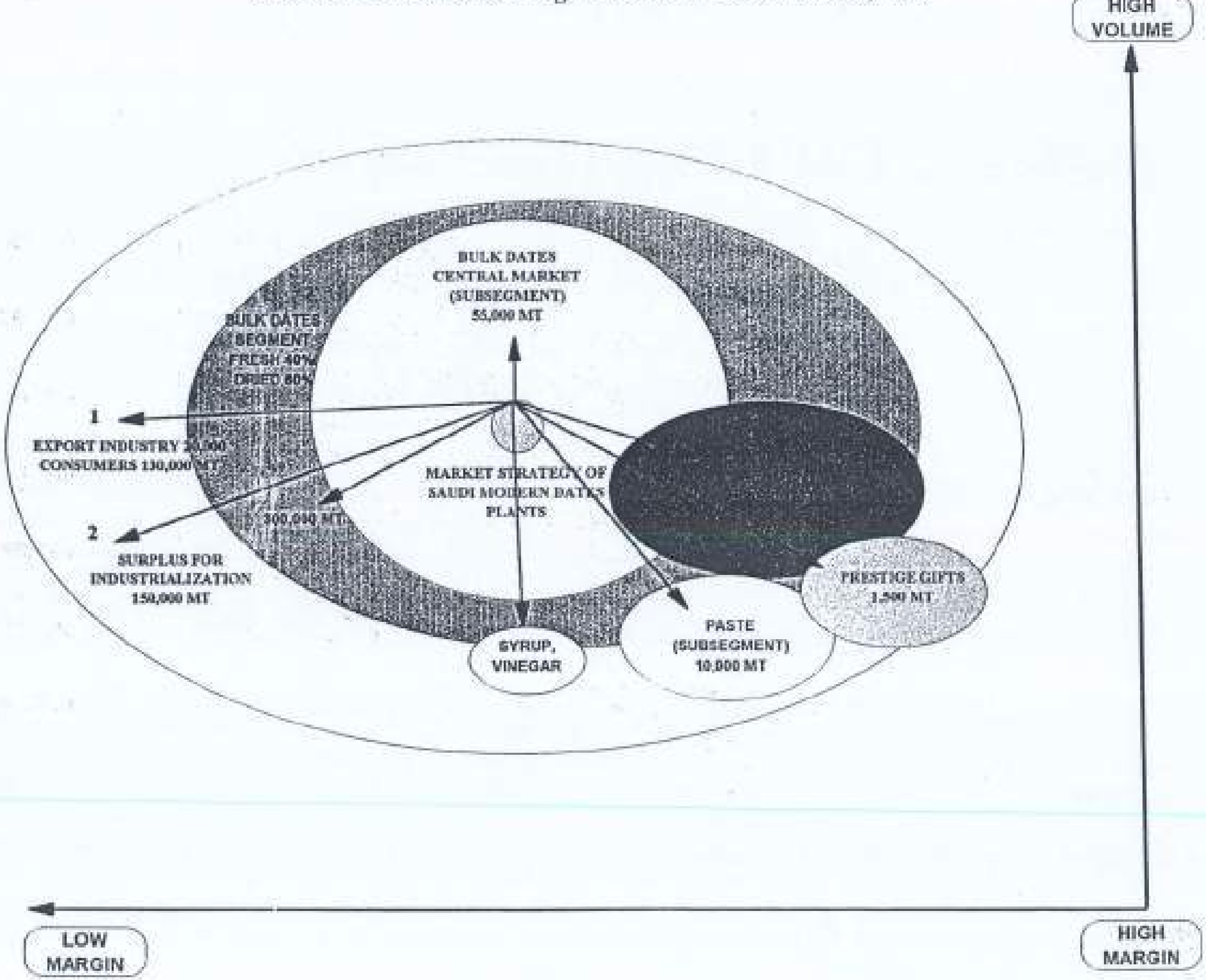
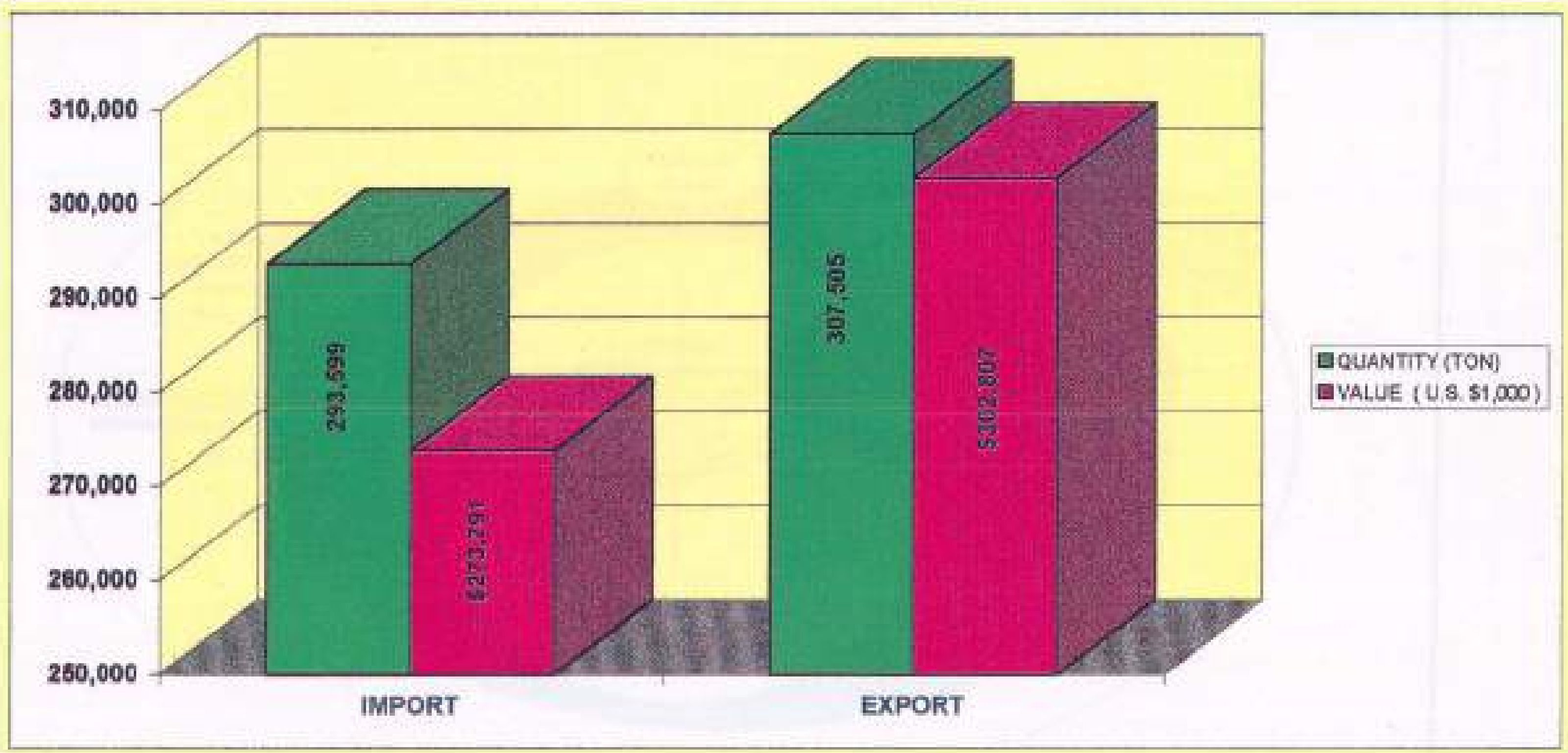


Figure-6. World Import / Export and their Values During 1995



7.2.2 Convenience Packs Sub-segment

Convenience packs are mainly in 1kg normal or shrink-wrapped plastic bags. Dates are also packed in pressed form, loose or vacuumized. Products of the modern dates packaging plants fit under this category. These products are handled by supermarkets and grocery shops and has a volume of 20,000 M.T./Year. Volume of convenience packs is expected to grow in the next years to cope with the increasing demand of the consumers. Processed date products which presently cover date juice concentrate (Dibis) and vinegar are also considered under convenience (portion packs).

7.3 Low Priced Segment

This segment can be broken down to the following subsegments:

7.3.1 Paste Subsegment

The date paste subsegment which has a reasonable size of 10,000 M.T./Year, is currently focused on industrial users (80%), with little portion to home users (20%) and can be developed more through family size smaller packs of 1kg & 2 kg or below.

7.3.2 Charity Sub Segment

The second subsegment covers the small packs of 50g or 100g sadaga and large packs donation products (20 kg). Although the volume of this subsegment is not known, the small size sadaga packs are believed to have good potential for Zakat, Omra visitors and pilgrims in addition to Saudi Charity Association for poor nations.Depitted dates of 50g are also expected to have its way in by Makka and Medina visitors.

7.3.3 Export Subsegment

As shown in Figure 6, the world import/export trade as given by FAO Trade and Commerce yearbook in 1995 is 293,599 tons and 307,505 tons respectively. Their estimated value is U.S. $273.8 billion and U.S. $302.8 billion. Saudi dates enjoy high quality and has its own spiritual status by the Islamic countries and Muslim communities worldwide. It can be, therefore, marketed and differentiated as superior performing products with desirable eating qualities. Saudi dates export during this period have reached 18,000 tons at a value of U.S. $ 11.5 million. Majority of this quantity have been packed by Al-Hassa government plant for World Food

Programme as aid to the less fortunate countries. As illustrated in Chart-3, potential export market of the Saudi dates is estimated at 300,000 M.T./Year. India is considered the first importer of dates in the World which imported 80,000 tons during 1995, followed by United Arab Emirates which imported 60,000 tons. Tapping this market in the form of bulk dates of 10-20 kg pack is essential for the modern dates packing plants and should be part of their strategy.

Export markets for medium priced products should also be targeted in developed countries with large Muslim communities (Europe & U.S.A.).

8- Present status of dates-by-products and palm residues

The ongoing government efforts to find out local feed resources as substitute for imported and subsidized animal feed have gained in prominence as of late. The government has recently limited the barley price for farmers to 0.52 Rials/kg while continuing to subsidize the barley as a source of carbohydrates for a value of SR 9.65 per 50 kg/bag. The accumulated by-products from existing dates packaging and processing plants are comparatively limited in quantities. Rejects from these plants include culls, damaged dates, calyxes, and rejects of sorting/grading operation.

Chart 3 shows a summary of the main by-products and residue of the Palm tree and its fruit. Generally, by-product residues of the dates and date palm tree may be divided into the following two main groups:

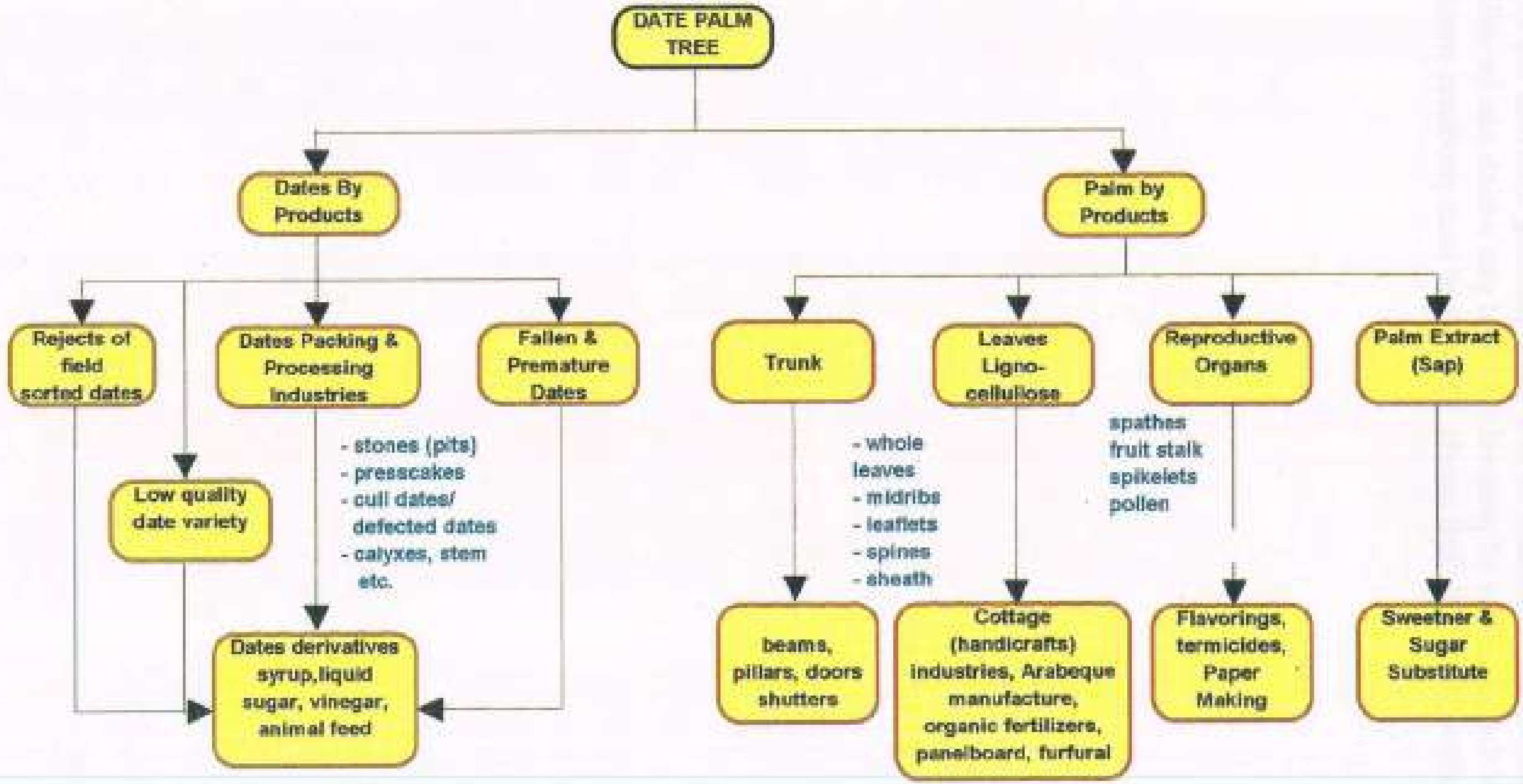
- Dates by-products, which will be available either as reject from date packaging and processing operations or from low grade dates, fallen or premature fruits.

- Palm products other than dates which include all parts of the date palm including cellulosic date palm leaves, its potential furfural and legnin contents, reproductive organs etc.

In order to be competitive on industries based on date palm rawstocks, The main criteria which govern its feasibility depends on the availability on large scale of low cost raw material and the optimum utilization of the plant by products i.e. pressed cake, and stones.

The annual quantities of these by-products (Table 2) are estimated at 3,820 tons. The recent operation of date juice concentrate (dibis) dates, vinegar and the establishment of new dates packing facilities are expected to increase the quantities of pressed cake and pits which can be utilized in the formulation of animal feed meals. The use of such products would also

Chart-3. **Date Palm By-products & Residues and their Uses**



improve the economics of operation of these plants by decreasing handling and disposal problems costs.

9- Recommendations and future prospects

Saudi modern dates packaging and processing plants should follow the following strategies:

9.1 Cost leadership

Cost leadership in dates processing plants is a must and should form the backbone for their strategy. To attain this goal, the following requirements are needed:

Plants should operate at full capacity to minimize overheads costs and optimize production scheduling that will account for the seasonality of the consumer product mix and continuity through out the year of less seasonal industrial products like paste, syrup and vinegar. Stones and presscake (fibres) should also be utilized as animal feed.

Gain substantial market share by overcoming fragmented competition of the cottage industry through competitive pricing, consistent quality, superior service and good distribution network.

Segmentation of products to cover a wide range of packaging styles and Sadaga packages in order to address the whole spectrum of consumer needs.

Minimize raw material cost through:

- Establishing data information system for potential farms.
- Maximizing direct purchase from single farm of high potential.
- Promising farms to be visited and start price negotiation before date harvest season to ensure quality.
- Minimize purchase from agents or direct auctions to avoid high price payment. Direct purchase from the market may result in poor quality purchase due to lack of time for monitoring quality.

Be cost effective by proper sourcing of all packaging material, and rationalization of all other operating costs, labor, advertising, and marketing.

9.2 Dates Marketing

Taking into consideration existing high competition from cottage packing houses, and in order to have a competitive edge over these industries Saudi modern packaging and processing plants should focus on the following:

Each state of the art plant should develop its own attractive brand name to attain brand loyality. Brand loyality may be developed by launching an aggressive local market programmes to warrant brand switching to quality packed dates with attractive prices. Efficient distribution channels are needed by sales departments to cover the whole country and making these brands national rather than regional or local.

Each modern plant should initiate a market and consumer research to identify the product mix needs of all regions and consumer groups.

Packing of fresh dates is an attractive business, and should not be underestimated. It has currently a small volume. The process of packaging fresh dates (Bisr or Rutab), followed by deep freezing is done by consumers in their homes and small part by dates traders. Attractiveness of this industry will increase in the coming ten years as the month of Ramadan will fall during August and September.

Address the retail market on a wide scale with a range of highly innovative product mix in style which would address all consumer segments locally and internationally.

Launch campaigns to win the young generation who are drifting away from the tradition of using dates through continuous R & D to develop suitable snack product which would cope with their demand.

Exploit media.

Exploit health attributes of dates in terms of its high nutritive value and heritage background.

Develop the industrial sector for paste, syrup and vinegar locally and internationally at very attractive prices with products for industrial users as well as Fast Moving Commodity Goods (FMCG).

Attain government protection of the industry by preventing import or taxation of similar products like other imported fruit vinegar, chemical acetic acid vinegar, other Dibis - like products as sugar cane, molasses, pomegranate concentrate and Kharrob.

Attain maximum utilization of manpower, machinery facilities and management by establishing not only date packaging facility but also date processing industry.

The potentials downstream emerging industries from low priced dates such as syrup and vinegar should be promoted for local as well as export market.

Capture a gradual share of the industrial and family size paste market by providing products which would address industrial users and consumer needs.

Dates export is a promising market for low margin but high volume. Saudi dates should occupy gradually good market share in the international market. The Saudi export volume of dates during 1995 represents only 6% of the Kingdom available dates surplus of 300,000 tons. Saudi dates should penetrate the international market specially The GCC, and Islamic countries for the low and middle price segment dates. Potential markets in Europe, Asia and U.S.A. should be indentified by meeting their specification in terms of dates variety, package size, packaging materials and processing requirement.

9.3 Dates Quality

- Dates quality begins from the orchard and ends at consumer table. Efforts should be made to improve horticultural practices by farmers and protection from infestation during transportation to ensure a steady supply of good quality dates.
- Promote date consumption and switch consumer food habits to dates by providing several choices of top quality dates and dates products.

9.4 Other Cellulosic Industries of the Date Palm

Initiate industries for handicraft, Arabesque manufacture, Kraft paper, panelboard, organic fertilizers, furfural, and fermentation industries from date palm residues. Such industries will have a better return to the farm owners, decrease costs involved in date palm cultivation and reduce environment pollution and disposal problems.

10 - Industrial research and development (R &D)

For better utilization of research findings by food research and engineering departments of the Saudi universities, it will be advisable to establish a coordinating scientific committee between researchers and dates investors of the private sector.

The King Abdulaziz City for Science and Technology (KAACST), presently acts as the financial authority and link between private sector and researchers. The King Faisal University's palm and dates research centre is undertaking extensive research programmes to improve the date palm and diversify products from dates.

For the last three decades, active research has been initiated by the Saudi universities and research centers supported financially by (KAACST), Riyadh. For future development of dates and date palm industries and to explore new products and derivatives, scientific research centres should undertake new horizons for applied research in the following areas:

1 - To explore technical problems arising during production and marketing of the existing factories and to find out solution through applied research taken by these department. Areas of research may involve, stickness problems, prevention of skin crackness, improving marketability of dates and their wholesomeness by glazing and skin coating, storage and shelf life of the date products.

2 - Innovation for new product development may be initiated for development of date meals based on traditional dishes used in Saudi Arabia such as Marees, Honaini and Bogaita. Research may include their quality improvement in terms of product fortification, nutritive value, good packaging and prolongation of its storage life.

3 - Incorporation of dates and their products (syrup, shredds, paste) in breakfast meals, moesli food, frozen products i.e. ice cream, yogurt, etc.

4 - Addition of dates as ingredients/or substitute for sugar in sauces, and ketchup formula.

5 - Production of dates powder and its performance as potential source in baby food, pre-mix cake powder.

6 - Development of special meals in which dates are main ingredient to be suited for institutions, hospitals, army, emergencies, etc.

7 - Explore research on the potential of immature dates in their green or red/yellow color stages of maturity as a source of polyphenols. These group of compounds have been recently used in U.S.A as antioxidant in fruit juices and processed ground beef at a level of 0.02% by weight[9]. It is also used as natural preservative to replace BHT, BHA Epicatechin isolated from green tea leaves, which also present in dates[10], have been reported to possess strong anticarcinogenic effect in mouse skin[11,12].

8 - Explore the possibility of extraction on commercial scale the spathe destillate of date palm. Earlier research on chemical composition and biological activities[13,14] of the water distillate have shown the presence of 1,2 dimethoxy-4-methyl benzene of up to 75%. The research was based on the traditional chewing or soaking of the tender spathe chips and its addition in water or hot tea as flavoring and preservative agents. Further research on this compound have shown its high lethal effect on termites[15]

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List of Government and Non-Government Organizations Involved in Dates Products and Utilization of Date Palm Residues

1. Governmental Organizations

Ministry of Agriculture & Water

Directorate of Research and Development
Riyadh

Saudi Industrial Development Foundation, (SIDF)
Box 4143, Riyadh 11149

Tel: (01) 477-4002 Fax: (01) 479-0165

King Abdul Aziz City for Science & Technology
P.O.Box 6055
Riyadh – 11442

Tel: 966-636 7320 Fax: 01-488 3990

Saudi Consulting House
General Government Establishment
Box 1267
Riyadh 11431
Tel: 01-448 4533
Fax: 01-448 1234
Attn : Mr. Mohammad Ali Al-Muslim

King Faisal University
College of Agriculture
Department of Animal Husbandry
Hofuf

Tel: 03-580 0000

Date Palm Research Center
King Faisal University
Hofuf

Attn.: Dr. Abdullah Al-Ghamdi
Director

2. Non-Government Organizations

Food Products Co.

Box 60573
Riyadh 11555

Tel: (01) 462-6415/462-6424/462-6450

Al-Qassim Dates Factory
P.O Box 126
Badaya
Qassim

Tel: (03) 321-1588

The National Agricultural Development CO
PO Box 2673 PO Box 2557
Hofouf 31982 Riyadh 11461

Tel: 530-1837 Tel: (01) 478-3488/4011
Fax: 530-1598 Fax: (01) 478-4127

Wadi Hanifa Dates Factory Ltd.
PO Box 10451
Riyadh 11461

Tel: (01) 455-0441
Fax: (01) 455-1207

Saudia Dates Factory
P.O.Box 2210
Buraydah

Tel: (06) 380-0677/0777/8877
Fax: (06) 380-0305

Al-Madinah Al-Munawarah Co. Ltd.
PO Box 5090

Al Madinah Al-Munawara
Tel: (04) 825-5124
Fax: (04) 825-5124

Non-Government Organizations

Hadhim
P.O Box 131
Buridha
Tel: 324-4801
Fax: 323-2346
Pager: 1932 2351

AL-Ahsa Development CO.
P.O. Box 2726
Al-Ahsa 31982
Tel: 592-5275
Fax: 592-6163

Kingdom's Dates Factory
P. O. Box 63043
Riyadh 11516
Tel: 01-4622444

AL-fakhra Date Company LTD.
P.O Box 63
Riyadh 11952
Tel & Fax: 654-6079 Tel: 442-1307
Factory Tel: 442-194

AL-kharj Dates Factory
P.O Box 1518
Al-Kharj 11942
Tel: 550-0224
Fax: 550-0677

Arabian Company For
Agricultural Services (ARASCO)
Riyadh
Tel: (01) 465 5255
Fax: (01) 464 5375

Attn.: Abdullah Al-Rbian

Al - Mukeresh, Kassim
Animal Feed Plant
Tel: 636 0730/636 4483
Fax: 636 4612

Attn.: Waleed Elias

Non-Government Organizations

Nagmat Al-Mada'en Dates Factory
P. O. Box 224
Al-Kharj 11942
Tel: 5449696
Fax: 5449660

Saleh Al-Bedewi Est.
P. O. Box 30566
Riyadh 11487
Tel: 4215143
Fax: 4214288

Samha Dates Factory
Riyadh
Tel: 4435396

Al-Noor Dates Factory
P. O. Box 1231
Al-Kharj 11942
Tel: 5447557

Al-Riyadh Dates Factory
P. O. Box 7412
Riyadh 11462
Tel: 4764721
Fax: 4791248
Date Store
Kharj
Tel: 5550857

International & Local Machinery Manufacturers & Packaging Material Suppliers

International Suppliers

1) CRYOVAC EUROPE
GraceItaliana S.P.A
Via Trento 7
Casella Posale 108
Attn: Giovanni Candida
Middle East Area Manager
ITALY

2) AIIMENTA SpA
1-35131 Padova Passaggio Gaudenzio, 3
Attn : Michele Bergamasco, Proposal Manager
Tel : 049/663255
Fax : 049/663672
ITALY

3) Ing-A-Rossi
Impianti Industriali S.R.L.
43100 Parma Via Moletolo, 4/A
Attn : Mr. Sabet Haj Issa, Area Manager
Tel : (0521) 271320
Fax : 774331
ITALY

4) CAUSTIER
Siege Social
191, Avenue Prades
66000 Perpignan
Attn: Claude Caustier President - Director General
Tel : 68 54 43 43
Fax : 68 55 51 33
FRANCE

5) IMECA
Zone Industrielle
B.P. 94
34800 Clermont - L'Herault
Tel : 67 96 25 22
Fax : 67 96 91 01
FRANCE

6) CENTAC Industry Contracting
Machinen ung Anlagen GMBH
Ratikonweg 37
88239 Neuravensburg
Attn: Jurgen Ressel
Tel : (07528)7388
Fax : (07528)6688
GERMANY

7) ELLIOT Manufacturing Co.
P.O. Box 11277
2654 So. Cherry Ave.
Attn: Mr. Amer Makki
Tel : (209) 233-6235
Fax : (209) 233-9833
U.S.A.

Local Suppliers

1) ZULTEC
P.O. Box 1579
Jeddah 21454
Tel : 02-6717756
Fax : 02-670034
Attn : Ali Khan, General Manager
Saudi Arabia

2) AL DEWAN PLASTIC PRESSING FACTORY
P.O. Box 40582
Riaydh 11511
Second Industrial City
Tel : 498 5050 / 498 3754
Fax : 498 3758
Saudi Arabia

3) National Packing Products Co. Ltd.
P.O. Box 25817
Riyadh 11476
Tel : 498 2211
Fax : 498 2483
Tlx : 406786 WATPAC S.J
Attn : Abdulghani Nablan - Sales Representative

Jeddah Office
Tel : 653 4369
Fax : 6513994

Damman Office
Tel : 834 4224
Fax : 834 1703

4) EASTERNPAK
P.O. Box 9942
Dammam 31423
Tel : 841 2762
Fax : 841 0967
Attn : Pierre J. Noon - Marketing Coordinator

Riyadh Office
Tel/Fax : 473 0559

5) NAPCO MODERN PLASTIC PRODUCTS CO.
P.O. Box 827
Riyadh 11421
Tel : 479 1086 / 479 1325
Fax : 01 479-1325
Tlx : 801049 NAPCO SJ
Attn : Boulos El-Hage - Sales Representative

Al Kharj Office
Tel : 548 6154

DATE PRODUCTION SUPPORT PROGRAMME IN NAMIBIA

OBJECTIVES, ACHIEVEMENTS AND FUTURE ACTIVITIES

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Windhoek, Namibia

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ABSTRACT

The authors will present the Date Production Support Programme in Namibia which is co-implemented by the Namibia Development Corporation and the United Nations Food and Agriculture Organization since June 1995. The project background and justification along with the addressed problems will first be highlighted. Focus during the oral presentation will also be on the following:

- Project development objectives;
- Target beneficiaries;
- Project objectives and expected outputs and;
- Realized activities and achievements; and
- Planned activities in date production, protection and propagation.

INTRODUCTION

1. **Background:**

To increase and to diversify crop production is the main Government policy thrust for agriculture. A diversification strategy with respect to agricultural production involves what crops perform best in particular area, and in which area will a particular crop perform best. It looks into the type of crops and fruit trees that resist or tolerate drought, and those which perform best under irrigation. Crop diversification is underway through the introduction of crops and varieties of some food crops and fruit trees not normally grown in Namibia.

The production of high value products, as water and arable land are scarce resources, is an appropriate strategy for agricultural development in Namibia. With limited water resources, such development can only be possible with increased productivity, modern production technology, use of efficient irrigation systems, and by the exploitation of semi arid areas. In such areas, a large part of the total amount of water is found in sites where the date palm is almost the only crop that can be grown.

Most date palm plantations were initiated by German troops (1900) and are always located in river beds. This is mainly because there are always two potential sources of groundwater: One is the primary alluvial aquifer along the river valleys and the secondary structural aquifers in the underlying and adjacent rocks.

Over the past eight years, substantial investments have been made in irrigation projects and in date palm production. The Government of Namibia allocated

N$8 658 000,00 to the Naute, Eersbegin, Tissue Culture Laboratory and Hardap projects before 1994. The funds have been used to construct water supply pipelines, irrigation systems (104 ha), housing, a shed/office complex and to put the land under irrigation into production. A further N$6.6 million has been allocated in support of the Project in 1994 and 1995, covering the same activities.

Problems to be addressed

With the present uncertainty in the world food supply and the expected increase in demand, the date palm would offer a good source of high nutritive value. Compared to other fruits (Apricot: 520 calories/kg, Banana: 970 calories/kg, Orange: 480 calories/kg) dates give more than 3000 calories per kilogram. The average annual per capital consumption of dates in the desert of many countries is very high and can reach 150 - 185kgs. Lower quality dates will constitute a component in the nutrition of animals whose milk or meat constitute, in turn the only meagre supply of animal protein for poor peasants inhabiting the southern areas of Namibia.

In addition to the date's high nutritive value, the date palm could play an important role in the ecology of various areas of the Namibian environment; this tree is, in fact, irreplaceable in irrigable desert lands, it provides protection to under-crops from the harshness of the climate (heat, wind and even cold weather) and their fronds are the only available means of reducing the damage from sand storms and wind erosion.

In this context, the development of any cash-crop in the southern areas of Namibia will not be possible without the micro-climate developed by Date Palm Culture. In fact, date palm plantations will allow the cultivation of some fruit trees and annual crops.

In many date growing countries, the date palm has another important economical and sociological role. In fact, for the people living in the Sahara. the palm trees supply an average of two thirds of their income. The date palm and its by-products offer an extra income and provide work to a considerable number of unemployed, landless and poor peasants.

The potentialities of a commercial date production industry in Namibia were realised many years ago (since 1906) in this evidenced by the planting of approximately 10 000 date seedlings in various areas of the country (mainly in Ukuib and Karibib).

Actually, the date palms are grown in five districts (Karibib, Swakopmund, Khorixas, Mariental and Keetmanshoop). Water quality and edaphoclimatic conditions are suitable for date palm culture.

The Date Industry, once established, will contributed to enhance the role of agriculture as the dominant employer and occupation. At a national level, the GCP will also be improved.

However, major hurdles and specific problems and issues for consideration in establishing a date production industry are the following:

a) Lack of high-quality date cultivars

Most date plantations consist of seedlings characterised by low fruit quality and yield. None of the high fruit varieties such as Medjool, Deglet Nour and others are found. The import and planting of such varieties, propagated through tissue culture techniques disease-free and fast growing, will provide the solid foundation of the future date production industry.

b) Lack of rapid techniques and modern facilities to propagate date palm

There is an absolute lack of appropriate propagation techniques for selected date cultivars. The Planting of seedlings still exists and should be discouraged. The removal and planting of offshoots is effected improperly and great losses result.

Only a well functioning tissue culture laboratory will be able to meet the future demand of the country. It will also be possible to enhance foreign exchange earnings, by satisfying the large demand for date planting material in the southern African Sub Continent.

c) Poor technical base

A major technical hurdle which could block the rapid expansion of the date industry in the near future is the almost complete lack of "know-how" of practical techniques of date palm culture. In fact, there is a lack of information related to such culture. Adequate propagation, planting of offshoots, pruning, pollination, fruit thinning and harvesting techniques are necessary to date cultivation.

The Government of Namibia, in the framework of its development plans, has placed the establishment of a date production industry among its priorities. The NDC through the Government requested assistance from FAO to study the technical situation of date palm culture in Namibia and the potential for its expansion. This assistance was approved in August 1992, under the Technical Co-operation Programme, through Project TCP/NAM/2255.

Through the TCP project, the situation of date production was assessed, technical constraints to be overcome were identified, and an overall strategy and action programme to support the development of the date industry in Namibia was formulated. Consequently, a Unilateral Trust Fund Agreement was signed on the 10th of February 1995, between NDC as agent of the Government of Namibia and The Food and Agriculture Organization of the United Nations.

The project is designed to provide technical and scientific skills to the date production enterprise by establishing a date industry, modern propagation and production techniques and training of personnel.

2. Project development objectives

a) Production and economic cultivation of dates resulting in income generation, foreign exchange earnings, increased work and investment opportunities are the aims of the project.

b) To improve the quality of date production for the local and export markets (South African Sub Continent, Europe and Middle East).

c) To provide a settlement action for landless and poor peasants in the rural areas.

d) To strengthen the staff and technical manpower of the NDC, the Government research Stations and private sector date growers.

3. Target beneficiaries

The immediate beneficiaries will be the Government and private sector date growers producing, retailing and exporting date products. Local date fruit consumers and the Muslim community in the neighbouring countries would also share the benefit due to the expected increase in dates available in the region. Finally, the ecosystem of semi-arid regions will be improved.

4. **Project objectives, expected outputs and activities**

1. **Immediate objective 1**

Establish high yielding and good fruit quality date plantations through the adoption of modern date production and propagation techniques. 30,000 superior date plants will be produced and planted at the project sites.

1.1 Output 1

Selection of high quality cultivars to be mass propagated and distributed.

* Improve the production conditions of existing date palm plantations.

* Selection of high quality cultivars among the existing date palm population.

* Propagation of the best genotypes from the existing date palm population.

* Import and select the best varieties adapted to Namibian climatic conditions.

1.2 Output 2

Mass propagation by 1998/1999 of selected cultivars and varieties imported.

* Establish the protocol for micro-propagation of superior selected genotypes.

* Optimise per variety the multiplication process.

* The tissue culture unit will be responsible for large scale multiplication and distribution in order to meet the demand and avoid the use of seedlings and importation. The NDC will assist the Tissue Culture unit with the distribution activities.

1.3 Output 3

Upgrade quality and quantity of date production in the private sector.

* The Hardap Research Station will supply the date growers with adequate date production and protection techniques.

* NDC will advise on the correct management of a commercial date plantation.

1.4 Output 4

Review of market potential for dates produced in Namibia, as a basis for recommendations regarding planting levels.

* Market survey through visit to RSA, research in Namibia and desk research regarding other markets.

1.5 Output 5

Recommendations regarding appropriate marketing arrangements for dates.

* Review of present marketing arrangements and proposals for future requirements.

2. **Immediate objective 2**

To strengthen the staff and technical manpower of the NDC, the Government research stations and private sector date growers.

2.1 Output 1

Trained staff and manpower capable of operating modern date plantation and carrying out research activities on date production and propagation.

II REALISED ACTIVITIES AND ACHIEVEMENTS:

1. **Inception report and workplan (July, 1995)**

   Within 6 weeks of the Chief Technical Adviser (CTA) arrival, an inception report was elaborated in order to update the 1993 date industry situation and also focus on the following:

   - Actual date production and potential market;
   - Assess the Windhoek tissue culture laboratory;
   - Project Personnel;
   - 5 Year workplan; and
   - The 6 months detailed workplan for the period July - December, 1995.

2. **National start up workshop:**

   In order to inform interested persons / institutions about the objectives of the project, its components and expected outputs, the 5 year-workplan, the availability of project personnel to technically assist private farmers, and the research aspects on date palm propagation, production and protection, a National start-up workshop was held on 6 September 1995 at Windhoek.

3. **Project implementations (cf. Fig. 1):**

   3.1 Date Production Projects

   - Naute Date Project
   - Eersbegin Date Project
   - Aussenkehr Project

   <u>Naute Date Project</u>

   - 20 ha planted with selected varieties.
   - 22 ha planted with Medjool and BouFeggouss date varieties.

Eersbegin Date Project

- 19 ha planted with local clones.
- 15 ha planted with Medjool and gene bank collection.

Aussenkehr Project

- 10 ha planted with selected date varieties.

3.2 Date Palm Research

- Climalogical adaptation of selected varieties tested at Naute, Eersbegin, Aussenkehr and Hardap Research Station.
- Water requirements of a date palm - Naute.
- Pollination and fruit thinning experiments - Eersbegin.
- Processing and packaging of fruit for marketing.

3.3 Tissue Culture Laboratory

- Support to ensure the establishment of economic viable production.
- Support to initiate selected varieties for propagation.

3.4 Private Date Farmers

- Evaluation of potential.
- Project planning guidelines.
- Technical support.

4. Consultancy missions:

Since its launch, the project did benefit from several consultancy missions undertaken by renown Experts hired through the FAO System. Up to June 1997, the following specialists visited the project and closely worked with the date national team according to their specific terms of reference:

- First consultancy mission on Date Tissue Culture: 14-23 December, 1995.

- First consultancy mission on Date Production: 07-24 March, 1996.

- First consultancy mission on Date Marketing and Handling: 5 March - 02 April, 1996.

- Second consultancy mission on Date Production; 22 July - 06 August, 1996.

- Second consultancy mission on Date Tissue Culture: 08-31 August, 1996.

- TCDC Date Protection consultancy: 10 October - 02 November, 1996.

- Third consultancy mission on Date Tissue Culture; 12-27 June, 1997.

5. **Other sources of technical assistance:**

During the Project's Five Years Period, several international Consultants (as stated above) and FAO staff from the Headquarters Technical Division are programmed to visit the project and make their advises and technical recommendations available to the National Date Team and to private date growers. Up to June 1997, the project was visited by:

- Mr. E.S. Seidler: AGSM-FAO Rome Headquarters (22-25/11/95)

- Mr. E.J. Arias: AGPC-FAO Rome Headquarters (04-12/02/96 & 21-27/04/97)

- Mr. C. Joly: CPO-TCO2 - Rome Headquarters (19-24/10/96).

- Other technical visits:

    * Technical backstop and Country Project Officer's visits (June/September each year).

* Evaluation Mission of the Project: November 1998 by an Independent technical specialist..

6. **Training activities already implemented:**

6.1 Study Tours:

According to the project's workplan, the following study tours were already implemented:

- A study tour for one month duration for two nationals, to Morocco, Tunisia and USA (05/01/96 - 08/02/96).

- A study tour on date palm production and protection (Morocco) for one month duration for three nationals, (05/01/96 - 03/02/96).

- Two weeks study tour to Israel for date production, packaging, handling and marketing (26 August - 10 September, 1996) for five nationals.

6.2 Training Activities:

- One month tissue culture training in Morocco for the Manager of the Tissue Culture Laboratory (05/01/96 - 03/02/96).

- Two weeks training course on Molecular biology held at the Experiment Station of the SA Sugar Association; 04-15/11/96 for the Manager of the Tissue Culture Laboratory.

- Two weeks training course on Tissue Culture Techniques held at the Roodeplaat - Vegetable and Ornamental Plant Institute (RSA); 06-12/10/96 for the Assistant-Manager of the Tissue Culture Laboratory.

- Two weeks training on FAO/UNDP project's Management for the National Project Director, at FAO-Headquarters (Rome, Italy); 20 - 31 January, 1997.

- Two weeks training course on Mycology and bacteriology held at the Plant Protection Research Unit (RSA); 12-23/05/97, for the Tissue Culture Laboratory Manager.

It is worth to mention that all above candidates did already prepare their study tour technical reports which were communicated to Government and FAO officials.

6.3 Hardap Annual Training Course:

Within the framework of its annual workplan, "Date Production Support Programme" organised a theoretical and practical training course on "Date Propagation, Production and Protection" on the 12, 13 and 14 of August 1996 at the Hardap Research Station.

The training course, held each year, is organised in order to impart training and to educate research workers, technicians and private farmers in improved methods of date palm production, propagation and protection. Fostering closer collaboration between all parties involved in the date palm industry in the country is also an aim of the course.

As mentioned above, the Date Production training course at Hardap is an annual event and will be held during the next years as follow: 18-19 August (1997), September (1998), and June (1999).

6.4 Informal Training:

Field demonstrations on date propagation (in vitro techniques and also type of offshoots to select for planting, technique of planting, fertilisation, ...), date production (pollination, thinning/pruning, inflorescences protection) and on date protection (symptoms of Black scorch and brown leaf spot diseases, attacks by rhinoceros and long horn beetles), ... were supervised by the CTA and the NPD. Project Managers and several private date growers did benefit from such demonstrations.

III PLANNED ACTIVITIES:

1. Date development:

* *Naute* : 40 ha of Medjool and Barhee varieties to be established during March/April, 1998.

: 30 ha of Medjool variety to be established during March/April, 1999.

* *Aussenkehr* : 20 ha of Medjool variety to be established during March/April, 1998.

: 20 ha of Medjool and Barhee varieties to be established during March/April, 1999.

2. Technical practices and extension activities:

Technical assistance is made available to all project sites, NDC and Government staff and private farmers. The project team is also conducting extension activities through the production of technical leaflets (up to June 1997, 12 were already distributed), specialised documents and illustrative photos.

3. Date palm annual technical calendar:

In the light of the experience gained during the last two years and in order to optimise the action of each project manager and date private farmer, an updated Annual Technical Itinerary will be established for date palm, which will cover all steps from pre-planting till harvesting.

4. Date research activities:

As soon as the Associate Professional Officer (APO) is recruited by FAO, he will be assisting the national team to conduct and monitor the research topics already initiated in the field of date propagation, production and protection.

5. Consultancy missions:

- Germplasm initial study by Dr. Anishetty. July 1997.

- Second consultancy mission of Date Marketing and Handling Expert. March/April, 1998.
- Annual Technical backstopping visits by FAO Headquarters (AGPC and CPO).
- Evaluation consultancy mission by an independent Expert. End of 1998.
- Third consultancy mission of Date Production Expert. March /April 1999.

6. **Training activities:**

- Study tour to Israel for date handling, packaging and marketing: 30 August till 15 September 1997. Five official candidates are already nominated.
- Study tour on irrigation for one national (Engineering Department, MAWRD); Israel - September, 1998.
- Second Annual Training Course which will be held at Hardap Research Station during 18 & 19 August, 1997. This year's subject will focus on "Hardening off, Field preparation and Planting Operations".
- Field demonstrations to new date farmers during visits and field trips.

IV ISSUES:

- Investigate the opportunity of Namibia becoming the World Date Germplasm and the signing of the FAO Protocol if beneficial for the Country.
- Legislation preventing the introduction of Bayoud and other diseases infested plant material.
- Support to encourage the establishment of date plantations.
  - → Extension and training
  - → Subsidised plant material

→ Financial support: Loans at "soft" terms.

- APO assistance request channelled through the FAO.
- Irrigation design, tenders and implementation

  Hardap Research Station : 6 ha research unit

  Naute Date Project : 30 ha production unit

  Aussenkehr Project : 20 ha settlement unit

- Eersbegin Project : Interplanting of 19 ha local clones with selected varieties.

V COMPONENTS TO BE INCLUDED IN THE NEAR FUTURE:

1. Packing house for date processing and packaging:

For the Date industry to be sustainable, Namibia needs to maximise sales revenue by targeting the higher priced markets of Europe and Middle East. However, to reach these markets, a modern processing and packing house needs to be established. This packing house is extremely important for achieving the Country's goal in growing, packing and exporting high quality dates.

2. Settlement projects:

One of the main objectives of the Date Production Support Programme is the settlement of landless peasants with a creation of job opportunities and income regeneration. Hardap and Aussenkehr are actually under investigations for date palm-based settlement purposes.

3. World date germplasm:

Namibia is now officially recognised as a date palm diseases and pests-free country. All major date diseases known in the Northern hemisphere are absent. At an international date palm conference organised by the IAEA in Vienna-Austria (27-29 March, 1996), Namibia was proposed as the World Date Germplasm. The plant Production & Protection Division (FAO-Rome) through Dr. Menini and Dr. Anishetty is working closely with the project team to study the feasibility of the Germplsam Establishment.

4. **International date palm symposium:**

As proposed in the Project's Document and also as highly recommended by different international consultants that visited the project, the organisation of an International Date Palm Symposium, will be of a great benefit to the Namibian Date Industry. Such event, will be held during the last year of the project and will gather Officials, scientists, Businessmen, Laboratory-managers and Date Growers, ... form all around the world.

VI NEW PROJECTS FORMULATION:

Recently, the terms of reference of the Chief Technical adviser were amended (December, 1996). The CTA is to assist the NPD and National Date Team in the preparation of technical assistance related to the Date Production Programme, i.e. Contribution to the preparation of Plan of Operations between Government and Donors (including FAO).

Hence, two project proposals were drafted and submitted for FAO approval:

1. TCP/Packing House for Date Processing & Packaging.

2. TCP/Preliminary Assistance for Date Industry Development in Southern and Eastern Africa.

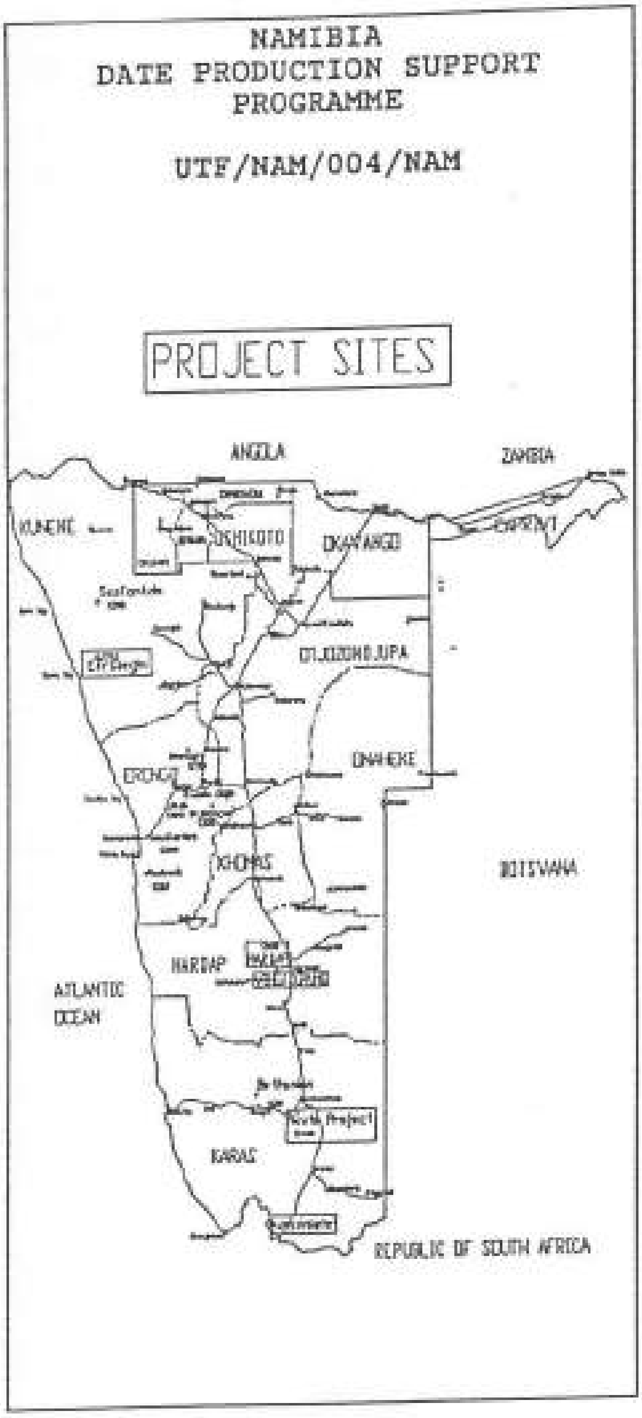

Figure 1. Date Palm Project's Sites.

DATE PRODUCTION AND MARKETING IN THE UNITED ARAB EMIRATES

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ABSTRACT

This study aims at exploring the present date palm situation in the United Arab Emirates (UAE) and determining the obstacles that hinder the expansion in growing date palms and suggesting the suitable solution. Date palms are the most important fruit trees in the UAE. In 1996, palms covered 92.4% (310 thousand dunums) of the cultivated fruit trees area, and the bearing trees (8.6 million of 21.2 million trees) produced 244644 tons of dates valued at US$ 264 millions. Therefore, it needs an expanding date processing industry and an efficient marketing system for its high production to reach new outlets.

Main cultural practices in dates growing are: irrigation, fertilizers, pollination, thinning, pruning, and pest control.

Major obstacles are: off shoots shortage of good cultivar, water and soil salinity in some regions, and marketing problems.

Asia is the most producing continent with 66,1% of world production in 1996. Arab - African countries produced 31.6% of the world production and 95% of Africa production in 1996.

As to Arab and Muslim Asian countries, they produced 98% of Asia production and 64.7% the of world production. The world largest producers of dates in 1996 were: Iran, Egypt, Saudi Arabia, Iraq, and Pakistan, successively. The major importers of dates for local consumption in 1995 were: India, Malaysia, Indonesia, and Russian Federal Republics. The UAE is a producer - trader of dates.

It imports significant quantities and re-exports it. Main countries that don't grow date palms but import to re-export dates are: France, Hong Kong, and Singapore.

Additional Index Words: date palms, growers, cultural practices, export, import, re-export.

INTRODUCTION

The blessed date palm tree is mentioned in many verses of the Holly Quran and in many sayings of the Prophet Mohammed (God`s blessings and peace be upon him), and used by our ancestors for many purposes, mainly for shelter and as a source of food all year round.

قال الله تعالى:

(ألم ترَ كيف ضرب الله مثلاً كلمة طيبة كشجرة طيبة أصلها ثابت وفرعها في السماء تؤتي أكلها كل حين بإذن ربّها ، ويضرب الله الأمثال للناس لعلهم يتذكرون) صدق الله العظيم سورة ابراهيم ، الآيات ٢٤، ٢٥

(Seest thou not how God sets forth a parable? A goodly word like a goodly tree, whose root is firmly fixed and its branches (reach) to the heavens, It brings forth its fruit at all times, by the leave of its Lord. So God sets forth parables for men, in order that they may receive admonition". True is the word of God, the great. Ibrahim chapter, verses 24, 25.

وقال تعالى:

(وهزي إليك بجذع النخلة تساقط عليك رطبا جنيا، فكلي واشربي وقري عينا)

صدق الله العظيم سورة مريم ، الآيات ٢٥، ٢٦

(And shake towards thyself the trunk of the date palm tree, it will let fall fresh ripe dates upon thee so eat and drink and cool thine eye 0 (True is the word of God, the great. Maryam chapter, verses 25,26.

وقال النبي صلى الله عليه وسلم

(إذا قامت الساعة وفي يد أحدكم فسيلة فليغرسها)،

The Prophet Mohammed (God's blessings and peace be upon him) said, "If the Judgement Day is setting out and anyone of you is holding an offshoot to plant, don't stop planting it."

I would like to assert that the President His Highness Sheikh Zayed bin Sultan Al-Nahyan realizes the importance of the date palm tree and is aware of its place in our deep - rooted history. Therefore the government of the UAE in general and the Department of Agriculture and Livestock in Al-Ain in particular have adopted a program for encouraging date palm farmers to improve dates production as to quantity and quality. Upon this, the Department has put a constructive and effective program in this direction.

Wherever the UAE is mentioned, one would think of its date palms, dates, landscape gardening and the warm friendship and hospitality of its people.

ORIGIN AND DISTRIBUTION OF THE DATE PALM

The date palm is related to the order Palmae, to the family Palmaceae, to the genus *Phoenix* and to the species *dactylifera*. So the scientific name is *Phoenix dactylifera* L.

"Several thousand years before its cultivation prehistoric man used the fruit from wild palms and carried the seeds over the wide area from India through the Middle East and later to North Africa. The date palm (Phoenix dactylifera L.) was known to ancient people as the "Tree of Life" and is probably one of the first fruit trees to be cultivated. Representations of the date palm, dating back to 3000 BC. Appear on Sumerian temple walls in present - day in Iraq .In Egyptian hieroglyphics the date palm is used as the symbol for a year and it's frond is the symbol for a month. Date palm logs were used to roof royal tombs as early as 2700 BC" (Laftin, 1995).

The date palm is exalted and magnified by God as it is mentioned in the introduction. Dates and date palms are mentioned in the Talmud. It is said in the Bible too that the supporters of the Christ had spread out fronds of date palms in his way when he entered Jerusalem and carrying an offshoot in his hands indicating that Jerusalem is the center of peace.

"Date seeds were probably carried around the Mediterranean sea by Phoenician traders. Introduction of date culture into the Saharan oases was furthered by the introduction of the camel and the Arab advance across North Africa. Subsequent piligrimages of faithful Moslims back to their homeland in Arabia promoted exchange of varieties in North Africa".

Spanish missionaries were the first who planted date palm in North America in the outset of the sixteenth century. Importation of offshoots took place around the year 1900.

CURRENT STATUS OF DATE GROWING IN THE UNITED ARAB EMIRATES (UAE)

The UAE is located in the tropic area (tropic of Cancer). The average annual temperature is about 27C. Maximum temperature is about 48c in

July and August, and the minimum temperature is sometimes about 4c in January. The palm tree has the capability to resist coolness due to the thick coating created at the base of the fronds and the fiber surrounding the palm trunk which isolate the palm from the outside atmosphere.

The average annual humidity is more than 50% in the coast areas and it reaches to 95% in hot summer. Rain falls in winter time, the average annual precipitation is about 40 mm in the west and 96 mm in the coast regions. The soil is permeable and well aerated.

Since date cultivation requires a high temperature, much sunlight, low humidity, low rainfall and since it is salt - tolerant; the UAE is appropriate for date plantation.

Relative humidity plays a great role in date plantation and variety distribution. Some varieties are suitable for the regions close to the sea coast with high relative humidity; others are suitable in the mountain regions and between the valleys and other varieties are suitable for the areas far from the sea as Al - Ain city.

Hereunder is the distribution of date plantation in UAE according to regions:

1- Abu dhabi region:

Date plantation extends around Abu Dhabi city and the western region which includes: Liwa, Ghayathi, Bed'e Zayed, Seer Bani Yas and Delma. It also extends in the eastern region which includes Al-Ain city, Um Ghafa, Al-Khazna and Swaihan.

Regions planted with date palms, have the advantage of low relative humidity which conduces to dates ripeness and dryness on the palm.

By virtue of the instructions and advice of the President His Highness Sheikh Zayed bin Sultan Al-Nahyan, His faithful Crown Prince H.H.Sheikh khalifa bin Zayed Al-Nahyan, the continuous follow - up of H.H. Sheikh Tahnoon bin Mohammad Al-Nahyan, the Ruler's Representative in the eastern region and the supervision of His Excellency Ahmad Sultan Al-Hallami, the Undersecretary of the Department of Agriculture and Livestock in Al-Ain, date palm plantation has expanded, whereas thousands of new farms have been established especially in the eastern region and donated freely to the citizens. Upon the instructions of the President of the State, Sheikh Zayed bin Sultan, every farmer must plant 2oo offshoots in the first year when he is given the farm and 50 offshoots / year for the four succeeding years.

The department of Agriculture and Livestock has placed all its capabilities for the attainment of agricultural development so as to achieve the eminent goals that the President has laid down their foundations. This is achieved through providing information for the farmers about cultural practices such as irrigation principles, manure, fertilisers, pest control, pollination, thinning, pruning, harvest and marketing.

The Department of Agriculture and livestock in Al-Ain has invited offers for importing certified offshoots (Barhi and khalas) to be planted in Al-Oha project (25 Km north of Al-Ain). The successful bidder delivered 10 thousand barhi offshoots and 13 thousand khalas offshoots in February 1997. The second bid is 40 thousand khalas offshoots in February 1998, and the third bid is 100 thousand khalas offshoots in April 1998. The Department also provides 1200 new farms in Al-Ajban region with 100 free of charge offshoots for each farm.

In 1997, the Department of Agriculture and livestock invited offers for constructing a date processing factory with annual capacity of 20 thousand tons at a cost of 141 million dirhams. The factory will be in operatian in May 1998. There is another date processing factory in Abu Dhabi city owned by Abu Dhabi muncipality with annual capacity of 6 thousand tons.

In Abu - Dhabi Emirate there are 16,199,671 date palms out of which 6,756,169 are bearing. They occupied 224057 dunums (1dunum = 0.1 hectar) and produced 108710 tons.

2- The middle region:

It includes areas from Dubai, Sharja, Ajman, Um - Elqiwain, Ras -El-khaima, and Al -Fujaira. Thes region has 1,972,978 date palms out of which 720,331 are bearing. They occupied 38,426 dunums and produced 60,637 tons.

3- The north region:

It includes most areas of Ras – El - khaima and some areas of Al Fujaira. The region includes 1,334,650 date palms of which 481,965 are bearing. They occupied 23317 dunums and produced 37,625 tons.

4- The east region

It includes areas on the east coast of Al -Fujaira, Sharja and Ras - EL - khaima. It has 1,715,282 date palms out of which 649,941are bearing. They occupied 24254 dunums and produced 37672 tons. Hereunder is some statistical tables about the date palm tree in the UAE.

MAIN CULTURAL PRACTICES.

1- Irrigation:

The palm tree is thirst tolerant and drought resistant to a great extent. This refers mostly to its morphology. In spite of that palm trees are water salinity resistant campared to other fruit trees, The yield palm trees starts decreasing when water salinity reaches 6000 ppm, and when water salinity reaches 12000 ppm the yield comes to standstill.

Frequency of irrigation depends on soil texture and weather condition .Producing date gardens in light soils are usually irrigated every 7-14 days in midsummer and every 20-30 days during winter, if flood irrigation is used. Growers in many date producing areas have had good success running their emiters continuously during hot summer months . Where drip irrigation is used from an early age, the root distribution of the palms will be within the area of moist soil around the tree .The emiters should be moved out away from the tree as it grows so that a normal spreading root system will develop. It is also important to let the soil aerate between waterings.

2- Fertilizers:

Palm trees respond positively to natural and chemical fertilizers especially in sandy and gravel soil. Shortage of fertilizers can be figured out through few, small, yellow fronds and slight yield.

Nitrogen (N) is always needed at a rate of 1.5 - 2.5 Kgs/tree /year. If the need exists for phosphorus (P) and or potassium (K), then a compound fertilizer should be used such as 20 -10 - 10.

If manure is used, the desired amount of N is easily calculated. Good steer manure usually contains about 2% N. About 90 Kgs of steer manure will give nearly 2 Kgs of N per palm. Poultry manure usually contains about 3-4% N, but is high in P so it should be mixed about half and half with steer manure to reduce the possible detrimental effect of too much P on micro-element nutrition.*

Manures, P and K are usually added in November and December, N is added in January, March and May. (Shabana, H; Date Palm in the UAE).

3- Pollination:

The common method of pollination is to cut the strands of a freshly opened male flower and insert 2 or 3 of them among the strands of the female flower cluster during the first few days after it has opened. It is advised to tie the pollinated cluster by a twine to hold the male flowers in place and to prevent the strands of the female flower cluster from becoming entangled in the leaves during the rapid growth that follows. To allow for expansion of the cluster as the fruit develops, the twine is commonly tied in a slipknot, having the free end long enough to permit later adjustment to the maximum size of the bunch. Sometimes, a small paper hold bag is placed over the pollinated flowers, held in a place by a date thorn against unexpected rain and strong wind. The bag will blow off later as the pllinated bunch grows.*

Mechanicul pollination can be applied through a duster with a long light pipe which conveys the pollen (mixed with white soft flour 1: 9) to the female flower cluster. This process is applied after 3-4 days from female pollen florescence and reiterated after 5 - 7 days for three times for each palm. (Shabana, H).

Dry pollen, protected from extreme heat, remains viable for 2 - 3 months. If stored in a sealed cantainer and placed in - 18c, it may be held until the next season. This is a good way to have pollen available in case we have some early female flowers the next year, before the male palms bloom. It is advised to observe which of the male trees are the best producers of pollen and to plant the offshoots from those trees for future pollen production.

4-Thinning:

Date palms tend to bear only in alternate years without thinning. To control yield and alternate bearing, one must limit the number of bunches per tree. The earliest flowers are usually the largest and most vigorous. Removal of later flowers in excess of the number wanted is advised. Thinning is practiced through two techniques:

a. Bunches cutoff

Weak bunches are usually cutoff through March and April, and after pollination.

b. Strands cutoff.

At pollination, about 1/3 of the upper portion of the flower is cutoff. Four to six weeks later, when pollination success can be determined,

* Laflin, Ibid. P28.

enough center strands are cut out to leave 1/2 to 2/3 of the total strands intact.

This method has the advantage of decreasing the bunch weight which lessens the later danger of fruitstalk breakage and improves the quality of the fruits.

Any method of reducing the number of fruits per bunch will increase the size to a certain point and improve the quality. Overthinning increases puffiness and blistering. The earlier thinning is done, the more effective it is in increasing size.

Most commercial growers follow a practice of pulling down and supporting the bunches. This is usually done at the time of the second part of bunch thinning. The fruitstalk is pulled down through the leaves and tied to the midrib of one of the lower leaves. Pulling down punches should be done with great care to avoid breaking fruitstalks. Bunches should not be pulled down until the fruitstalk is long enough to permit some of the curvature to be distributed at the whole stalk, so that the base will not take all of the stress. If it is done before entirely ceased fruitstalk elongation, there will be more probability of stalk breakage. Broken fruitstalks are a yield loss, and partial breakages are also a source of low grade yield. Fruitsaiks grow rapidly through the first few weeks after pollination. During this time they are pliable and easily bent at their bases.

5- Pruning

Palm pruning covers:

a. fronds cutoff: It is done twice per year (i.e., at pollination and curvature)

b. fronds bases cutoff: once every two years in winter and autumn time. It is not advised to do this process while the palm is young (i.e. less than four years old).

c. fiber removal among frond bases.

d. spines removal from all leaves from the previous year growth

e. removal of bunches, bunches' holders, and pollen coats from the previous season.

f. removal of some offshoots and pruning of others.

6- Pest control

In regard to this topic, it will be covered by a specialist colleague.

F = FAO estimate

* = unofficial figure

The Average world production was 3532 thousand tons through 1989-91. It increased to 4492 thousand tons in 1996, (i.e. 27.2%). Asia is the most producing continent, 66.1% of world production in 1996 .Its production increased to 2969 thousand tons in 1996 from 2272 thousand tons in 1989-91, (i.e. 30.7%) while the percentage increase was 21.7% in Africa for the same period.

Production is concentrated in Arab and Muslim countries. Arab countries in Africa produced 1421 thousand tons in 1996, (i.e. 31.6% of world production and 95% of Africa production).

As to Arab and Muslim Asian countries, they produced 2905 thousand tons in 1996, which is 98% of Asia production and 64.7% of world production.

The world's largest producers of dates in 1996 were Iran, Egypt, Saudi Arabia, Iraq, and Pakistan, successively. (795, 680, 597, 550 and 533 thousand tons), this corresponds to 17.7%, 15.1%, 13.3%, 12,2% and 11.9% of world production, respectively.

As to the UAE, the average production was 152 thousand tons in 1989-91 and 236 thousand tons in 1993 (55.3% increase), and increased to 240 thousand tons in 1996.

Table 6. Date Main Exporters, Traders; Re-Exporters and Importers (1993-1996)

	Import (ton)			Export (ton)		
	1983	1994	1995	1993	1994	1995
World						
Producer – Exporters	317699	405446	293411	302906	371856	307362
Iran	-	-	-	109120	134603	100 000 F
Iraq	-	-	-	10000 F	30000 F	30000 F
Sudan	-	-	-	1000*	1100*	1000*
Algeria	-	61	-	19809	3763	21852
Saudi Arabia	172	-	260*	18181	16622	18000 F
Tunisia	4	56	15	18510	20781	20782
Oman	3	55	1361	6046	6547	5697
Producer - Traders						
Egypt	975	1067	737	5407	5653	2513
Pakistan	6419	16189	11214	29012	52515	45700
USA	5426	5337	3239	6085	6523	5814
United Arb.Em.	82333	121814	60000 F	50000 F	69369	30000 F
Re-Exporters.						
France	20484	17759	16987	9596	5128	5476
Germany	5775	4840	4291	359	389	448
Hong Kong	6584	7073	5250	5426	4758	3342
Singapore	6505	4408	3121*	4272	2846	3260
China	2848	7444	3319	792	52	1098
UK	11391	12707	11949	942	1273	1127
Nonproduer- Importers						
Malaysia	8237	12088	15180*	47	664	199
India	69528	98948	80000 F	173	7	7 F
Indonesia	7031	6537	9279	174	43	30
Russian Fed	14233	12171	6455	-	143	167
Yemen	9039	6444	6000 F	-	-	-
Italy	5022	4999	4951	83	130	679
Canada	5718	5743	4691	302	121	106
Syria	5451	7011	4000 f	-	12	-

Source: FAO Trade Yearbook, vol. 49-1995

F = FAO estimate, * = Unofficial figure

Tables 5 and 6 show that world export of dates in 1993-1995 was 7.5%, 8.5% and 6.9% successively compared to the world production for the same period, while dates world import compared to world production of dates was 7.9%, 9.3% and 6.6% for the same period.

Table 6 show we notice that the main non - producer' importer countries had imported 124259, 153941, 130556 tons of date of the world imports in the years 1993, 1994,1995 successively, (i.e. 39.1%, 38.0%, 44.5% of the world imports).

We notice three types of date exporters:

1- Producer - Exporters: Iran, Iraq, Sudan, Algeria, Saudi Arabia, Tunisia and Oman. They are large producers with surplus to export.

2- Producer - Traders: Egypt, Pakistan, USA and UAE. They produce and export, but at the same time. They re- export imported dates.

3- Re-Exporters: France, Germany, Hong Kong, Singapore, UK and China. They are non -producing countries, but re-export imported dates.

We have also the non-producer importers India, Russian Fed, Italy, Canada, Yeman and Syria who do not grow date palms. They import significant quantities and may or may not re-export insignificant portion.

Non -producing countnies in Europe, (especially the emerging markets in East Europe), Australia, the Far East and Canada are promising markets for date producers and can increase the present demand supported by the awareness of the nutritional value of dates.

FINDINGS AND RECOMMENDATIONS

Some regions in the UAE have some advantages that other producers do not have. They are very hot and have a long growing season almost without rain, and are capable of producing early good quality dates for the market. Thus they are able to gain some of the higher early market prices.

If date palms plantation is encouraged on commercial bases, the following main recommendations have to be adopted and utilized:

1- Propagation by offshoots rather than tissue culture plants should be adopted, because new palms will be exactly like the mother palm. The same for offshoots of good selected males.

2- Varieties with the greatest possible success and with the greatest commercial potential should be planted.

3- Establish certified offshoot nurseries of good commercial cultivars of dates.

4- In older plantings, farmers should be encouraged to remove excess trees of poor cultivars especially in dense plantings. Too many trees close together reduce tree yield and use water in quantities that can't be justified by the fruit produced. There should be at least 7 - 8 m between trees.

5- Establish new demonstration plots in the several regions for dates production to show farmers all stages of growing and harvesting dates.

6- Promote dates consumption via various media channels, emphasizing the excellent nutritional value of dates.

7- Establish some kind of Date Palm Institute envolving persons from the agricultural stations, university researchers, and experienced farmers to exchange views and ideas with more concern and interest to market research.

8- Expand date processing industries to absorb excess produce and to meet the demand in foreign markets which will bring benefits to the economy like employment generation, value added and foreign exchange earnings / savings.

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ADAPTATION OF THE RESEARCHES TO THE PECULIARITIES OF THE DATE PALM (*PHOENIX DACTYLIFERA* L.) CULTURE AT ELCHE (SPAIN).

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ABSTRACT

The date palm grove of Elche presents very peculiar characteristics: northern marginal latitude, agricultural practices, pests, uses, legal status, socio-economic context.

Because of these peculiar traits, original research concerning date palm are carried out at Elche on various subjects: varieties behaviour, anatomical date palm study, in vitro adult date palm propagation, physiology of the date fruit development and maturation, controlled maturation and conservation technology, new pest studies and biological control, farming systems and market studies.

Additional Index words: date technology, date maturation, tissue culture, organogenesis, somatic embryogenesis, axillary buds, biological control, red scale, date market, farming systems, landscape.

INTRODUCTION

Date palm culture is considered as typical of the arid hot climate. But, date palm, as ornamental tree, is also present in many other places and, particularly, in the South of Europe where the winters are not too cold.

Nevertheless, date palm for its cultivation has also been introduced in some places of Europe. It is used to be said that Elche grove, "el palmeral de Elche" is the unique of Europe. Although this is not totally true because there are some other small plantations in Spain (Ferry, 1995) and in Italy, the date grove of Elche constitutes the main one in Europe.

It is located in a very marginal situation. Except one place in Kurmenistan (Munier, 1973), it is the northern locality for date production purposes (38° North).

The number of adult date palms is evaluated to be around 150.000 and the total area of the palm grove does not exceed 400 ha. The total production of dates of Elche can be estimated at 5000 tons per year but only, 100 tons per year are sold for human consumption (Ferry and Greiner 1997).

For many reasons that have probably affect each other, this palm grove presents many peculiarities. These peculiarities constitute specific problems regarding the survival and development of this agrosystem. I will present the major original characteristics of this palm plantation, the problems that they involve for the development of this culture and the different researches that have been defined to contribute to solve them.

THE INSUFFICIENCY OF HEAT AND THE BASES OF THE RESEARCH ON DATE TECHNOLOGY.

During the main period date maturation, heat is missing in Elche. The lack of heat can be expressed by the heat fructification sum: Elche has 792 heat units compared with 1854 for Touggourt (Algeria), a typical date station (Munier, 1973). In this example, the heat units were calculated by the multiplication of the mean month temperatures minus 18°C by the number of days of each month from pollination time to harvest time.

Problem of date maturation

This lack of heat has various consequences for date maturation in general:

- A part of the crop does not achieve to maturity or matures in a bad way, and can not be used for human consumption.

- The heterogeneity of maturation on the same tree and in the same bunch is high: it is common to find on the same bunch dates at the kimri stage as well as the kalal and rutab stages. As a consequence, the dates are generally harvested one by one. Consequently, a date producer in Elche has to climb 12 to 15 times to harvest all the ripened dates of a same tree. This has evidently an important consequence on the profitability of this activity. A traditional technique is used to mature artificially a part of the date production that is harvested as total bunches: the dates are wetted with vinegar and, then, kept confined for two days.

- The majority of the dates are of the soft type. They have to be picked up at the right time otherwise they spoil rapidly and they have also to be sold and consumed quickly: their shelf life is very short, 2 to 5 days.

Bases of the research on date technology

Nevertheless, some rare date palms of Elche produce dates of interesting commercial potential: attractive size and colour, good taste, original quality as soft dates. The last point carried on the problems of harvesting and conservation described before but, if technologies are set up, it constitutes also the commercial advantage to offer a new type of dates that are very different with the main imported ones (Deglet Nour, Medjool), they will not have to compete with them, that should be probably impossible, and they fit well with the consumption tendencies (attraction for newness, natural and less caloric products).

Consequently, researches have taken place at the Phoenix Station in two very associated directions: artificial maturation and conservation and processing to offer "fresh" soft dates (Vilella and Bousquets 1996). To set up these technologies, the physiological and bio chemical mechanisms of development and maturation are also being studied (Ros et al, 1996; Vilella and Del Rio 1998). Indeed, although a lot of papers on chemical date composition have been published, little is known in fact on the mechanisms involved during date fruit development and maturation.

Of course, as in Elche, the rare interesting date palms for commercial date production have different unique genotypes, This research on date technology takes sense because in a complementary way are developed other researches on the propagation of these genotypes as well as on the cultural and farming systems that will make profitable the creation of new date palms plantations.

THE DATES PALMS HAVE BEEN CULTIVATED AS A SECONDARY CROP. THEY ARE PROPAGATED BY SEEDS. CONSEQUENCES FOR THE RESEARCH

Very strangely, at Elche, the date palms are propagated by seeds. Consequently, there are no varieties but a population of hybrids. Because this population has been propagated like this for centuries and probably since the beginning of its existence, it expresses of very high phenotypic diversity.

How can it be explained that the vegetative propagation by offshoots has never been used in Elche?

Although date palms were present in this area as in many places of the Spainish coast before the arrival of the Arabs (Pline the Ancient, 77 traduction from Ernout, 1956), the date grove of Elche as an agrosystem has probably been developed by Moslem conquerors and, perhaps, much more later, contrary to our previous hypothesis (Ferry and Greiner, 1997).

In the rare documents concerning Elche during the Moslem era no reference is made to the date grove. As emphasised by Jaén (Jaén, 1994) and contrary to what is usually claimed and published, nothing at all is said about Elche date palms in the chronicle of Jaime I of 1267, when the Christians recovered this region of Spain! In fact, the creation of the city of Elche itself and the islamisation of this area have been late, perhaps X century or even XI century (Ramos, 1994). Furthermore, islamisation does not mean that this area was occupied by Arab people and even less by people knowing date palm culture.

But, even in the many other places of Spain, where agro-ecological conditions were similar or better to Elche's and where Arabo-Berbers remained for various centuries, date palm culture was not developed. I think that, if this type of culture has not been developed in Spain, even during the Islamic domination when date, demand was the highest, it is because of the problems of date quality at this northern latitude. In Spain, because of the lack of heat, dates do not generally ripen well and they can not be kept. Pline stated the lack of sweet taste of Spainsh dates even in the first century.

In Elche, the development of date culture has reached, probably little by little, a relative importance but it has always be very limited. As emphasised by Jaén (Jaén, 1994), the number of date palms has probably never exceeded 70.000-80.000 date palms before the 20th century (again contrary of what is usually claimed).

Date palms have been grown here as a secondary crop, at high density, at the periphery of plots on which were cultivated the main crops. As in many other groves in the world, they have been grown for their multipurpose interest: handicraft, construction, firewood, animal feeding or landscaping. Furthermore, in Elche, the ancient (XV century) and original production of white leaves has probably contributed to a more special interest for this culture.

Cultivated for these various uses much more than for their fruit production, there was no need to do a selection and to use the delicate vegetative propagation technique. The propagation of the date palm by seeds constituted a simple and quite satisfactory technique.

This situation explains well why, in Elche, the vegetative propagation and the creation of varieties have not been done. Consequently, the date grove of Elche is a population of date palms.

Research on the in vitro propagation of adult date palms

There are no varieties in Elche and, in addition, as the offshoots are not used, they are killed to facilitate the work at the base of the date palms and to promote the growth of the mother-tree. The only offshoots that are kept are the offshoots of few date palms that appear and develop in aerial positions at the same level and offshoots are sustained by metallic supports to avoid their breaking down. These branched palm trees constitute remarkable ornamental specimens; the most spectacular and famous one is the Imperial palm tree of the Huerto del Cura: it has 7 branches at the same level all around the mother trunk.

Besides the absence of varieties and the traditional practice to suppress the offshoots, the largest part of the adult date palms of Elche is very old (more than 50 years). For the last 10 years, numerous date palm nurseries for ornamental purpose have been created but these date palms are still too young to make possible the evaluation of the quality of their date production. Consequently, the rare interesting genotypes for their commercial date quality that have been found till now are old trees.

The only way to multiply these selected palm trees is by tissue culture. But, knowledge on the use of adult palm tree for tissue culture is rare. Consequently, the first work of the Phoenix research station has been to study the structural biology of the adult date palms and, particularly, of the shoot tip and of the axillary shoots. It has been established that it was possible to extract a large number of undifferentiated axillary buds from the shoot tip (Ferry et al, 1996; Ruiperez and Ferry, 1996).

As a result, research on in vitro propagation by organogenesis has been carried out. A very high percentage of reactive explants of this type has been obtained by culturing them in liquid media (Ruiperez et al, 1995). Vegetative plantlets have been obtained in vitro but, in majority, the evolution of the explants has been floral (Ferry et al, 1994). Researches are going on to find a way to eliminate the floral signal.

In a parallel way, research on propagation by somatic embryogenesis has been carried out. Vitroplants have been obtained starting from young spicklets and leaves (Navarro and Ferry 1996).

Research has also been carried out to study the behaviour of foreign varieties under in Elche conditions. Vitroplants of 11 varieties produced by the GRFP by the organogenesis technique have been planted in Elche in 1989-1990. The study of last year's harvest has demonstrated that the Medjool variety produces dates that fully to mature in Elche.

THE PRODUCTION OF WHITE LEAVES, THE RED SCALE AND OTHER NEW PESTS.

The production of white leaves

Peculiar to its location and origin, there is also in the palm grove of Elche a use of the palm leaves very old and nearly unique in the world, the production of white leaves (Gomez and Ferry, 1997).

This production is based on protecting from the sunlight the group of leaves that emerges and develop starting at the beginning of the spring. Their are protected by the outer leaves, strongly tied together making a straight cone at the top of the palm, giving to a part of the date palms of Elche a very peculiar appearance. This curious aspect is reinforced six months later when the cone is recovered at its top by a black plastic cowl to protect from the light the upper part of the inside white leaves that are growing. Nine months later, all the leaves are cut and around 15 white leaves are harvested. Five years are then necessary for the date palm to recuperate and to be ready for an other production of white leaves.

All this work, done at various meters above the ground, it constitutes a very elaborated and impressive technique transmitted from generation to generation. The olderst written document that has been found, speaking of white leaves is of 1429 (Castaño, 1992).

From at least that time and untill now, this production of white leaves is sold for religious purposes. Each Palm Sunday, first Sunday of the Holy week, processions take place in Elche and in other cities of Spain where people defile with a white leaf in the hand to commemorate the reception of Jesus Christ when he arrived in Jerusalem.

The red scale (*phoenicococcus marlatti* cockll.) and other new pests

During the winter 1992/1993, a new pest has appeared in Elche. The red date scale (*Phoenicococcus marlatti* Cockll.) considered in the other palm groves of the world of minor or none importance has developed here in a very explosive way (Gomez et al, 1995). Withina few years, all the palms trees of the area have been affected.

Very probably, the red scale has been introduced with those adult date palms imported from Egypt in great number. Indeed, during the last 15 years, a high demand for adult palm trees has appeared in relation with the municipalities gardens and parks needs as well as with the Olympic Games of Barcelona and the Universal Exhibition of Seville. The well adaptation of the imported red scale to the Spanish ecological conditions and the lack of local effective enemies explain its explosive development.

In Elche, the introduction of red scale has taken a large importance because of the consequences of its attacks on the white leaves production. The red scale stings the leaflets or the rachis and, around the sting point, necrosis of the tissue or fungus spread out creating brown stains. The leaves that must be perfectly white to be sold are lost. Furthermore, the microclimate created inside the cone and the cowl is very favourable to the red scale development.

Research has been carried to fight this pest that has not been much studied till now. The red scale is mainly present hidden very deeply at the base of the leaves. Characteristic external symptoms of its presence have been well established: brown spots at the base of the leaflets, terminal part of some of the central leaves totally white.

No specific pesticide is known against the red scale. To try to get some efficiency to reach the very hidden colonies of red scale, chemical treatments would be difficult to realise and they would more probably kill a large part of the fauna present in date palm crown without eliminating the red scale. For these reasons and also for health considerations in a place where a large proportion of date palms are located in the city, research on biological control of the red scale have been carried on (Gomez and Ferry, 1996a).

Local predators have been identified and the production of one of them, *Lindorus lophantae* has been initiated (Gomez and Ferry, 1996b).

In addition to the red scale, at least two other pests have been introduced into Spain with imported date palms. *Arenipses sabella* Hmps has been reported for the first time in 1996 (Gomes, 1997). The very serious pest, *Rhinchophorus ferrugineus*, has been discovered in the coast of Grenade Province in 1994 (Barranco et al, 1996); it has not yet been reported in the palm grove of Elche.

THE SOCIO-ECONOMICAL CONTEXT

A traditional agrosystem in the process of disappearance.

As said above, in Elche, the date palm has probably always been cultivated as a multipurpose tree in association with other fruits trees and crops. In addition, date palm culture has started to extend meanwhile irrigated agrosystems were already present for centuries. This situation explains quite well the peculiar organisation of the date plantations in Elche: the trees are planted, in one or two lines, around cultivated and irrigated plots that are generally of rectangular shape and measure around 1000 m^2. This division into small parcels of cultivated land has existed for centuries. It has been probably adopted since the installation of the irrigation network and it complies to the irrigation management constraints of the farmers.

An other reason must be added to explain the cultivation of the date palms around the plots. Compared with typical region of date palm culture, Elche suffers from a lack of sun and heat and is affected by a relatively high humidity; these conditions are not favourable to a system where the associated crops are located at the shadow of the date palms; consequently, the date palms can not been planted over the cultivated area but at its periphery. Such plantation structure exists in some other places in the world, as for example in Gabes (Tunisia).

The crops cultivated inside the plots used to be cereals, alfalfa, cotton or fruit trees like citrus or pomegranate. Animal husbandry with small livestock completed the agrosystem. Nowadays, this complex agrosystem has nearly totally disappeared because date palm culture has practically lost all its original economical and multipurpose interest: a residual profit of Elche dates for human consumption because of higher quality requirements of the consumers; very little use of the dates for animal consumption because of the nearly total disappearing of local animal husbandry, no use of the leaves (apart from white leaves) and trunk because of new substitution products.

A new interest has appeared during these last thirty years, the demond for date palm two meters or more as ornamental trees but as a law forbade the removal of the trees, it has not been, except in an illegal way, exploited. For the last 15 years, many date palm nurseries have also been created inside the plots surrounded by the protected date palms. In this new system, the traditional agrosystem is only apparently maintained: the physical structure is there but it has no function.

By the way, we may ask if a different law leaving the right to exploit for ornamental purpose a proportion of the protected date palms providing their that they are replaced will not have been a way to give a new economical sense to the traditional agrosystem or at least to the traditional structure of plantation. At the difference of the present law, it would have had in addition the advantage to allow the progressive biological renewal of the protected plantations and the future maintenance of this traditional structure.

Because of the decline in economical interest for the date palms, their progressive biological renewal has not been realised, their care has been reduced or abandoned and, consequently, a high proportion of the date palms of Elche, particulary in the city, are old and close to disappearance.

Selective tradition of work on date palm

The tradition of date cultivation in Elche has created a very original and effective know how on some date palm cultural practices that have been transmitted till now. These practices concern mainly the work on the top of the date palm to prune the leaves and of course to produce the white leaves.

The persons that climb to the palm trees utilise a rope that used to be done with the fibrillum of the palms. Nowadays, it is made of nylon plies to each of which has been added a metallic cable located in its centre. This rope is very solid but, above all, presents a rigidity that constitutes a very important improvement with reference to the other existing ropes. This rigidity facilitates radically the ascent to the date palm. An improvement of this rising system has been realised in 1997 to assure more safety and to offer new advantages to this system (Vilella and Ferry, 1997).

A part from the rope, the date palm farmers of Elche have created various original and specific manual tools. I will quote two of them used to cut the leaves: "el corbillote" that allows particularly to cut dried leaves, "la gumia" that has a handle and with which it is very easy to cut the green leaves. I consider that these two tools are superior to the existing others manual tools and should be propagated with profit in the other palm groves of the world.

I will not extend here on the work, know-how and special tools concerning the production of white leaves. They are very specific of Elche and represent in a spectacular way the level of control reached by some people of Elche in the work at the top of a date palm.

Nevertheless, if the work at the top of the date palm is extraordinary well dominated, the practices for date production, apart for the traditional artificial maturation of the dates with vinegar, are not so much controlled. There is no knowledge concerning offshoot cutting. Leave pruning follows strange conceptions and practices. Leaves are cut much more before they dried. In fact, leaves are cut very soon and the date palms used to bear only 50 to 70 leaves. Leaves are often considered as competitors for the palm growth and, even, the dates production. That is also why the white palms producers take off; unfortunately, the external leaves instead of keeping them to help the tree to support the treatment and to recuperate.

In fact, the technical deficiencies in the cultural practices of Elche date palms cultivators can be explained by the traditional multipurpose role attributed to the date palm. They are cultivated at very high density (400 trees per ha) if density is calculated for the total surface area but it is in fact much higher as the trees are planted close together at the periphery of the plots. This external position of the plantation is accompanied by a traditional lower agronomic status for the date palm: fertilisation and irrigation used to be for the central main crops. The force of this tradition is so strong that, nowadays, when there is no more associated crops, irrigation is usually still done for all the surface of the plot!

Research to maintain heritage of the date palms plantations

The date palms plantations of Elche are part of the patrimony of this city. They constitute one of its more symbolic aspects and their maintenance represents a collective obligation. Various solutions are proposed. I will present here the two proposals for which research is carried on.

Reestablish an economic interest in date production

One of the proposed solutions to maintain the date palm patrimony is to find an economic interest for date culture for fruit production. This research constitutes the main applied local objective of the Elche Phoenix Station. The realisation of this objective means the future creation of new plantations of date palms that are economically profitable. Research in carried on out establish the technico-economic conditions necessary to assure this profitability.

Studies on the very competitive date market and on date demand are to better define the quality, the prices and the quantity of the fruit carried out that could reflect demand (Greiner, 1996a, 1996b). Parameters of the production costs in Elche are studied to simulate the various possible profitable production systems (Greiner, 1996d). The cost of the manpower and the needs of specialised working time per tree and per year will limit very much the number of possible solutions. The need for irrigation is relatively high in this area (ETP is of about 1000 mm per year for a rainfall very irregular and of only an average 250 mm) and is an other determinant element of the different possible solutions: irrigation water is costly and/or not available and/or of bad quality. In reference to this aspect, the areas of El Hondo and of Las Saladares where there is a water table close to the surface seem to be the most appropriated places for future plantations. The higher humidity of those areas that affects date fruits when they are mature should not be a problem because the objectives of the research on date technology implicate precisely to harvest the date fruits before maturation, at the khalal stage.

To develop an attractive rural and urban date palm landscape to contribute to the economic tourist activity and to improve the living environment of the inhabitants.

Research hase started to identify the needs of the inhabitants and tourists concerning the date palm grove of Elche. This research concern specifically the demand of landscape. They will allow to establish if the present policy to maintain the date palms patrimony respond to the landscape demand of the inhabitants and of the tourists and how, eventually, this policy could be improved.

For the moment, the policy adopted as well as the law of protection for the date grove contribute for the maintenance of the traditional plantation structure. But, this structure had a sense because of the existing agrosystem of which it was a part. Without associated crops as it is very often nowadays, this plantation structure has lost its sense and, perhaps as a consequence, it has lost its landscape value (Ferry et al, 1996).

Is it possible to find a new sense for this traditional structure and, in the same time, to produce a valuable landscaping? Researches have started to study by making computerised image simulation the various types of urban and rural landscapes based on the date palm than can be imagined. This work will also permit to simulate the aspect that will have the urban date plantations in the future years with the death of the important proportion of trees that is represented by the tallest ones.

CONCLUSIONS

The existence for centuries of a tradition of date palm culture in a place quite different form the classical ones has led for various original characteristics. These characteristics concern the date palm itself growing in a very marginal place, but also the farming practices and systems that the people have adopted.

The study of these characteristics is necessary to look for solutions to maintain this original agrosystem, which is on the point of disappearance. Research has to be conducted in various different and complementary fields to propose a comprehensive global solution.

Farming systems based on date palm cultivation are close to disappear in Elche but are also in crisis in many other places in the world (Ferry, 1995). The types of research carried out in Elche are also conducted by most of the others research centres concerned with date palm. Comparison of the situations, of the approaches and of the research and development proposals between palm groves and date palm centres located in such different contexts is of a great interest. It must conduct to promote exchanges and co-operation projects.

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THE PHYLLOTAXIS OF THE DATE PALM (PHOENIX DACTYLIFERA L.)

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ABSTRACT

Much confusion exists concerning the date palm phyllotaxis. A study of the leaves arrangement of a large number of date palms has permitted to clarify very precisely, the phyllotaxis pattern of this specie. It has also permitted to discover a correlation between a morphological leaf character and phyllotaxis. A simple method is described to numerate and count the date palm leaves

Additional Index Words: Phoenix dactylifera, morphogenesis, date palm leaf, parastichies, modelisation, architecture

INTRODUCTION

The phyllotaxis, that, strictly speaking, corresponds to the arrangement of the leaves, has generated for centuries a very special interest. The science of phyllotaxis has been enlarged to the regular disposition of others parts of the plants like, for example, flowers or pine cone scales. It is still a very actual subject of multidisciplinary study and, often, of controversy (Douady, couder 1993; Cottignies, 1993).

The papers on the study of the phyllotaxis of palms are not numerous. Tomlinson dedicates a small paragraph to this subject (Tomlinson, 1990). The more numerous publications are of Davis and concern different palms species and especially the coconut palm (Davis, 1963, 1970). But Davis does not present any information on the date palm although he gives some results on a neighbour specie, *Phoenix canariensis* (Davis, 1970). Concerning the Canary Islands palm, he gives a strange result saying that this palm has thirteen spirals (contact spirals? one side? maximum?). In fact, Davis observations of palms phyllotaxy demonstrate that risks of confusion are frequent in studies on phyllotaxis. This fact has been emphasised by Jean (Jean, 1994).

Concerning date palm phyllotaxis, no specific publication exists. But, some authors have occasionally spoken of it. Higelman (Higelman, 1951) gives a not very understandable "diagramatic representation" of the leaves distribution. Bouguedoura (Bouguedoura, 1974, 1983) states that the adult date palm presents various foliar helices but, in the same time, she says that there is left and right foliar helices and she uses the concept of divergence angle. This use of the term of "foliar helice" does not correspond to the definition of this concept elaborated by Plantefol (Plantefol, 1946).

For the adult date palm, Bouguedoura gives a phyllotaxy fraction of 3/8 meanwhile Higelman mentions that it is of 5/13 and lastly Tomlinson indicates that its typical value is of 8/21.

So, data on date palm phyllotaxis are not only rare but also confuse. In this paper results of observations on date palms leaves distribution to clarify the question and to present methods to study this question is presented.

MATERIAL AND METHODS

The phyllotaxis of about 2.000 date palm has been studied. The date palm specimens were either offshoots or adult trees or vitroplants. They have been totally dissected or their foliar development in the field has been followed during many years and in various places of the world.

The principle of the method that has been used is very simple: the respective rank of each leaf for each palm has been established according to its age en relation with the others leaves. No leaf could remain out of the ranking. To realise this ranking, various methods presented in the results part of this paper have been set up.

RESULTS

Although there is a great diversity in the patterns of date palm phyllotaxis, their geometrical regularity is always respected and they present common properties.

The chronological curve

For all the date palms observed, excepted for one of it of which I will speak later, a perfect curve could always be drawn from the youngest leaf to the oldest one (Fig 1).

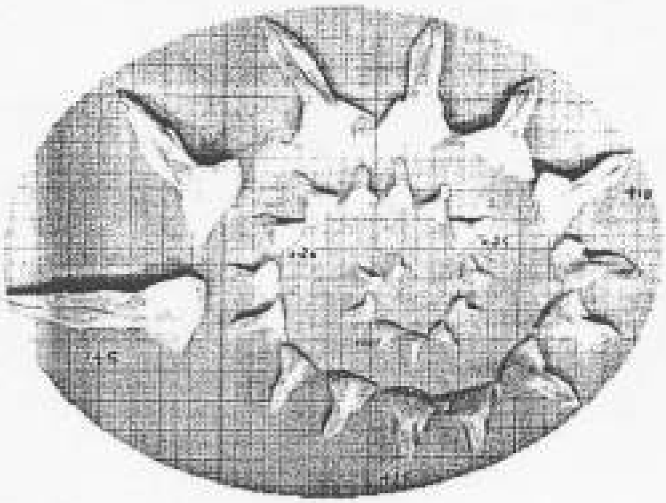

Fig 1: shematic representation of the chronological spiral in the inner part of the crown

For the about 2000 date palms studied, I have just observed for one of it a change of rotation direction of this curve. I will explain it more in detail farther on.

The dissection of adult trees indicates that this curve is perfectly respected as well in the external part of the foliar crown as in its inner part. In an adult tree, the number of hidden leaves is similar to the number of visible ones. The last or youngest inner leaves (around 1 mm length) form a very small reverse cone in the centre of which is located the terminal meristem. This reverse cone presents a very interesting problem of morphogenesis whose study would give precious informations on the simple but astonishing palm meristems (Fig 2).

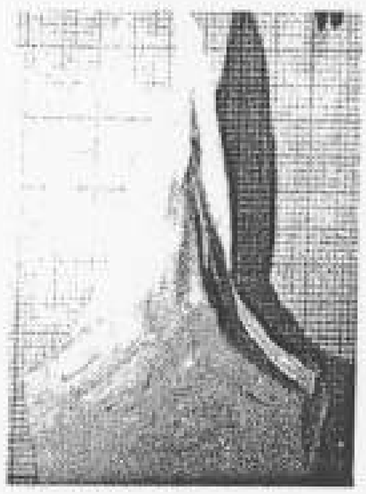

Fig 2: apex with its peculiar reverse cone morphology

The chronological curve constitutes a regular spiral in the upper part of the date palm that has a conic shape. As a consequence of the absence of diameter growth, it gets a very flattened helix form below the cone, where the trunk has reached its maximum final diameter.

The chronological curve is easy to follow in the inner part of the crown. It is still easy to follow with the group of central spear shape leaves (leaflets still jointed and folded along the rachis) and the first rows below it. But, below these leaves, it is next impossible to do it by a direct observation as the chronological consecutive leaves are no more in contact. To locate the chronological curve in this part or lower in the trunk, it is necessary to use the parastichies. The parastichies are visible helices that the leaves draw along and around the trunk. I will give a more detailed description farther on. Three types of parastichies can be easily identified. They constitute a sufficient number to determinate accurately the whole phyllotaxy of the crown and to follow the chronological curve till the basis of the trunk.

I do not want to enter here in the debate concerning the Plantefol foliar helices (Loiseau, 1969). But, once identified this chronological curve, there is no need to look for eventual foliar helices to describe accurately the date palm phyllotaxis.

Once (one palm for 2000), in spite of many attempts, it has not been possible to identify this chronological spiral. The dissection of this palm gave the explanation of this failure: the leaves organogenesis was exceptional; the leaves were jointed by their sheath and, then, the phyllotaxis pattern was not spiral but whorled (photo no 3).

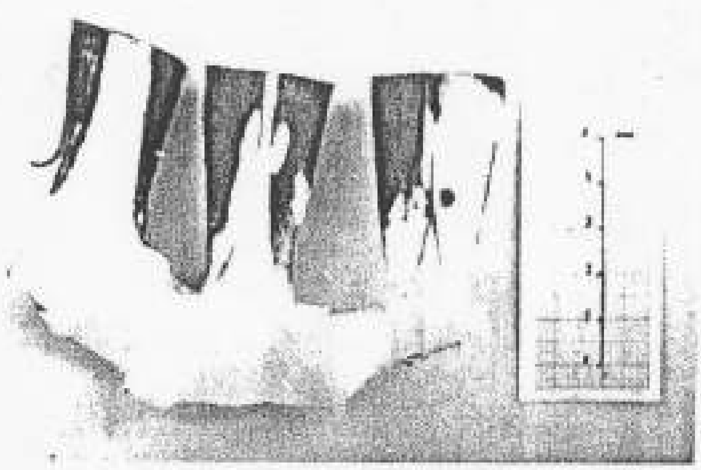

Fig 3: abnormal whorled phyllotaxis

Concerning the rotation direction, I have found only one palm for which this direction has changed. A close observation of this palm has shown that this change of direction could be attributed to an accident of organogenesis: one leaf in the chronological spiral was missing; its youngest following leaf was found in the right place but the next one has developed more or less at the free place on the spiral where was missing a leaf and consequently the spiral has changed of direction.

The rotation direction of the chronological curve.

As established for other species, the chronological curve can be right-hand or left-hand. These two directions are defined by an observer placed in front of the palm tree and looking at it.

I will just give here the main results concerning the rotation direction of the about 2.000 palms studied. There are similar of what has been observed with other plants: the distribution between left-hand and right-hand is practically equal; palms of the same clone, in the same place, can be either left or right hand and, logically, offshoots can be of equal or different rotation direction as the mother palm.

The spire method to establish the rotation direction of the chronological curve.

In the centre of the external crown of a date palm, the leaves are in a fast growing stage of their development. The more inside ones have a spear shape and constitute a tight group that is often called a spire because of its form. This spire encloses a small group of youngest leaves that are also in a fast growing stage.

The growth of these leaves is shifted according to their respective age. Consequently, they are of different length and it is easy to establish their respective rank according to their age. As the leaves are very close each other, it is easy to select three consecutive ones. To find the direction of rotation, it remains only to establish the direction, left or right, to go from the largest leaf to the smallest one passing by the medium one (The difference of length may be small). There is of course only one possibility that corresponds to the chronological curve. I have called this method, the spire method.

By convention the rank 1 or 0 will be given to the youngest visible leaf and the ranks of the following older leaves will be negative numbers to distinguish them from the inside hidden leaves of the crown.

The rank of all the leaves of the centre part of the external crown can next be established by looking for each successive leaf: each one will be found more or less in the middle of the opposite quarter (135 degrees) on the left or to the right according the chronological curve direction. To find the successive leaves, it is not necessary to determine the exact value of divergence angle.

A method to establish all the leaves ranks with the parastichies

Once the chronological curve direction is established, a simple method allows to determine the ranks of all the leaves.

The parastichies are helices in the cylindrical part of the date palms. They constitute spirals in its conic part. Three of these helices are generally easy to recognise: the helices 3, 5 and 8; these figures means that along these helices the differences of rank between two leaves are respectively 3, 5 and 8. That means also because of geometrical reasons, that the date palm has 3 helices 3, 5 helices 5 and 8 helices 8. Palms can also exhibit a phyllotaxis pattern that makes visible the helix 13.

To locate these helices, I will present the pattern for a date palm with a right-hand chronological helix (photo no 4).

Fig 4: a right-hand phyllotaxy

Looking at the base of any chosen leaf (rank n), the closest lowest leaf above it and at its right belongs to the helix 3 (n+3), the closest lowest leaf above it and at its left belongs to the helix 5 (n+5); the leaf of the helix 8 (n+8) can be encountered and so confirmed by two ways: the closest lowest leaf above the leaf n+5 and at its right (n+5+3) or the closest lowest leaf above the leaf n+3 and at its left (n+3+5). When these leaves have been encountered it is easy to find the leaves below (n-3, n-5, n-8) and so to visualise the helices. Step by step, it is easy to establish the relative ranks of all the leaves.

For a date palm with a left-hand chronological curve, the relative position of the leaves will be exactly symmetric: n, n+3 at its left, n+5 at its right, n+8 at its left (Fig 5).

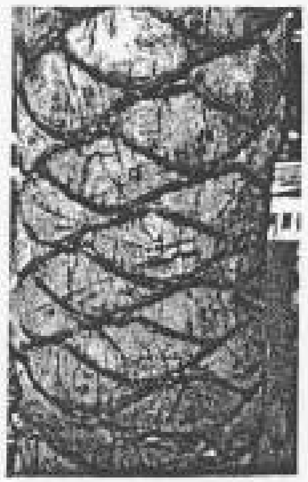

Fig 5: a left-hand phyllotaxy

The helices 3 and 8 wind in the same direction as the chronological curve and the helix 5 in the opposite direction.

The leaves of the helix 13 are also easy to distinguish although this helix were not a contact parastichy. The leaf n+13 is the closest lowest leaf between the leaves number n+5 and n+ 8. The helix 13 winds usually in the opposite direction of the chronological curve but, with some date palms and varieties, it is very easy to recognise because it is in a vertical position or close to this position, constituting a more or less perfect orthoparastichy. These date palms are very spectacular with their leaves superposed (Fig 6).

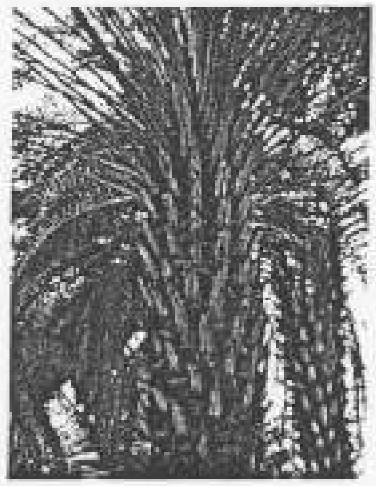

Fig 6: the orthoparastichy 13

Because of the perfect geometrical pattern of the date phyllotaxis, if a mistake has been done in establishing either the rotation direction or the parastichies, it will appear obligatory and rapidly: it will be impossible to give a unique and coherent rank at each of the leaves observed.

One has to be careful in establishing the parastichies that change from a helix form to a spiral one in the cone part and that draw up more and more from the base of the cone to its top.

The parastichy method to establish the direction of the chronological curve.

It is not always possible to climb at the top of the tree to study the relative disposition of the spear leaves for establish the direction of the chronological curve, an other method can be used based on what has been described before, the identification of the parastichies.

Looking at one remaining leaf base or one leaf scar, the slopes with the surrounding bases or scars are drawn: 3 slopes can usually be traced: the more horizontal one corresponds to the helix 3, the helix 8 has a greater slope in the same side; the helix 5 has an intermediate slope in the opposite side (photo 7).

Fig 7: a right-hand phyllotaxy date palm; the 4 slope marks drawn on the central leaf base correspond to the parastichies 3 and 8 at the right, 5 and 13 at the left

A risk of error exists with patterns where the slope of helix 3 is very horizontal and the bases or scars corresponding to this helix, a bit far from each other, are hidden by the bases or scars of the helix 8. This last one can be confounded with helix 5 and consequently a mistake can be done with the direction. But, this mistake can be discovered easily by establishing the ranking of the scars all around the palm at the same level to come back to the initial scar: this one should receive a new rank, differing by one unit from the initial one, that constitutes an absolute proof of the mistake.

If this method is used, the verification indicated here above has to be realised.

The date palm foliage winding and deviation: two morphological traits of the date palm foliage and their correlation with phyllotaxis

Two peculiar morphological characteristics of the date palm leaf that is, for the first one, usually neglected and, for the second one, ignored, have to be considered.

Fig 8: leaf winding and deviation

The first characteristic is what few authors have taken in consideration and called the leaf winding (Toutain, 1979). A right definition of this parameter is not easy. We must consider two plans to describe it: one plan is constituted by the axis of the leaf (cental basal portion of the rachis) and the vertical axis of the date palm at the base and the centre of the leaf; the other plan is the medium plan of the leaflets (leaf plan). This last plan is more problematic because, with the growth and the ageing of the leaf, it differs from the low leaflets to the terminal ones and loses its plan appearance with the increasing curving of the leaf. Most generally the angle between these two plans is not right but the leaf plan winds to the left or to the right.

The second characteristic concerns the end of leaf rachis. As probably a mecanical consequence of the winding of the leaf, the last portion of the leaf rachis is generally not straight but curved in the same direction as the winding. I gave to this leaf morphological characteristic (usefull regarding phyllotaxis and, according to my information, never mentioned till now) the name "deviation" to avoid confusion with the leaf curvature (Nixon, 1950).

I have established the direction of the winding angle and of the deviation of the leaves of the 2000 date palms studied. I have found that, for each of the date palm observed, all the leaves close to the spire (central spear shape leaves), excepted few leaves sometimes, presented the same winding and deviation direction,. Very often, this is also true for all the leaves of the same date palm.

It is therefore possible to attribute to any date palm what I have called a winding and deviation foliage direction.

More old is the leaf more great are generally the winding and the deviation; leaves of certain palms can develop a beginning of helix winding and sometimes, two opposite directions of winding between the base and the terminal part. The intensity (and not the direction) of the winding angle and of the deviation and the final shape of leaf plan are morphological traits genetically controlled but sensitive to environmental conditions.

Now, I have found that, for all the date palms observed, without any exception, the winding and deviation direction was identical to the chronological curve direction. Therefore, it can be concluded that there is a strong morphogenetic link between the leaves phyllotaxis and these traits of the leaf morphology.

Consequently, it was not surprisiong to find that these leaf morphological characteristics have some identical aspects as the chronological curve direction: equal distribution between left and right directions, no clonal trait.

By counting the number of leaflets of the right side and of left sides, I have also established that the difference of number that may occur between the two sides, is not correlated with the winding direction.

Because of its relation with phyllotaxis, the establishment of the winding and deviation direction constitutes an other way to find the chronological curve direction.

CONCLUSIONS

The various methods presented in this paper to establish the date palm leaves distribution should permit to study more deeply the phyllotaxis of this specie. Date palms present different phyllotaxis patterns. The accurate analysis of these differences can be realised. This research could give some interesting new keys on the question of phyllotaxis.

Concerning the date palm, the chronological curve represents a perfect and constant response to explain the date palm phyllotaxis. There is no raison to distinguish this curve with the ontological spiral. The two exceptions described in this paper constitute at the contrary elements that give force to this hypothesis. One of these two exceptions, the change of direction of the chronological spiral, fits strangely well with the theory of the first available space to explain phyllotaxis (Snow, 1962).

The link that has been established between leaves chronological curve and two traits of leaves morphology of course reinforces also the hypothesis of the morphogenetic signification of the chronological curve.

The practical interests of the results and methods present in this paper are numerous: easy calculation of the total number of leaves or of the leaves production (Ferry, 1988), sampling of leaves of the same rank, ranking of the inflorescences and of the bunches, accurate phenology with reference to the position, leaves and palm architecture modelisation.

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BRANCHING ABNORMALITY AND AXILLARY BUDS OUTGROWTH AFTER APICAL DOME DECAPITATION OF DATE PALM (*Phoenix dactilifera*, L.)

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ABSTRACT

Branching abnormality in date palm trees has been observed and recorded in two different locations in Egypt. Frequently, this phenomenon occurs naturally. Sometimes, farmers decapitate or wound the terminal bud of the tree in order to extract a sweet drink (coined as "Lagby"). Generally, the axillary buds around the wounded area of the apical region are dormant. Decapitation or wounding this apical dome enhances and accelerates the outgrowth of these buds to form new branches. Theories of these abnormal phenomenon are reviewed and discussed.

Key words: *Phoenix dectylifera*, L.; Branching; Dichotomy; Axillary buds outgrowth.

INTRODUCTION

Morphologically, it is well known that date palm tree is tall and has a straight undivided stem with a single head. Rarely some date palm plants exhibit such branching in the apical growth as an abnormal phenomenon.

SCOPE AND DISCUSSION

The causes of such abnormal growth may be taken place due to two different reasons:

I. Internal reason:

The Natural Dichotomy Branching: Zaid (1987) and Fisher (1974) have cited some examples of the true dichotomous branching in angiosperms specially in palmaceae. In our survey and observations, We found a specimen (male tree) in Rosetta (Rashid) region

(Northwest Delta in Egypt) as shown in Fig. 1.

Fig. (1): The natural dichotomy branching.

The form of branching of this tree is as the terminal bud has been split down into two dichotomic meristems. Such growing system of dichotomous branching in this may suggest a genetic factor controlling this phenomenon. Furthermore investigations are needed to identify the nature of the genetic factor which affects such phenotype. Zaid (1987) found the same phenotype in one specimen after three years of survey in Moroccan date plantations.

Another system of dichotomous branching was noticed in one specimen in Siwa Oasis. The growth system of this tree differed drastically from that one of Rashid region. Siwa tree showed a compact dichotomous branching (Fig. 2). It is important to suggest that these two cases of dichotomous branching are produced from natural seeds germination. This may suggest that both of them are genetic segrigants. So there are different genetic factors may control such phenotypes, one responsible for elongated branching and the other for compact branching.

Fig. (2): The compact dichotomous branching.

II. External reasons:

In addition to the internal causes of the stem branching in date palm and or the genetic effect on abnormality of the branching, there are external effects may cause such phenomenon. Zaid (1987), and Dijerbi (1983) reported that the two minor diseases in date palm (Black Scorch and Belaat diseases) are responsible for the destruction of the terminal bud. Some attacked palms could recover or revert by developing one or several lateral buds.

Another interesting cause of abnormal branching or outgrowth of new axillary buds in date palm is the artificial decapitation or wounding the apical dome by the farmers. In Siwa Oasis farmer does not usually plant his own date palm offshoots in a regular matter. In addition, some seedlings might grow into Juvenile and the mature stages accidentally within his plantation. So over crowded trees grow up, the farmer is enforced to reduce the high density of the plants by cutting the close nonbeneficial mature ones.

Traditionally, before doing such procedure, usually he decapitates or wounds the terminal bud in order to extract a sweaty drink (coined as Lagby) as shown Fig. 3. This extract is a good tasty drink, as it is, or if it is boiled it converts to artificial honey with very good taste. In most cases, This procedure leads to complete damage of the whole apical dome and subsequently death of the tree. Later, the farmer cuts the dead stem to use it in different purposes in his life. Sometimes the decapitation treatment is not deep enough to complete elimination of the apical dome. In such case one or more of the dormant axillary buds surrounding the eliminated terminal bud begins to activate and grow up to new branch or branches (Fig. 4, a & b). Sometimes, a new terminal bud starts its growth from the central part of the decapitated region (Fig. 5). This phenomenon might taken place due to differentiation some meristemic cells of the residual apical dome after decapitation into adventitious bud. In other words, it is not always that the outgrowth of new branches is produced from activation of dormant axillary bud but also there is a chance to initiate adventitious buds (Goodwin, 1978). So, if the new outgrowth produced from central adventitious bud, then after sufficient period of development, it seems to be a new tree mounts the old trunk (Fig. 6).

This Figure clearly shows that the old trunk still carries old leaves on its residual crown in the outer circumference. As advancing in growth the new stem elongates, the old leaves from the old trunk are going to die and finally disappear. Such procedure leads production of an obvious constriction in the attached point between the old and the new stems (Fig. 7).

(Fig. 3):
Decapitation
of apical
dome for
extract
sweety drink.

Fig. (4a): New axillary bud begins to grow-up after decapitation.

Fig. (4b): Two new axillary buds begin to grow-up after decapitation.

(Fig. 5): New terminal bud starting to grow from the central part of the decapitated region.

(Fig. 6): New tree are differentiated from central adventitious bud mounts the old trunk.

(Fig. 7): Attached point between old and new trunks.

The physiological events of releasing the new formed axillary buds after apical decapitation in mature trees could be explained on the following basis: young palms have very extensive and actively growing root system, which produces high amounts of cytokinins. High endogenous cytokinin in the small palm will stimulate buds at the basal portion to produce offshoots. When palms become mature and tall enough and start to flower, cytokinin produced by the root system will be diluted through the large part volume. A low level of cytokinin will allow auxins produced by the terminal apex to inhibit further development of axillary buds (Abo El-Nil and El-Ghamdi, 1986). So if the terminal bud or the apical dome has been damaged or decapitated, unbalance between auxins and cytokinins will produce. The apical dominance will be removed and axillary buds will be released or adventitious buds will start to initiate.

In conclusion, these observations could be utilized to initiate new formed axillary buds of rare and unique mature date palms via apical decapitation and then macropropagate these new axillary buds *in situ* directly (in the open field). Young palms produce from this procedure will take the chance to give new offshoots for more vegetative reproduction.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to the Egyptian Ministry of Agriculture and Land Reclamation, Agriculture Research Center, Regional Council for Research and Extension for providing a grant to carry out this research.

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الملخص العربي

التفرع الشاذ ونمو البراعم الجانبية بعد قطع القمة النامية لنخيل البلح

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تم ملاحظة وتسجيل التفرع الشاذ في أشجار نخيل البلح في منطقتين مختلفتين في مصر . عادة هذه الظاهرة تحدث طبيعيا لأسباب مختلفة . وفي بعض الأحيان يقطع المزارعون القمة النامية أو البرعم الطرفي أو يتم جرحه وذلك لاستخراج محلول سكري يطلق عليه " لاجبي" . عادة البراعم الجانبية حول المنطقة المجروحة من القمة النامية تكون ساكنة . وقطع أو جرح القمة النامية ينبه هذه البراعم لتكوين جذوع جديدة . نظريات وأسباب هذه الظاهرة الشاذة تم عرضها ومناقشتها في هذه الدراسة .

EVALUATION OF SOME DATE PALM CULTIVARS GROWN IN SIWA OASIS

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ABSTRACT

Some physical and chemical fruit characteristics of Siwa Date Palm cultivars grown in Siwa Oasis, Matroh Governorate, Egypt were studied during the 1996 and 1997 seasons. According to fruit moisture percent, the 7 tested cultivars were classified into 3 groups i.e., (1) Dry: Ghazal, Ghorm Ghazal and Ferehy, (2) Semi dry: Kakwengeb, Siwy and Oshikagbil and (3) Soft: Tagtagt. The results indicated clearly that different cultivars varied significantly among themselves in both physical properties (Fruit and Flesh weight, Flesh weight %, Fruit diameter, Fruit length and Flesh thickness) and chemical properties (Moisture %, T.S.S. %, Reducing sugar %, Non reducing sugar % and Total sugar %). The relative evaluation for fruit quality showed that Ghazal cultivar gained maximum accumulation units of quality (99.44 units) followed by Siwy cultivar (90.93 units), while Tagtagt had the lowest units (78.78).

Key Words: *Phoenix dectylifera*, L.; Evaluation-Siwa, Date palm cultivars.

INTRODUCTION

Siwa oasis lies in the western desert of Egypt. It is characterized by its excellent cultivars of date palm and olive. These two crops represent the main source of income to the farmers. Generally date palm of the oasis are in three types according to its fruit moisture content, i.e. dry, semi dry and soft (Selim *et al.*, 1968). These cultivars are well adapted to the local environmental conditions. Among these cultivars there are two main famous and more frequent ones, i.e. Ferehy (dry) and

Siwy (Semi dry). The others can be considered as local varieties which are consumed at the level of local community (although some of them have excellent fruit characteristics) they are found in very low frequency, and their production are not enough for external market,

The aim of the present study is to evaluate the physical and chemical fruit properties of seven domesticated varieties of Siwa Oasis in order to rank them according to their quality.

MATERIALS AND METHODS

The present investigation was conducted to evaluate physical and chemical fruit properties of seven local date palm cultivar grown in Siwa Oasis during two successive seasons i.e., 1996 and 1997. These cultivars are classified and nominated according to their moisture content into three groups as follows:

Dry: Ferehy, Ghazal, and Ghorm Ghazal.

Semi dry: Siwy, Oshikagbil and Kakwengeb.

Soft: Tagtagt.

The study was carried out as follows: For each cultivar five trees from the same age and vigor in the same area were chosen as a source of fruit samples. Fifty fruits in complete mature stage harvest stage and the time of harvest? were collected from all bunches per each tree. The evaluated characteristics for every fruit are: Physical properties, i.e., Fruit weight, Flesh weight, Flesh weight %, Fruit length, Fruit diameter and Flesh thickness. Chemical properties, i.e., Moisture %, Total Soluble Solids, Reducing Sugars %, Non reducing Sugars %, and Total Sugars %. All procedures of evaluation were carried out according to the methods described in the A.O.A.C. 1975. The disign of the experiment? Data were statistically analyzed and the significant differences between means of cultivars were tested using L.S.D. (Steel and Torrie, 1960).

The final relative evaluation of the quality of every tested cultivar was calculated on the basis of 100 units which were divided up among the various fruit properties according to Hussein *et al.* (1982) and Moustafa *et al.* (1986) with simple modification as follows: 30 units for both fruit weight and total sugars percentage, and 20 units for each of flesh weight percentage and T.S.S. Each cultivar that gave the best results in any character was given the "full mark" specified for this character, while each of the other tested cultivars took lower units equal to their qualities as a percentage from the best cultivar.

RESULTS AND DISCUSSIONS

The morphology of fruit, Flesh and seed for each evaluated Siwa cultivar are shown in Figure 1.

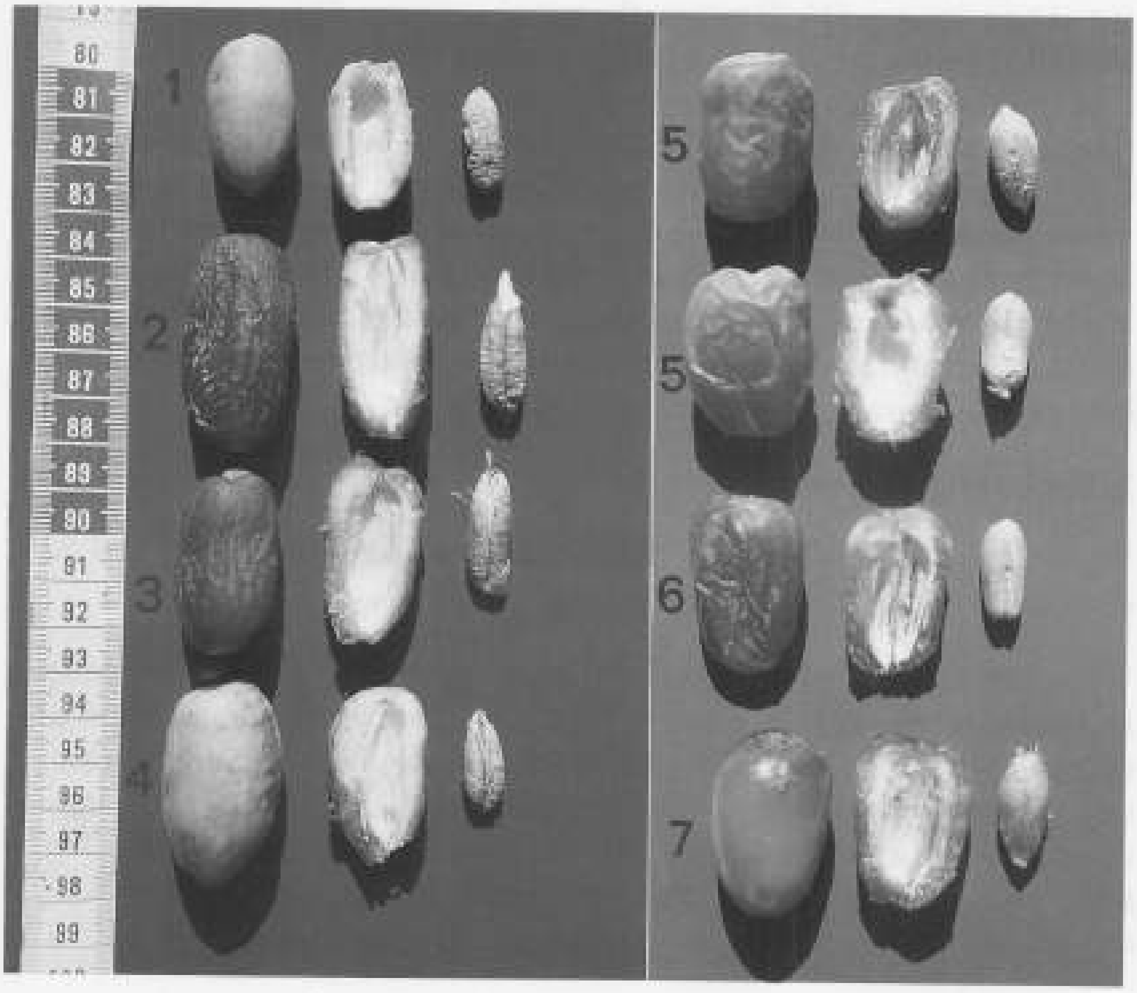


Figure (1): Fruit morphology of different Siwa date palm cultivars.

1. Ferehy 2. Ghazal 3. Ghorm Ghazal 4. Kakwengeb

5. Siwy 6. Oshikagbil 7. Tagtagt.

Data for all tested characteristics were expressed as average of the two seasons.

Tested characters

A. Physical properties:

1. Fruit weight and Flesh weight (gm):

Figure 2, clearly indicated that Ghazal had the heaviest fruit weight in grams (11.7) among the tested cultivars. Other cultivars were ranked as follows: Siwy (11.0), Kakwengeb (10.9), Ghorm Ghazal (10.8) and Tagtagt (10.5). There was insignificant differences among their means. They were followed by Oshikagbil (8.0) in which it significantly differed from them. The significantly lightest one was Ferehy (6.4). The same trend were found for flesh weight character as shown in Figure 3. Hussein and Hussein (1983), Hussein *et al.* (1976), Selime *et al.* (1968) studied the same character in different Egyptian date cultivars from different localities. They found that there were significant differences between fruit means within and between varieties.

2. Flesh weight percent:

The relation between flesh weight and seed weight can be expressed as flesh weight % (Figure 4).

Oshikakbil had the highest significant value (89), while Ferehy exhibited the lowest estimate (83%). The other intermediate values of ranked fruit means showed significant differences between most of them i.e., Kakwengeb, Ghazal, Tagtagt, Siwy and Ghorm Ghazal. These results are in agreement with this obtained by Selim *et al.* (1968). The same characteristic was studied by Al-Bekr (1972), and Khalifa (1973) on various date cultivars.

3. Fruit length (cm):

As shown before in fruit weight estimates (Figure 2), Ghazal had the tallest fruit (4.14 cm) while Ferehy exhibited shortest value (8.45) (Figure 5). Insignificant difference was found between Kakwengeb and Ghorm Ghazal. The same result was obtained in the comparison between Oshikagbil and Tagtagt. Siwy cultivar decreased significantly in its mean when compared with the other mentioned values. Nour *et al.* (1986) studied fruit length on some dry dates in upper Egypt. They found that cultivars of this locality ranged from 3.9 to 5.4 cm. Hussein and Hussein (1983) studied Sakkoty variety from upper Egypt. They found that the fruit length ranged from 2.8 to 2.9 cm.

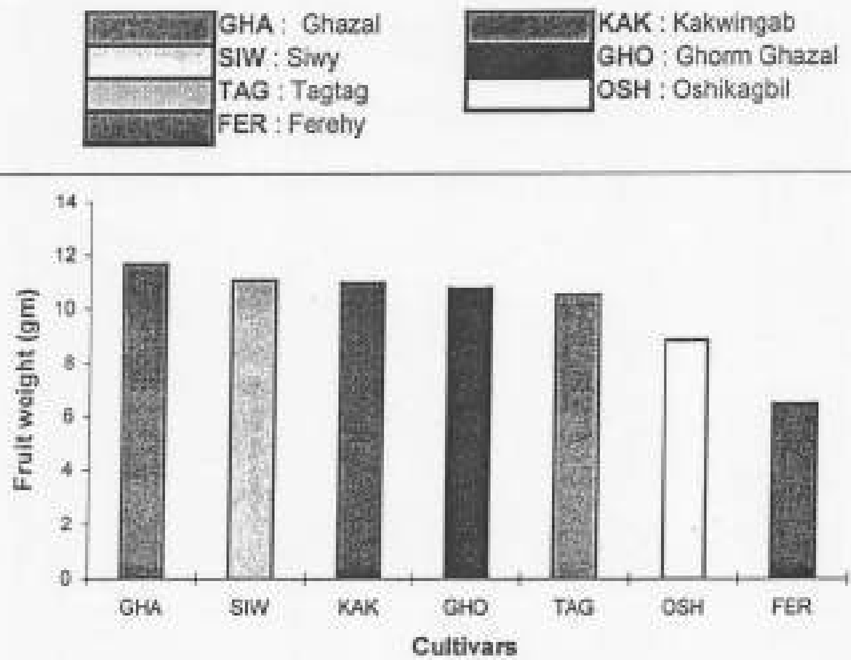


Figure (2): Fruit weight in gm for different Siwa date palm cultivars.

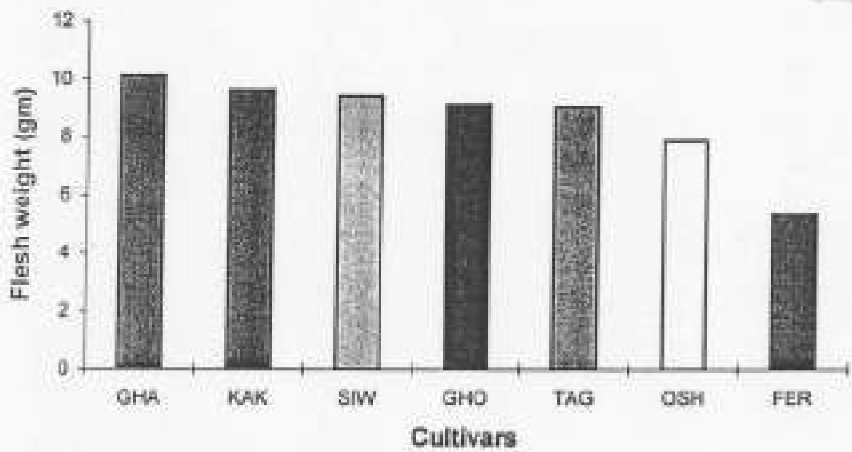


Figure (3): Flesh weight in gm for different Siwa date palm cultivars.

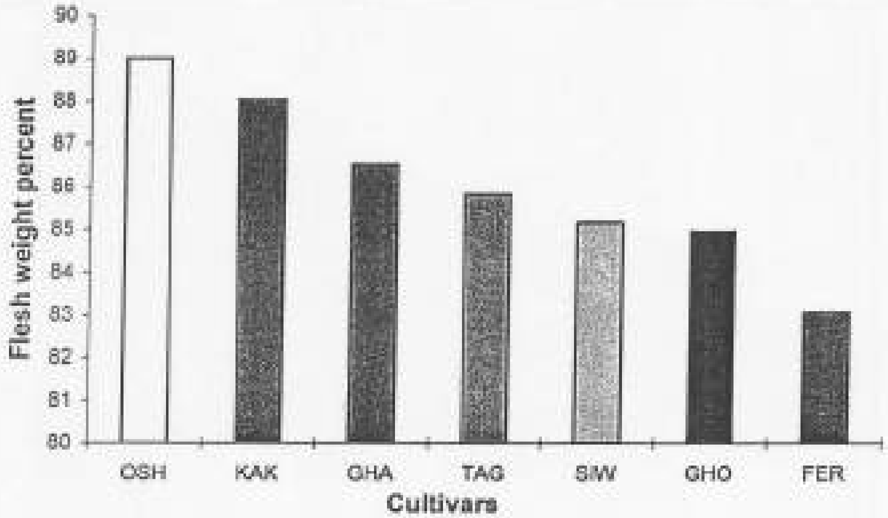


Figure (4): Flesh weight percent for different Siwa cultivars.

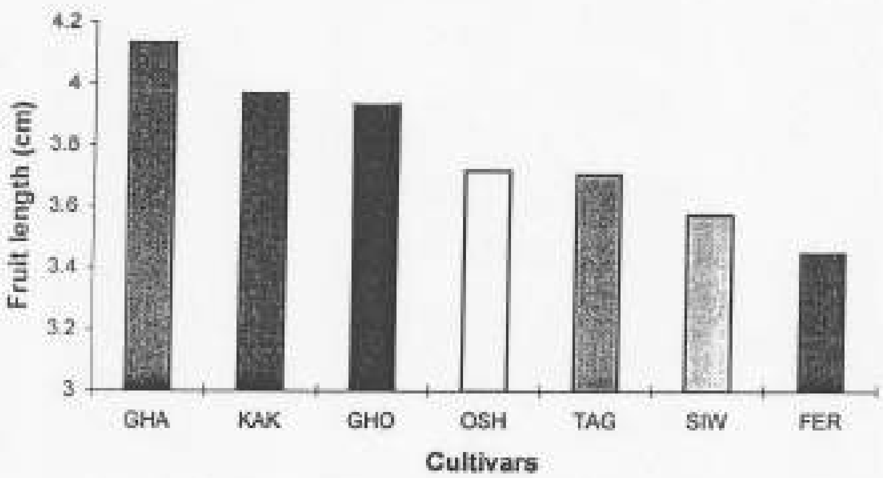


Figure (5): Fruit length in cm for different Siwa date palm cultivars.

4. Fruit diameter (cm):

Tagtagt as a soft cultivar, exhibited the highest value (2.9) of fruit diameter (Figure 6). Other cultivars showed almost insignificant differences between their fruit means. Ferehy and Oshikagbil had the same lowest value (2.14). Nour *et al.* (1986), Hussein and Hussein (1983) and Selim et al. (1968) studied the same character in different cultivars.

5. Flesh thickness (cm):

Figure 7 indicated that Tagtagt showed the highest value (0.69) followed by Ghazal (0.54), and Kakwengeb (0.52) which there is no significant difference between them. The followed three cultivars, i.e., Siwy, Ghorm Ghazal and Ferehy were almost in equal mean values. The lowest significant value was for Oshikagbil cultivar (0.39). Selim et al. (1968) found the same trend in Siwa cultivars.

B. Chemical properties:

1. Moisture percent:

Moisture percent can be considered as the main factor to classify different cultivars according to their characteristics as dry (less than 20%), Semi dry (20-30%) and Soft (more than 30%) (Selim et al. 1968).

According to the above classification Figure 8 clearly demonstrated that Siwa cultivar can be classified into three types according their moisture content, i.e. soft: Tagtagt (35.6%), Semidry: Siwy (23.3%), Kakwengeb (22.1%) and Oshikagbil (22.1%) and dry: Ghazal (17.6%), Ghorm Ghazal (15%) and Ferehy (11.8).

2. Total Soluble Solids Percent (T.S.S. %):

The total soluble solids % has negative significant correlation with moisture % in date fruits. Figure 9 clearly agreed such observation. Tagtagt cultivar which has the highest moisture % exhibited the lower value of T.S.S. (42.5). Ghazal and Ferehy which considered as dry cultivars had the highest values of T.S.S. [(65.0) and (63.0) respectively]. Such results are in agreement with Selim *et al.* (1968), Nour *et al.* (1986), Hussein (1970) and Hussein and Hussein (1983).

3. Sugar Percent:

a. Reducing sugar percent:

Figure (10) exhibited that Oshikagbil had the highest significant value of reducing sugar % (49.8), while Ghorm Ghazal (30.2) and Kakwengeb (29.7) had the lowest values with insignificant difference between them. The intermediate values of cultivars, i.e., Siwy, Tagtagt, Ghorm Ghazal and Ferehy showed 39.7, 37.5, 35.4 and 32.4 percent respectively.

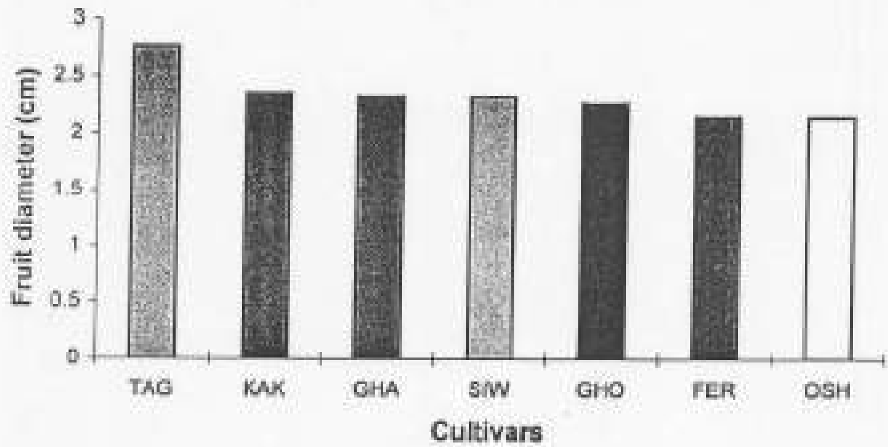
b. Non reducing sugar percent:

Such character showed highly significant negative correlation with moisture %. The highest values for non reducing sugars %, the lowest value for moisture % and Vice versa.

Figure (11) demonstrated that the dry group, i.e., Ghazal, Ferehy and Kakwengeb had the highest value of non reducing sugar (Sucrose), i.e. 26.3, 24.6 and 20.7% respectively. While the soft cultivar tagtagt had the lowest value 2.7%. The Semi dry group i.e., Ghorm Ghazal, Siwy and Oshikagbil had intermediate values as follows 20, 10.7 and 2.9%, respectively. The differences between these semi dry means were highly significant.

Total sugar percent:

As shown in the results of non reducing sugars %, total sugar exhibited the same trend (Figure 12) but not drastically declined in ranked cultivar mean values. The dry cultivar, Ghazal showed the highest significant value (61.8), while the lowest Total Sugar % was for the soft one Tagtagt (40.2%) Other dry and semi dry cultivars were in between the two extremes with insignificant difference between themselves.



Fugure (6): Fruit diameter in cm for different Siwa date palm cultivars.

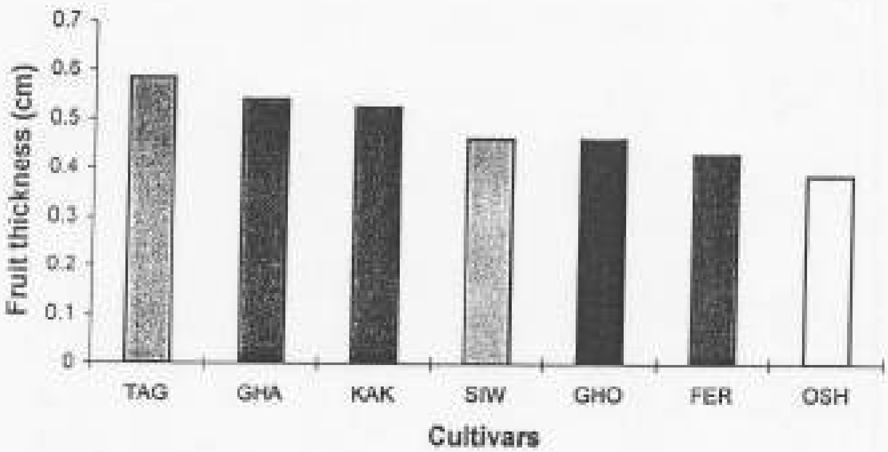


Figure (7): Fruit thickness in cm for different Siwa date palm cultivars.

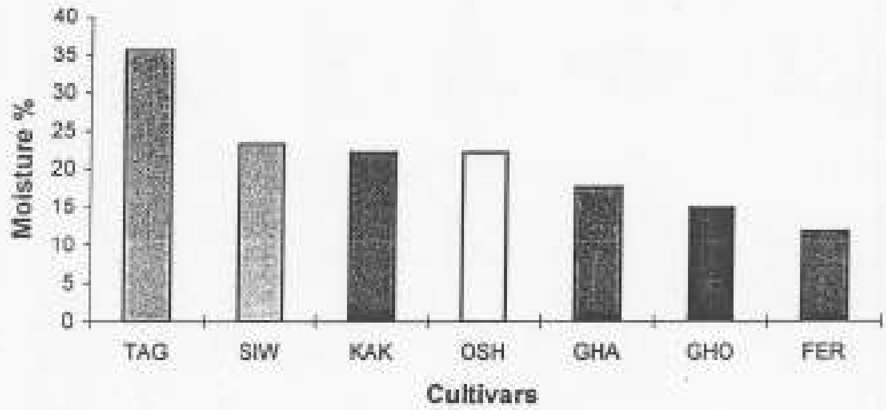


Figure (8): Moisture percent for different Siwa date palm cualtivars.

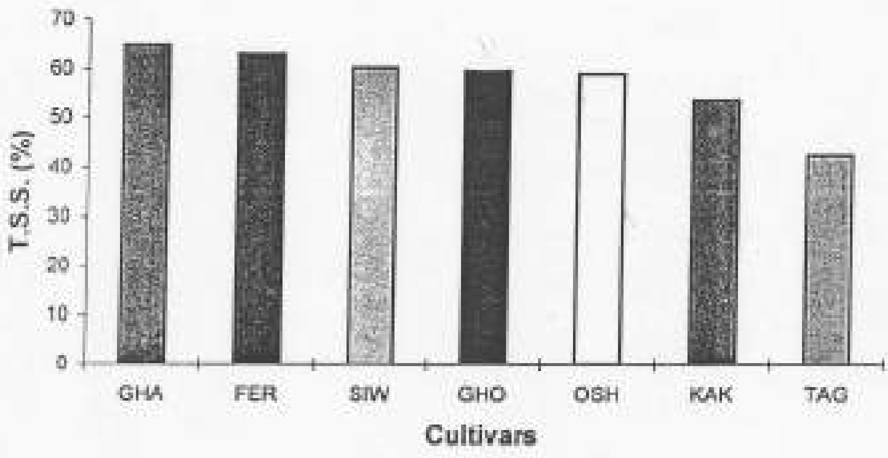


Figure (9): Total soluble solid percent for different Siwa date palm cualtivars

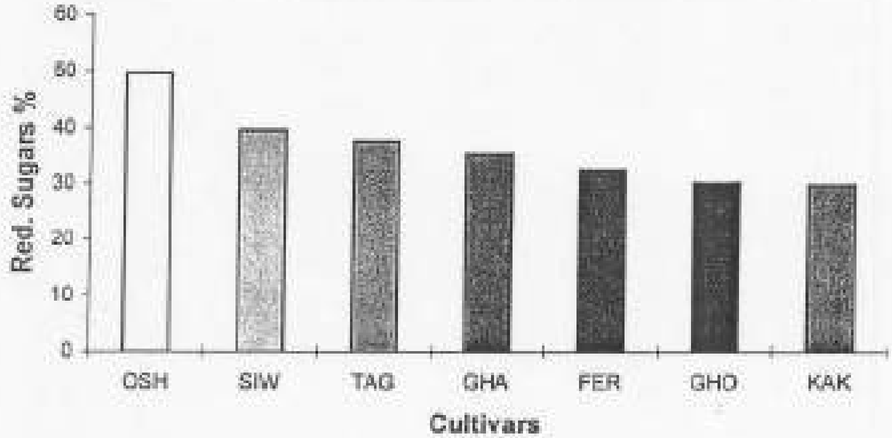


Figure (10): Reducing sugars percent for different Siwa date palm cultivars

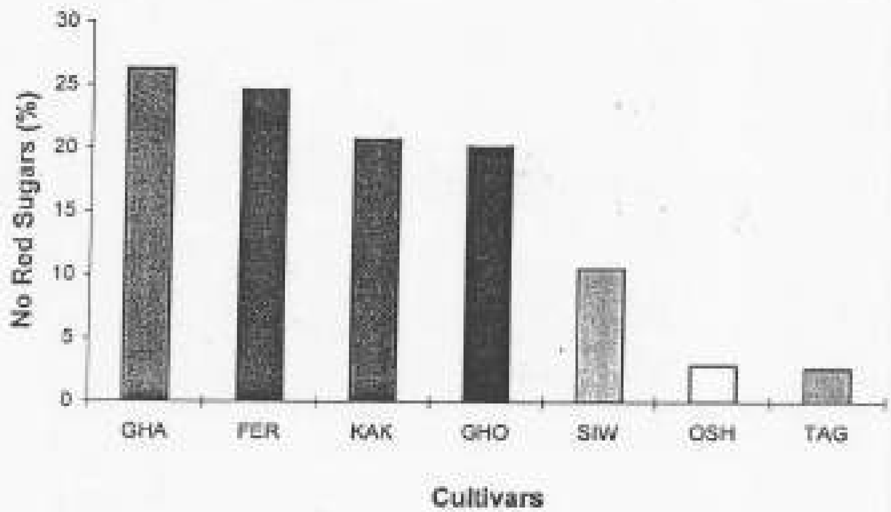


Figure (11): No reducing sugars percent for different Siwa date palm cultivars.

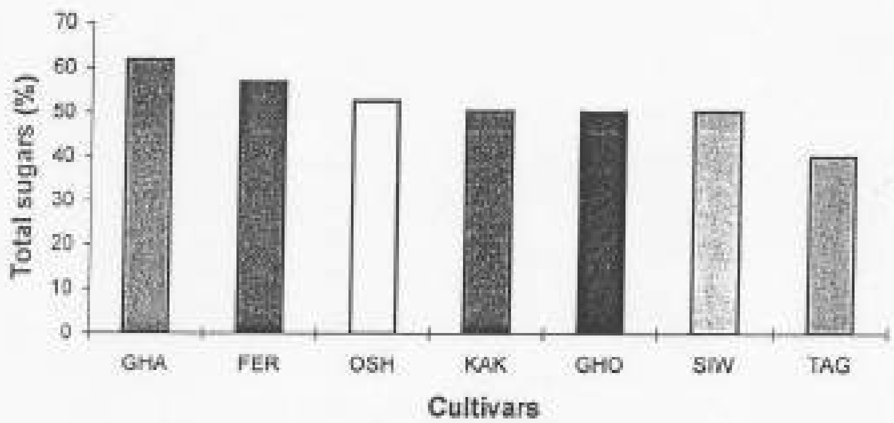


Figure (12): Total sugars percent for different Siwa date palm cultivars.

Many other studies were carried out on fruit sugar contents in date palm cultivars. Selim *et al*. (1968) reported sugar percentage ranged from 9.92 to 47.24% for reducing sugar, from 6.03 to 47.24 for non reducing sugar and from 39.17% to 56.45% for total sugars. Hussein (1972) reported reducing, non reducing and total sugars of fruit ranged between 14.3 to 32.3%, 44.2 to 46.03% and 72.4 to 79.6% respectively in dry dates. Cooks and Furr (1953) reported that soft date cultivars combined little amount of sucrose (non reducing sugar). Hussein (1972) reported that fruits of soft date cultivars contained little or no sucrose, while those of dry cultivars contained a relatively high proportion of sucrose to reducing sugar.

Relative evaluation for fruit quality:

Relative evaluation of the Siwa date palm cultivars are summarized in Table (1). The Ghazal cultivar as the dry date palm had gained maximum fruit weight, T.S.S. and total sugars, while its order was the second for flesh weight percentage. So such cultivar ranked the first in the general evaluation for fruit quality. As it attained the maximum accumulation units (99.44 units) as compared to the other cultivars.

Siwy cultivar stood second in the general evaluation but it overcome the other semi dry ones, it attained 90.93 units. The score for Tagtagt cultivar as the soft date palm (78.78 units) was the lowest in the general evaluation. So, the Siwa cultivars tested could be ranked pertaining to the general evaluation as: Ghazal, Siwy, Ghorm Ghazal, Kakwingeb, Oshikagbil, Ferehy and Tagtagt.

Unfortunately in spite of the Ghazal variety gained the first degree of quality, its frequency in the Oasis is very limited. This is due to the ordinary method of vegetative reproduction for it is not available because it produces very limited offshoots for propagation. So other methods of propagation must be applied for such variety specially micro propagation by using tissue culture techniques.

Table (1): The evaluation units of the Siwa date palm cultivars.*

Index	Units specified	Ferehy	Ghazal	Ghorm Ghazal	Siwy	Oshikagbil	Kakwingeb	Tagtagt
Fruit weight (gm)	30	16.52	30.00	27.58	28.33	22.29	28.09	26.93
Flesh weight (%)	20	18.67	19.44	19.09	19.13	20.00	19.78	19.29
T.S.S. (%)	20	19.38	2000	18.36	18.57	18.15	16.51	13.08
Total Sugar %	30	27.59	30.00	24.39	24.36	25.35	24.62	19.48
General evaluation of cultivars	100	82.16	99.44	89.42	90.39	85.79	88.64	78.78

• Means of two seasons.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to the Egyptian Ministry of Agriculture and Land Reclamation, Agriculture Research Center, Regional Council for Research and Extension for providing a grant to carry out this research.

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Table (1): Fruit characteristics of Siwa date palm cultivars for 1996 and 1997 seasons.

	Ferihy		Ghazal		Ghorm Ghazal		Katwengeb		Swig		Oshikagbil		Tagtagt		L.S.D.	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Fruit weight (g)	6.43	6.45	11.71	11.68	10.78	10.72	10.96	10.92	11.02	11.07	8.82	8.79	10.48	10.52	0.15	0.13
Flesh weight %	82.92	83.26	86.54	86.59	85.07	84.85	88.04	88.03	85.15	85.27	89.19	88.82	85.75	85.90	0.52	0.83
Flesh thickness (cm)	3.45	3.45	4.12	4.12	3.94	3.93	3.97	3.97	3.57	3.58	3.37	3.71	3.71	3.70	0.13	0.12
Fruit length (cm)	2.13	2.16	2.32	2.33	2.28	2.25	2.34	2.36	2.33	2.31	2.13	2.15	2.78	2.75	0.05	0.07
Fruit diameter (cm)	0.43	0.43	0.54	0.54	0.46	0.46	0.53	0.52	0.47	0.45	0.39	0.38	0.59	0.58	0.02	0.04
Moisture %	12.0	11.67	18.0	17.17	15.0	15.0	22.17	22.0	23.17	23.43	22.17	22.0	35.50	34.70	1.15	1.43
Fruit diameter (cm)	63.33	62.67	66.0	64.0	60.0	59.33	54.0	53.33	60.67	60.0	58.67	59.33	43.33	41.67	3.64	3.12
T.S.S. %	32.33	32.12	35.67	35.37	29.67	30.67	29.33	30.00	39.50	39.83	49.92	49.50	37.0	38.0	1.69	1.47
Reducing sugars %	25.33	23.9	25.83	26.80	20.10	20.13	21.33	20.27	10.10	11.03	3.70	2.17	3.53	1.80	1.86	2.69
Total sugars %	57.67	56.07	61.50	62.17	49.77	50.80	50.67	50.27	49.60	50.87	53.60	51.93	40.52	39.80	1.28	2.27

تقييم بعض أصناف البلح النامية بواحة سيوه

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الخلاصـــــة :

أجريت هذه الدراسة لتقييم الصفات الثمرية لسبعة أصناف من نخيل البلح النامية فـي واحة سيوه – محافظة مطروح بمصر في أعوام ٩٦ – ١٩٩٧ . وقسمت الأصناف إلي ثلاثة مجموعات وهي : مجموعة الأصناف الجافة وتشـمل الفريحـي والغـزال وغـرم غـزال ومجموعة الأصناف النصف جافة وتشمل السيوي والكاك ونجب وأوشـيك أجبيـل ومـن الأصناف الرطبة طقطقت . وقد أظهرت النتائج بوضوح أن الأصناف تختلـف فيمـا بينـها معنويا في كل من المواصفات الطبيعية مثل وزن الثمرة ووزن اللحم ونسبة اللحـم للثمـرة وقطر الثمرة وسمك اللحم . والمواصفات الكيميائية مثل نسبة الرطوبة ونسبة أعداد الصلبـة الكلية الذائبة ونسب كل من السكريات المختزلة والغير مختزلة والكلية وعند تحديـد التقييـم النسبي لتلك الأصناف فإن صنـف الغزال حصل علي الترتيب الأول في الجـودة حيـث أن درجة تقييمه بلغت ٩٩,٤٤ يليه السيوي حيث حصل علي ٩٠,٩٣ بينمـا حصـل الصنـف طقطقت علي أقل درجة من الجودة وقدرها ٧٨.٧٨ بالنسبة لباقي الأصناف .

SURVEY ON PRODUCTION, HANDLING, STORAGE AND MARKETING OF DATES IN THE NORTHERN REGION

G. A. ALI[1] A. K. KARIBL[1] AND M. IBN AUOF[2]

ABSTRACT

A Survey on dates production, storage and marketing was conducted in the Northern State (Merwi area) during 1996 using the Rapid Rural Appraisal Method (RRA). Data collected revealed that average dates productivity was high (120 Kg/tree) compared to other producing countries such as Tunisia (55 Kg/tree). Most abundant cultivars were of the dry type mainly Barakwi. The system of ownership depends mainly on inheritance (69%); which results in poor cultural practices particularly irrigation. The intercropping of legumes which was found to improve quality and yield was practiced up to 50%. The prevailing insects were the scale insects and during storage the weevils. The improper traditionally practiced methods of dates harvest, handling, drying and storage coupled with the absence of quality standards for the marketing system lowered the quality of dates.

INTRODUCTION

Date Palm (Phoenix dactylifera L.) is a major fruit crop in Sudan. A considerable number of cultivars are grown mainly in the Northern region where the climate is favourable for date cultivation. According to FAO reports annual production of dates Abdelmajid (1996) is around 152000 tons this ranked Sudan as the 7th largest producer of dates among arab countries. The objectives of this study are:

- To collect basic data concerning dates production, handling, storage and marketing.
- To find out technical solution to the problems facing producers.

METHODOLOGY

The survey was conducted in the Norhern State (Merwi Province) using the Rapid Rural Appraisal (RRA) method which can be defined as a: Systematic, semistructured activity conducted on site by a multi disciplinary team with the aim of quickly and efficiently acquiring new information and hypotheses about rural life and rural resources. The data

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was collected from various sectors including: Farmers, Farmers' Union, Agricultural Cooperatives, Governmental emplpoees, Wholsalers, and Retailers.

RESULTS AND DISCUSSION

Table I shows that the minimum area cultivated date palm is 0.5 fedan and the maximum 30 fedan. Average number of trees is 288 and average productivity is 120 Kg/tree. It appears from Fig 1 the system of ownership depends mostly on heritability (69%). Most of the cultivars are of the dry type with the cultivar Barakawi dominating (60%). However the cultivar Gondaila is of high quality it constitutes only 3% due to propagation obstacles (Fig 2). It was observed that recently there is a trend to propagate the semidry type of (Mishrig Wad lagi and Wad Khatieb).

Cultural Practices:

The majority of date palm grown in the in the Northern region is irrigated by pumps from the river Nile. The irrigation interval ranges from 2-3 weeks. Collected data showed that up to 50% of the fertilization is through the application of farm manure and 40 % utilize urea (Fig 3). The inter-croping of legumes (Cowpea and Pigeonpea) which was proved to have a positive effect on the soil and consequently dates quality is praciced up tp 3 5%, while 15% of the studied cases practiced the intercropping of Abusabaien which adversly affects the soil (Fig 4).

Pests and Diseases:

Fig 5 illustrates the insects prevailing in the area. Severe damage is caused by the white scale insects, the most serious store pest is the weevils which cause drastic loss and detracts product quality. Except DDT which is applied during storage insecticides and pesticides were never utilized. Most common diseases which were reported in the area are symptoms of yellowish, wilting, abushiba and black smut.

Pollination and Harvest:

Pollination is done manually by experienced labours. Although farmers are acquainted with the effect of thinning on fruit quality, thinning is rarely practiced through delayed pollination.

Harvesting is done by throwing the bunches either on the ground directly or on mats. This method of harvest resulted in a high percent of losses quantitatively and qualitatively. Elsafia and Salih, (1984) reported that harvesting by ropes reduced the losses up to 45%. Farmers considerd harvesting by ropes a laborious method.

Postharvest handling and Storage:

Sorting is done only for shrinked and immature dates which is utilized as animal feed. Losses that may occur during harvest and handling were not estimated. Sorting process is very important for fruit quality and storability, since fruits which are not intact are more susceptible to insect damage and microbial attack and always creates a source of infestation. Buxton (1920) reported that dates fruits attacked by birds are more susceptible to attack by red spider mite. The harvested dates is packed in jute sacs and transported by crates to the farmers' houses for sun- drying.

However sun-drying decreased the possibility of insect infestation due to the fact that high temperature have a lethal effect on insects and larvae (Alzawi et al., 1983), this traditionally practiced method of sun drying has many disadvantages:

- The product is prone to contamination by dust and rains,
- The product is subjected to losses by rodents and insects.
- Dates will undergoe undesirable changes in colour, texture and general appearance

Stacked jute sacs of dates are somtimes treated with DDT and stored on yard. Devastating dammage is caused by the weevils during storage. The cultivar Gondaila is more susceptible to infestation, this may be attributed to the high percent of cap separation during harvest in this cultivar. Barreveld, (1994) reported that insect development in storage is favoured by:

1. High initial degree of infestation prior to storage (eggs),
2. Elevated temperature and humidity of the air.
3. High moisture level of the dates.

Producton Cost & Marketing:

Price setting depends on supply and demand. Table (2) shows details of production cost. It appears that the profit is 40%. There are no quality standards in the market system and the peak of selling during December and January. Table (3) illustrates the problems facing dates production ranked according to its seriousness.

RECOMMENDATIONS

Prospects of dates production in Sudan are promising, to secure high product quality the following strategy should be followed:

1. To solve the irrigation problem.
2. Apply proper cultural practices and insect control.
3. Improvement of harvest and handling methods (Sorting, grading and packaging). Such as drying in plastic houses and treatment with phosphotoxin before storage and packing in polyethylene lined propylene bags tightly closes.
4. Creation of coordination and links between the frmers, research centres and extension units.

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Table I : Area cultivated, numper of date palm and productivity

Parameter	Area (Fedan)	No. of trees	Age of palm (Year)	Productivity
Minimum level	0.5	45	1	70
Maximum	3.0	1000	100	150
Average	5.42	2.88	16	120

Table 2: Cost of production per one tree

Process	Cost (Sudanese pound)
Irrigation	1500
Fertilization	3000
Pollination and harvest	4875
Transport and Packing	4000
Crop taxes	1500
Zakat	1500
Local taxes	1500
Market taxes	4000
Taxes	335
Total	22210

Table 3: Problems facing production of dates in the area:

Problem	Ranking			
	1	2	3	4
Irrigation			-	-
Pests and diseases	-			
Poor cultural practices				
Packaging material	-	-		-

Fig 1: System of ownership in Merwi area

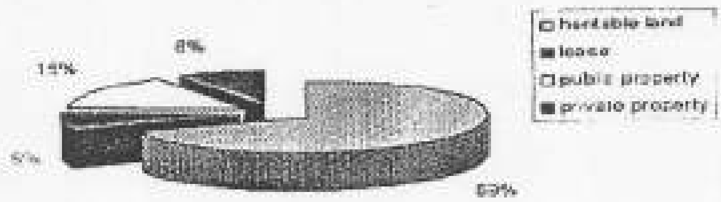


Fig 2: Main dates cultivars grown in Merwi area

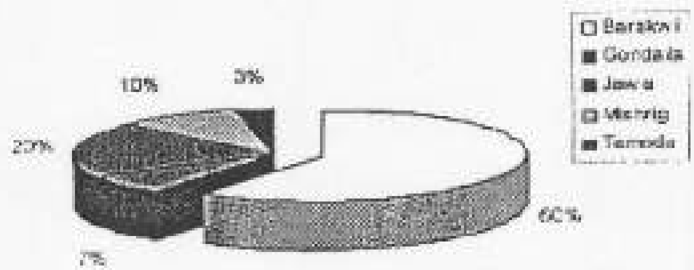


Fig 3: Frtilizers application in Merwi area

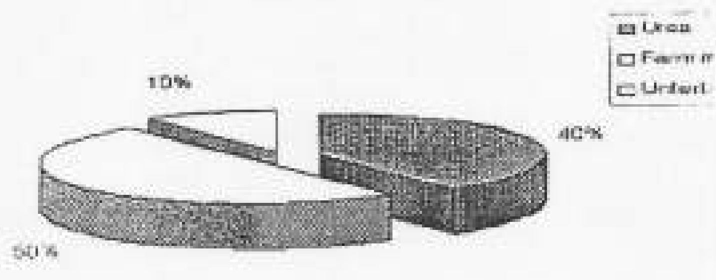


Fig 4: system of intercropping

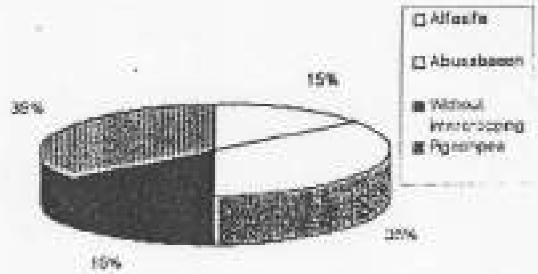
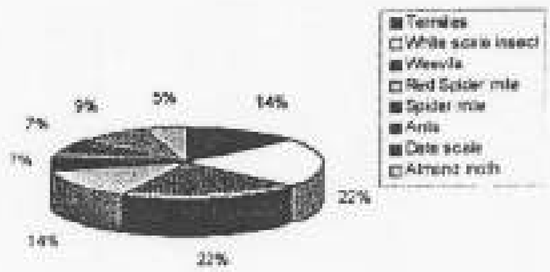


Fig 5: Pests of date palm prevailing in Merwi area



EFFECT OF ACID-TREATED AND UNTREATED DATE PITS ON THE GROWTH PERFORMANCE OF BROILER CHICKS

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ABSTRACT

The objectives of this study were to investigate the effect of acid-treated and untreated date pits used in broiler starter diets on the growth rate and efficiency of feed utilization, and to evaluate the use of untreated date pits in broiler finisher rations on growth performance of broiler chicks. One hundred twenty day-old commercial broiler chicks, were randomly assigned to each of the four treatments with three replicate groups. The chicks were housed in Petersime battery brooders for four weeks and each pen housed 10 chicks. There were four different dietary treatments, the diets were isonitrogenous (21.5% CP) and isocaloric (3.05 Mcal/kg). Diet 1 (control), a corn-soybean diet, contained no date pits. Diets 2, 3 and 4 contained 10% untreated, acid-treated and acid-treated (adjusted pH) date pits, respectively. The addition of treated or untreated date pits to the starter broiler diets supported growth performance similar to those chicks fed the control diet. During the finishing period (weeks 5-6), chicks in the control group were fed a finishing ration. Chicks in the other groups were fed a finishing ration containing 10% untreated date pits. There were no significant differences observed among dietary treatments in body weight gain, feed intake and efficiency of feed utilization (feed/gain) throughout the finishing period. Chemical analysis of date pits used in this trial showed a composition of 8.3% moisture, 14.4% fat, 18.8% crude fiber, 5.6% crude protein, 1.2% ash and 60.0% NFE, and there were no significant effects of acid treatment on these parameters.

Key Words: Growth rate, feed efficiency, broiler, date pits

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INTRODUCTION

For the last two decades the poultry industry in the United Arab Emirates (UAE) has been growing exponentially to meet the higher demand for eggs and broilers in the UAE. Feed costs make up 60-70 % of any poultry production budget. In order to reduce the cost a possible alternative local source for feedstuff could be date pits, which are readily available in abundance in the UAE. Annual production of dates is around 234,135 tons (UAE Ministry of Agriculture, 1993/1994), of which 31,000 tons are date pits.

A previous experiment in the UAE showed that up to 10% untreated date pits could be included in broiler diets to support growth performance (Hussein et al. 1998). Previously, several researchers used date pits in broiler rations. Kamel et al., 1981; Al-Yousef et al., 1986; and Vandepopulliere et al., 1995; reported the addition of date pits to broiler diets supported growth performance compared to the control corn-soybean diet. However, Jumah et al. (1973) found that diets containing date pits caused reduction in broiler weight gain compared to the control diet.

The objectives of this present study were to determine the effect of using acid-treated date pits in broiler starter diets on growth performance of broiler chicks and to evaluate the nutritional value of date pits.

MATERIALS AND METHODS

Date pit preparation

Date pits were obtained from different varieties of date palm trees. The collected date pits were washed with water to remove all foreign materials, then oven dried at 60 °C for 24 hours and divided into three groups. Untreated date pits in the first group were ground in a special mill to one millimeter in size. In the second group date pits were treated with a 70% concentration of sulfuric acid for half an hour at room temperature, then rinsed with water through a sieve to wash away the acid and to remove the outside layer. In the third group date pits were acid-treated as in the second group, and then treated with a 10% sodium hydroxide solution in order to bring it to the normal pH of untreated date pits. Treated date pits in the second and third groups were dried and ground separately in a mill to one millimeter in size.

Experimental design

The present experiment lasted six weeks. In the first part of this experiment which lasted four weeks, one hundred twenty chicks (Commercial broiler strain, mixed sex), one-day old, were divided randomly into twelve replicate groups, each replicate having ten chicks. There were four different starter dietary treatments (Diet 1, Diet 2, Diet 3 and Diet 4) with three replicates each. The diets were isonitrogenous (21.5% CP) and isocaloric 3.05 Mcal/kg. Diet 1 (Control) was a corn-soybean diet containing no date pits. Diet 2 was a corn-soybean diet containing 10% untreated date pits. Diet 3 was a corn-soybean diet containing 10% acid-treated date pits. In Diet 4, a corn-soybean diet contained 10% acid-treated date pits but, pH was adjusted (Table 1). The calculated nutrient composition of the experimental diets was based on ingredient composition tables (Scott et al., 1982).

Dietary treatments were mixed fresh weekly and fed on an ad libitum basis. The following parameters were measured and calculated every week: chick weight, feed intake, body weight gain, feed conversion ratio (FCR) and mortality.

Since no significant differences were observed on growth performance of broiler chicks fed date pit starter diets in the first period of the trial, subsequently in the second part, chicks in treatment 1 were fed a control finishing ration containing no date pits. In treatments 2, 3, and 4, chicks were fed a diet containing 10% untreated date pits (Table 2). The finishing diets were isonitrogenous (20% CP) and isocaloric (3.1 Mcal/kg). The chicks were housed in finishing Petersime batteries and managed as in the first part for two weeks.

Tissue sampling

At the end of the first part of the trial (fourth week), two birds per replicate group were sacrificed by a conventional slaughterhouse procedure. The carcasses were then deboned and all meat and skin parts were ground for the carcass chemical analysis. At the the end of the second part (sixth week), the same conventional slaughterhouse procedure was used for determining carcass yield and dressing percentage.

Chemical analysis

Chemical analyses of date pits (Table 3) and carcass samples were performed according to AOCA reported method (1984) .

Statistical analysis

The collected data were subjected to ANOVA by using a linear model program (SAS) for microcomputers (SAS Institute,1989) to determine the significant differences between the experimental diets. Means were separated statistically by the test of least significant difference (LSD) only when a significant value for F was obtained in the ANOVA (Snedecor and Cochran, 1980).

Table 1. Composition of experimental starter diets[a]

	Diets			
Ingredients, %	1	2	3	4
Yellow corn	59.55	44.70	44.70	44.70
Soybean meal, 48% CP	32.00	30.28	30.28	30.28
Date pits	0.00	10.00	10.00	10.00
Corn oil	2.70	7.38	7.38	7.38
Meat meal	1.46	4.16	4.16	4.16
Salt	0.45	0.40	0.40	0.40
Limestone	1.20	0.98	0.98	0.98
Dicalcium phosphate	1.42	0.86	0.86	0.86
Vitamin-mineral premix[b]	1.00	1.00	1.00	1.00
DL-methionine, 99%	0.22	0.24	0.24	0.24

[a]Calculated nutrient composition: ME_n, 3050 kcal per kg, CP, 21.5%; methionine, 0.56%; methionine+cystine 0.91%; and lysine1.14%.
[b]Provided the following per kilogram of diet: vitamin A 6,000 IU; vitamin D_3, 1,000 ICU; vitamin E, 15 IU, menadione dimethylpyrimidinol bisulfite, 2.0 mg; thiamin, 5.94 mg; riboflavin, 5.4 mg; pantothenic acid, 15 mg; niacin, 41 mg; pyridoxine, 4.5 mg; biotin, 0.23 mg; choline, 1,450 mg; folacin, 0.83 mg; vitamin B_{12}, 0.14 mg; ethoxyquin, 125 mg; Se, 0.2 mg; Cu, 6 mg; I, 0.53 mg; Fe, 120 mg; Mn, 83 mg; Zn, 60 mg; and Co, 5 mg.

Table 2. Composition of experimental finisher diets[a]

	Control	Untreated date pits
Ingredients, %		
Yellow corn	63.00	48.22
Soybean meal, 48% CP	28.30	26.43
Date pits	0.00	10.00
Corn oil	3.00	7.68
Meat meal	1.46	4.31
Salt	0.40	0.35
Limestone	1.22	0.98
Dicalcium phosphate	1.42	0.83
Vitamin-mineral premix[b]	1.00	1.00
DL-methionine, 99%	0.20	0.20

[a]Calculated nutrient composition: ME_n, 3100 kcal per kg, CP, 20%; methionine, 0.52%; methionine+cystine 0.83%; and lysine1.05%.
[b]Provided the following per kilogram of diet: vitamin A 6,000 IU; vitamin D_3, 1,000 ICU; vitamin E, 15 IU, menadione dimethylpyrimidinol bisulfite, 2.0 mg; thiamin, 5.94 mg; riboflavin, 5.4 mg; pantothenic acid, 15 mg; niacin, 41 mg; pyridoxine, 4.5 mg; biotin, 0.23 mg; choline, 1,450 mg; folacin, 0.83 mg; vitamin B_{12}, 0.14 mg; ethoxyquin, 125 mg; Se, 0.2 mg; Cu, 6 mg; I, 0.53 mg; Fe, 120 mg; Mn, 83 mg; Zn, 60 mg; and Co, 5 mg.

RESULTS AND DISCUSSION

The effects of acid-treatment on the chemical analysis of dietary date pits are shown in Table 3. There were no significant differences in the levels of fat, fiber, protein, ash and NFE among the untreated, acid-treated and acid-treated & pH adjusted date pits. In addition, the chemical analysis data of date pits showed that dry matter content was 91.7%, which was similar to those obtained by Zumbado et al., 1987; Yousif et al. 1996; El-Hammady et al., 1997; Nwokolo et al., 1976; Kamel et al., 1981; and Vandepopuliere et al., 1995. However, ether extract content (14.4%) was much lower than that obtained by Zumbado et al., (41%). Also, the ether extract value of the present study was higher than the other values obtained by Yousif et al., 1996 (10.7%); Gualtieri and Rapaccini, 1990 (6.18%); El-Hammady et al., 1997 (5.3%); Nwokolo et al., 1976 (7.8%); Kamel et al., 1981(10.62%); Vandepopuliere et al., 1995 (5.1%); and Hussein et al.,1998 (9.35%). The variations in the ether extract values could be due to the different date pit varieties as well as date processing. Protein content of the date pits (5.6%) was similar to those values obtained by Gualtieri and Rapaccini, 1990 (5.85%); Vandepopuliere et al., 1995 (5.7%); Yousif et al., 1996 (6.1%); and Hussein et al., 1998 (6.05%) and lower than those found by Nwokolo et al., 1976 (21.3%); El-Hammady et al., 1997 (7.1%); and Zumbado et al., 1995 (7.9%). In addition, Table 3 shows the crude fiber content of date pits was 18.8%, similar to values obtained by Nwokolo et al., 1976 (17.5%) and Gualtieri and Rapaccini, 1990 (19.2%); lower than that found by Kamel et al., 1981 (26.5%); and higher than that reported by El-Hammady et al., 1997 (12.2%); Zumbado et al., 1995 (11%); and Yousif et al., 1996 (14.4%). It was found also that the ash percentage of date pits (1.2%) was similar to that previously reported by Zumbado et al., 1995 (1.9%); Hussein et al., 1998 (2.1%); Yousif et al., 1996 (2.4%); Kamel et al., 1981 (1.7%); and Gualtieri and Rapaccini et al., 1990 (1.0%) and lower than the values obtained by Nwokolo et al., 1976 (5.0%); El-Hammady et al., 1997 (5.7%). The nitrogen free extract value (60.0%) of the date pits was similar to those results obtained by many researchers. El-Hammady et al., 1997 found that date pits contained 60.3% NFE; Gualtieri and Rapaccini, 1990 found 56.2% NFE; Yousif et al., 1996 found 66.4% NFE; and Kamel et al., 1981 found 56.8% NFE. The variation in the chemical composition of date pits utilized by all of these researchers could be due to using different methods in date processing, as well as the different varieties used. There were no significant differences obtained among dietary treatments as shown in the chemical analysis of chicken carcasses (Table 4).

Broiler chicks which received diets containing 10% date pits (acid-treated, acid-treated(pH adjusted), and untreated date pits) had body weight gain similar to birds fed the control diet during the four-week trial. In addition, feed intake and efficiency of feed utilization of chicks fed starter diets containing date pits were not significantly different from the control (Table 5).

Table 3. Chemical analysis of dietary date pits (dry matter basis)

	Date pits		
TYPE	Untreated	acid-treated	acid-treated + pH adjusted
Dry matter, %	91.7	91.5	92.0
Ether extract, %	14.4	14.5	15.2
Crude fiber, %	18.8	17.1	18.1
Crude protein, %	5.6	5.3	5.8
Ash, %	1.2	1.0	1.1
NFE, %	60.0	62.1	59.8

Table 4. Chemical analysis of chicken carcasses at four weeks of age (dry matter basis)

	Dietary treatments				Pooled
TYPE	1	2	3	4	SEM
Moisture, %	68.0	67.7	66.9	67.5	1.8
Ether extract, %	42.6	43.5	46.3	46.1	3.8
Crude protein, %	54.7	54.0	50.7	51.0	3.6
Ash, %	2.7	2.5	3.0	2.9	0.4

During the finishing period (weeks 5 and 6), the addition of 10% untreated date pits to the finishing diets of treatments 2, 3, and 4 supported body weight gain and feed/gain ratio similar to those chicks fed the control diet (Table 6). A similar trend was observed regarding the effect of dietary treatments on carcass yield at the end of the finishing period. Carcass yield percentages were similar in all four treatments.

The results of feeding broiler chicks starter diets containing 10% date pits on growth performance were almost similar to those obtained by Hussein et al. (1997), in which the authors found that body weight gain and feed/gain ratio of broiler chicks at four weeks of age were not significantly different from the control diet. Also, Gualirei and Rapaccini (1990) reported a similar observation to that found in the present study, where they stated that using 10% date pits in broiler starter diets produced growth performance similar to that gained from a corn-soybean diet. In addition, the results of the present study agree with those reported earlier by Vandepopuliere et al. (1995), and Kamel et al. (1981), but disagree with the findings of Jumah et al. (1973).

Hussein et al. (1997) reported that the inclusion of 10% acid-treated or untreated date pits in broiler finisher diets supported and enhanced chicks' body weight gain and feed efficiency ratio similarly to those fed the control diet at the end of six weeks. Also, Gualirei and Rapaccini (1990) fed chicks a grower diet containing 10% date pits during the finishing period and reported that the inclusion of date pits in broiler diets were suitable for supporting growth performance similar to those in the control group. The findings of Hussein et al. (1997) and Gualirei and Rapaccini (1990) were in agreement with results obtained in the present study, since the inclusion of 10% date pits in the finisher rations was suitable to support chicks' growth performance as well as in the control group.

In general, it could be concluded that the addition of untreated or acid-treated date pits to broiler diets supported growth performance similar to those fed the control diet. The incorporation of acid-treated date pits in the starter diets did not increase feed intake of broiler chicks during the starting period. The data obtained in this study showed that dietary date pits can be used to replace part of dietary corn in the broiler rations without causing an adverse effect on birds' growth performance.

Table 5. Effects of experimental diets on growth performance of broiler chicks during the starting period[a]

	Diets				Pooled
Variable	1	2	3	4	SEM
Body Weight ,g					
Week 1	108	108	106	111	5
Week 2	303	297	289	313	12
Week 3	643	648	619	665	17
Week 4	1049	1071	1025	1056	17
Feed Intake, g					
Week 1	91	98	89	95	5
Week 2	283	280	266	291	11
Week 3	523	524	493	521	14
Week 4	707	734	674	707	16
Body Weight Gain, g					
Week 1	63	63	61	67	5
Week 2	195	189	184	203	7
Week 3	340	351	330	346	6
Week 4	406	424	407	397	13
Feed/Gain					
Week 1	1.24	1.32	1.28	1.23	0.05
Week 2	1.45	1.48	1.45	1.43	0.02
Week 3	1.54	1.50	1.51	1.51	0.05
Week 4	1.74	1.73	1.67	1.78	0.05

[a] Each value is the mean of 3 replicate groups of 10 chicks each.

Table 6. Effects of dietary treatments on growth performance of broiler chicks during the finishing period[a]

Variable	Diets 1	2	3	4	Pooled SEM
Body Weight ,g					
Final	1915	1937	1834	1914	52
Feed Intake, g					
Total	1790	1855	1800	1871	60
Body Weight Gain, g					
Total	866	865	808	858	41
Feed/Gain					
Total	2.07	2.15	2.23	2.19	0.06
Eviscerated Weight, g	1375	1403	1336	1392	45
Carcass yield, %	71.8	72.7	72.5	72.7	1.5

[a] Each value is the mean of 3 replicate groups of 8 chicks each.

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SULFURIC ACID TREATED DATE PITS AS DIETARY INGREDIENTS IN TILAPIA (*Oreochromis niloticus*) DIETS

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ABSTRACT

Five isonitrogenous (40% CP) and isocaloric (19 MJ/kg) diets were formulated to investigate the utilization of acid treated date pits as carbohydrate source for tilapia fingerlings (*Oreochromis niloticus).* Tilapia with an average body weight of 6.61 ± 0.04 g were randomly stocked for 42 days in self-cleaning, fiberglass tanks. Diet 1 (control) contained 30% wheat flour as the main source of carbohydrate. Wheat flour in diets 2 and 4 was replaced by 50% (15% of the total diet) and 100% (30% of the total diet) untreated date pits, respectively. Also, treated date pits replaced 50% and 100% of the wheat flour in diets 3 and 5, respectively. Date pits were immersed in 70% H_2 SO_4 for 30 min. and neutralized to pH 7 by sodium hydroxide. Growth performance, feed conversion ratio and protein productive value were significantly ($P<0.05$) higher in fish fed diet 3, whereas fish fed diet 4 gave the lowest values ($P>0.05$). Fish received diets containing treated date pits had better productive performance values than that fed untreated date pits, within the same replacement percentage. Carcass analysis showed significantly ($P<0.05$) lower crude protein content in fish received treated date pits compared to the groups received untreated date pits. Dry matter and ash content were not affected.

INTRODUCTION

Around the world in tropical and sub-tropical areas, the numbers of date palm trees are increased vigorously because of its suitability to be grown under arid conditions. Wasted date and date by-products are promising non-traditional carbohydrate sources in animal nutrition. Utilization of date by-products in animal feeds was first carried out by Ali et al. (1956) for dairy cows. Al-Azzawi (1960), Afifi et al. (1966), Al-Hiti & Rous (1978) Al-Yousef et al. (1986) investigate the utilization of date by-products for broiler, Nagib et al. (1994) for layer hen and Aldosari et al. (1995) for sheep.

The use of date and date pits as fish feed source was first mentioned by Yousif et al. (1996). They found positive growth performance in all fish groups fed diets containing date pits and were superior on that fed date pulp. Also Belal and Al Jasser (1997) found that the total replacement of corn starch by date by-product improve tilapia weight gain, feed conversion and protein efficiency ratio. Date pits includes high amount of crude fiber (14.40%, Yousef et al. 1996 – Richter and Becker, 1956), which decrease the utilization of other nutrients. Al-Yousef et al. (1986) reported that sodium hydroxide treatment of date pits increased the rate of in-vitro digestibility by solubilizing some of the cell wall. The purpose of the present study was to evaluate the utilization of acid treated date pits in *Oreochromis niloticus* diets.

MATERIALS AND METHODS

Diets preparation:

Diet ingredients were obtained from the local market in Al Ain City. The Faculty of Agricultural Sciences Farm (Aloha) provided date pits. Five isonitrogenous (40% CP) and isocaloric (18.9 Mj/ Kg) diets were prepared. Date pits were included in the experimental diets in a rate of 0, 15, 15, 30 and 30% for diets 1(control), 2, 3, 4 and 5, respectively. The date pits in diets 3 and 5 were immersed in 70% H_2SO_4 for 30 min. to remove the outside cover and then washed-up with tap water. Date pits (untreated and treated) were ground in 2mm-mesh sieve. Chemical analyses of treated and untreated date pits are presented in table 1.

Table 1: Chemical analysis of date pits (% DM)

	Moisture	CP %	EE %	CF%	Ash	NFE
Date pits (untreated)	8.24	5.90	7.20	31.59	0.95	54.36
Date pits (treated)*	8.68	5.46	8.27	22.26	1.78	62.23

*) Date pits immersed in H_2SO_4 (70%) for 30 min.

In preparing the diets, dry ingredients were first ground to small particle size, then they were thoroughly mixed and water was added to obtain a 30% moisture content. Diets were passed through a mincer with 0.6-mm diameter and were dried at 55° C for 16 h using a dry oven. After drying the diets were broken up and sieved into convenient pellet size. All diets were frozen (-15° C) until feeding.

Composition and chemical analysis of the experimental diets are presented in table 2.

Table 2: Composition and chemical analysis of the experimental diets.

	Diets				
	Control	2	3	4	5
Feed composition					
Fish meal	34	35	35	37	37
Soybean meal	25	25	25	25	25
Wheat flour	30	15	15	--	--
Date pits	--	15	15[1]	30	30[1]
Corn oil	5	5	5	5	5
Vitamin mix.[2]	3	3	3	3	3
Cellulose	3	2	2	--	--
Chemical analysis					
Dry matter	95.9	94.2	94.7	95.1	94.9
Crude protein	40.4	40.4	40.2	41.5	40.3
Ether extract	6.7	7.5	7.4	9.0	8.6
Crude fiber	4.1	8.7	7.7	11.4	10.5
Ash	10.7	10.8	10.4	11.3	10.2
NFE	38.1	32.6	34.3	26.8	30.4
Gross Energy (MJ/kg)	18.7	18.8	18.9	19.1	19.1

1) Treated.

2) Vitamin mixture: Shrimp tonic, JV Marine East. Co. Ltd, Thailand.

Experimental fish:

Oreochromis niloticus fingerlings (6.6 g/ fish) were obtained from the fish stock of the fish culture laboratory. Fish were acclimated for one week indoor 10-liter fiberglass tanks at a rate of 1 fish/ 1 liter and fed the control diets (40% CP and 19 Mj/ Kg). Three tanks were used per treatment. Fish from each tank were weighed at the beginning of the experiment, every 2 weeks and at the end of the feeding trial. The fish were fed the experimental diets for 6 weeks twice a day, 6 days per week at a level of 5% of the body weight per day. At initiation and end of the feeding trial fish were retained for carcass analysis. Fish were decapitated homogenized in blender, stored in polyethylene bags and frozen for subsequent ash, protein and lipid analysis. After homogenization, a 15-g sample was oven dried at 105° C for 24h for moisture determination.

Growth performance and feed conversion were measured in terms of final fish weight, specific growth rate (SGR, %/ d), feed conversion ratio (FCR), feed intake, protein efficiency ratio (PER) and protein productive value (PPV%). Growth response and feed utilization parameters were calculated as follows:

$$SGR\ (\%/\ day) = \{\ln W_1 - \ln W_0) / T\} \times 100$$

Where:

W_1 is the final body weight of the fish,

W_0 is the initial body weight of the fish and

T is the culture period in days

FCR= Total feed fed (g/ fish) / total wet weight gain (g/ fish)

PER= Wet weight gain (g/ fish) / amount of protein fed (g/ fish)

PPV= {Amount of protein fed (g/ fish) / amount of protein retained (g/ fish) x 100

Experimental system:

The feeding trial was conducted in 15 (10 L) fiberglass tanks, in the fish culture laboratory, Faculty of Agricultural Sciences, United Arab Emirates University. The tanks were a part of a complete recirculating water system provided with biological and mechanical filters. Continuos aeration was provided by an air blower and air stones. Throughout the experimental period, water temperature was maintained at 26 ±1° C by using thermostatic electrical heater. The water in the system was partially exchanged at a rate of 5% daily. Each tank was supplied with water at a rate of 3 L/ min.

Chemical analysis:

Chemical analyses of the experimental diets and fish body were performed according to the standard methods of AOAC (1984). The nitrogen free extract (NFE) was calculated by difference {100 – (crude protein + crude fat + crude fiber + ash)}. Gross energy was calculated based on the conversion factors: protein 23.27 kJ/ g, lipid 37.67 kJ/ g and carbohydrate 16.74 kJ/ g (Garling & Wilson 1976).

Statistical analysis:

Data were statistically analyzed by analysis of variance (ANOVA) using the MSTAT4 (Nissen 1987). Duncan's multiple-range test was used to compare differences among individual mean at $P<0.05$.

RESULTS AND DISCUSSION

Replacement of 100% of wheat flour in the diets of *Oreochromis niloticus* fish by untreated date pits (diet 5) reduced significantly (P<0.05) weight gain % and SGR. However, the differences between gain of groups (control, 2, 3 and 4) were not significant (P>0.05). Fish group received diet 3, where 50% of the wheat flour was replaced by treated date pits showed the highest growth values. It seems that sulfuric acid treatment had reduced the crude fiber content of the date pits which consequence increases the utilization of the diets. Vandepopuliere et al. (1995) concluded that high fiber content in diets of monogastric animals decreases their weight gain. Also Belal and Al-Jasser (1996) found that with increasing the inclusion rate of date by-products up to 30%, instead of corn flower in *Oreochromis niloticus* diets, fish weight gain was increased significantly (P<0.05). They suggested a certain dietary ratio between complex and simple sugar of 3:1 for best performance of tilapia fish. This may explain the reduction of weight gain obtained in the present study when untreated date pits (high fiber content) was the only source of carbohydrate in fish feeds (diet 4). Shiau and Lin (1993) concluded that tilapia fish utilizes complex carbohydrate (starch) more readily than those simple sugars. Feed conversion (FCR) showed better significant (P<0.05) values in group 3 followed by control, diet 2 and 5 than group 4 which showed the highest significant (P<0.05) FCR values. However, with replacement of 100% wheat flour by untreated date pits, significant reduction (P<0.05) in feed utilization parameters, with treating the same replacement level with 70% sulfuric acid, utilization of the carbohydrate source was improved.

Protein utilization values of group 3 (15% treated date pits) was superior significantly (P<0.05) on all other fish groups including the control. More than 15% date pits in the diets decrease the utilization values of the dietary protein. Belal and Al-Jasser (1996) found that incorporating wasted date in tilapia feeds improved the protein sparing effect of fat and carbohydrate during protein synthesis.

Table 3: Performance of *Oreochromis niloticus* fingerlings fed the experimental diets

	Diets					
	Control	2	3	4	5	± SE
Initial wt.	6.61	6.58	6.61	6.59	6.63	0.04
Final wt.	13.97^{a}	13.54^{a}	14.92^{a}	11.25^{b}	13.10^{ab}	0.62
Gain (g/ fish)	7.35^{a}	6.96^{a}	8.31^{a}	4.76^{b}	6.47^{ab}	0.63
Weight gain (%)[1]	114.17^{a}	105.80^{a}	125.70^{a}	72.17^{b}	97.53^{ab}	10.0
SGR[2]	1.77^{ab}	1.72^{a}	1.94^{a}	1.43^{b}	1.61^{ab}	0.11
Feed intake	15.98^{a}	15.85^{ab}	16.39^{a}	14.84^{b}	15.58^{ab}	0.31
FCR[3]	2.23^{b}	2.30^{b}	1.98^{b}	3.22^{a}	2.45^{ab}	0.23
PER[4]	1.05^{bc}	1.19^{ab}	1.33^{a}	0.83^{c}	1.04^{bc}	0.08
PPV[5]	24.01^{b}	27.58^{ab}	29.87^{a}	15.85^{c}	23.82^{b}	1.68

1) Weight gain % = (Gain/ initial wt) x 100

Chemical compositions of fish body are presented in table 4. . In all groups including date pits in the diets improved fish body protein content. Fish fed diet 5 (30% treated date pits) showed the highest protein content. Elgasim et al. (1995) explained the protein deposition in animal tissue may due to the hormonal effect of date pits as a repartitioning agent (acts in a similar way as estrogen) which alter the energy deposition towards protein and away from fat.

Generally, lower percentage of body fat was observed by increasing the treated date pits percentage in the diets.

In conclusion, the present experiment showed that treated date pits with sulfuric acid could be utilized in *Oreochromis niloticus* diets up to 30% with out adverse effects on its utilization as an available carbohydrate source in fish feeds.

Table 4: Carcass composition (% of dry weight) of *Oreochromis niloticus* fed the experimental diets

	Initial	Groups					
		Control	2	3	4	5	± SE
Moisture	71.96^{a}	71.40^{a}	70.09^{b}	71.80^{a}	68.13^{c}	69.81^{a}	0.36
Crude protein	52.25^{d}	55.07^{c}	56.40^{c}	59.44^{b}	55.26^{c}	63.52^{a}	0.37
Lipid	13.69^{c}	14.97^{b}	16.43^{a}	14.63^{bc}	14.77^{bc}	11.56^{d}	0.31
Ash	21.17^{a}	17.50^{b}	17.79^{b}	18.66^{b}	18.14^{b}	18.37^{b}	0.30
Rest	12.89^{a}	12.44^{a}	9.41^{c}	7.22^{d}	11.83^{b}	6.56^{e}	0.14

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Effect of Nitrate Concentration on Recovery of Date palm Vitrified Embryos

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ABSTRACT

Shoot tip fragments of adult date palm *(Phoenix dactylifera* L.) cv. Khalas offshoots were cultured on a nutrient medium containing Murashige and Skoog (1962) inorganic salts supplemented with 100 mg/l 2,4-dichlorophenoxyacetic acid and 3 mg/l kinetin and 3 mg/l activated neutralized charcoal to develop nodular callus after 8 months and embryogenic callus two month later.

Callus with recorded number of vitrified and normal embryos were cultured in hormone-free medium with nitrate level modified to 0, 0.25, 0.5, 0.75 and 1.0X that of normal MS level. The recovery rate of normal embryogenic traits was associated with 0.5 level of Ms nitrate, whereas, medium devoid of nitrates resulted in severe browning and eventual death of embryos.

INTRODUCTION

Vitrification is a physiological disorder that frequently hampered *in vitro* micropropagation of woody plants (Ziv, 1991; Debergh *et al.,* 1992). The affected plantlets characterized by translucent brittle stems and leaves, inferior epidermis with prominent stoma, absence or discontinuous cuticular layer and lack of procambium connecting leaf primordia and stem vascular tissues (Leshem, 1983; Vieitez *et aL,* 1983; Paques and Boxus, 1983). The phenomenon has been observed in a number of plants under *in vitro* propagation, such as: apple, pears, grape and date palm (Al-Maari, 1996).

The consequences of vitrification are clearly manifested on the decreased proliferation rate of tissue-cultured plantlets and enhanced difficulties arising at the time of *in sun* acclimatization (Paques and Boxus, 1983). Apparently, these facts represent serious regeneration problem (Debergh, *et al.,* 1992).

Fortunately, experiments with a number of species have demonstrated that the morphological aspects of vitrification can be controlled by various means including, optimization of growth regulators, increasing agar concentration, reducing ammonium nitrate in culture medium, improving gas exchange and controlling culture environmental conditions. However, investigations undertaken on this subject do not allow a thorough comprehension of the mechanism(s) inducing the phenomenon. Therefore, this work attempts to focus on the role of nitrate in the process of date palm embryo vitrification so as to determine the adequate level that would be effective against the occurrence of vitreous embryos and recovery of vitrified ones.

MATERIALS AND METHODS

Offshoots of female *(Phoenix dactylifera* L.) cv. Khalas were detached from adult mother plant. The leaves along with the leaf sheaths were removed acropetally to expose the tender portion enclosing shoot tips. These portions were transferred to an antioxidant solution (ascorbic acid 100 mg/l and citric acid 150 mg/l) containing 3% of sodium hypochlorite for 22 hrs,

Explants were further trimmed to about 1.0 cm and cut into 15-20 small segments. Each segment was initially cultured in 25 - x 150 mm glass culture tube containing 25 ml of nutrient medium composed of Murashige and Skoog (1962) inorganic salts, 3% sucrose, 3% activated neutralized charcoal, 0.8% agar-agar, and in mg/l, myo-inositol, 100; thiamine-HCI, 1; pyridoxine-HCI, 0.5; nicotinic acid, 0.5; glycine, 2;2, 4-dichlorophenoxyacetic acid, 100; kinetin, 3. The pH of the medium was adjusted to 5.7±1 with O. IN NAOH and HCI prior to agar addition.

The cultures were incubated at 28±2°C in darkness and subcultured every2months.Afriablenodularcalluswasinitiated after 8-months of culture. After appearance of embryogenic callus the cultures transferred to hormone-free medium and maintained under 3000 Lux light under 28±2°C for initiation of somatic embryos.

Embryogenic callus tissues exhibiting symptoms of vitrification (plate 1) were used for experimentation. Callus tissues measuring 5mm in diameter weighing about 100 mg with recorded number of normal and vitrified embryos were cultured in Murashige's minimal organics (hormone free medium) with nitrate level modified to 0, 0.25, 0.5, 0.75 and 1.0X the normal level of MS inorganic salts. Twenty cultures were employed per treatment. The cultures were maintained for 11 weeks (transferred to fresh medium once) at 28±2°C and under 16 hr daily exposure to 3000 Lux light.

The confidence limits for the binomial distribution were computed according to Diem *et al* (1982).

RESULTS AND DISCUSSION

As reported previously, shoot tips cultured on medium containing high levels of auxin produced good callus growth (Tisserat, 1979; Mater, 1986). After few subcultures onto fresh medium, explants gave rise to yellowish aggregates of nodular callus that transferred to hormone-free medium to initiate embryogenic callus under light.

The incidence of vitreous embryos was observed after a couple of subcultures. This disorder decreased the proliferation rate of embryos. Similar results were obtained in different plants (Leonhardt and Kandeler, 1987; Paques and Boxus, 1987; Ziv, 1991)

Restoration of normal embryogenic traits was attempted only via amelioration of nitrate level in MS salt formula, though various remedies like reducing ethylene accumulation (Leonhardt and Kandeler, 1987), increase of agar fractions concentration (Marga *et al.*, 1997) and changing medium physical conditions (Veramendi and Navarro, 1996) were investigated to overcome of vitrification and hyperhydricity.

It is clear that the medium devoided of nitrate resulted in severe browning within the first weeks of culture, failed to support growth and the embryos eventually died (Plate2). This signiries the importance of nitrogen in the morphogenetic responses of tissue cultured plantlets (Murashige and Skoog, 1962). Cultures maintained in 0.25 and 1.0X level of nitrates suffered partial necrosis. This is probably attributed to nitrogen deficiency in the former and the high level of nitrate in the form of potassium and ammonium of the MS salt formula in the latter (Brand, 1993).

The proportion of normal to vitreous embryos was appreciably higher at half concentration of Murashige and Skoog (1962) nitrate salt concentration within the first five weeks of culture compared to other concentrations (Fig. 1). Similarly, the ratio of normal to **vitrified** embryos was higher at the same concentration (Fig. 2). These results were in agreement with other studies of date palm where the concentration of inorganic salts were lowered to increase the proliferation rate and to avoid arrested state of growth (Omar *et aL*, 1992).

The recovery of normal embryogenic qualities of date palm embryos at 0.5X MS nitrate level was associated with parallel decrease in the incidence of vitrified embryos (Fig. 3). The inverse correlation between nitrate level and incidence of vitreous embryos is seemingly due to reduction of ammonium form of nitrate that affect availability of soluble substances by means of chemical interaction (Daguin and Letouze, 1986; Brand, 1993). In fact, vitrification is reported to occur occasionally in rich media such as Murashige and Skoog (1962) (Paques and Boxus, 1987).

Therefore, the first data of this study allow us to conclude that the best concentration of nitrates for normal somatic embryo development of date palm is half strength of MS nitrate. Obviously, further research is required so as to identify the type of nitrate influencing vitrification and to understand the role of nitrates and other chemical(s) being used in date palm culture media on normal embryo development.

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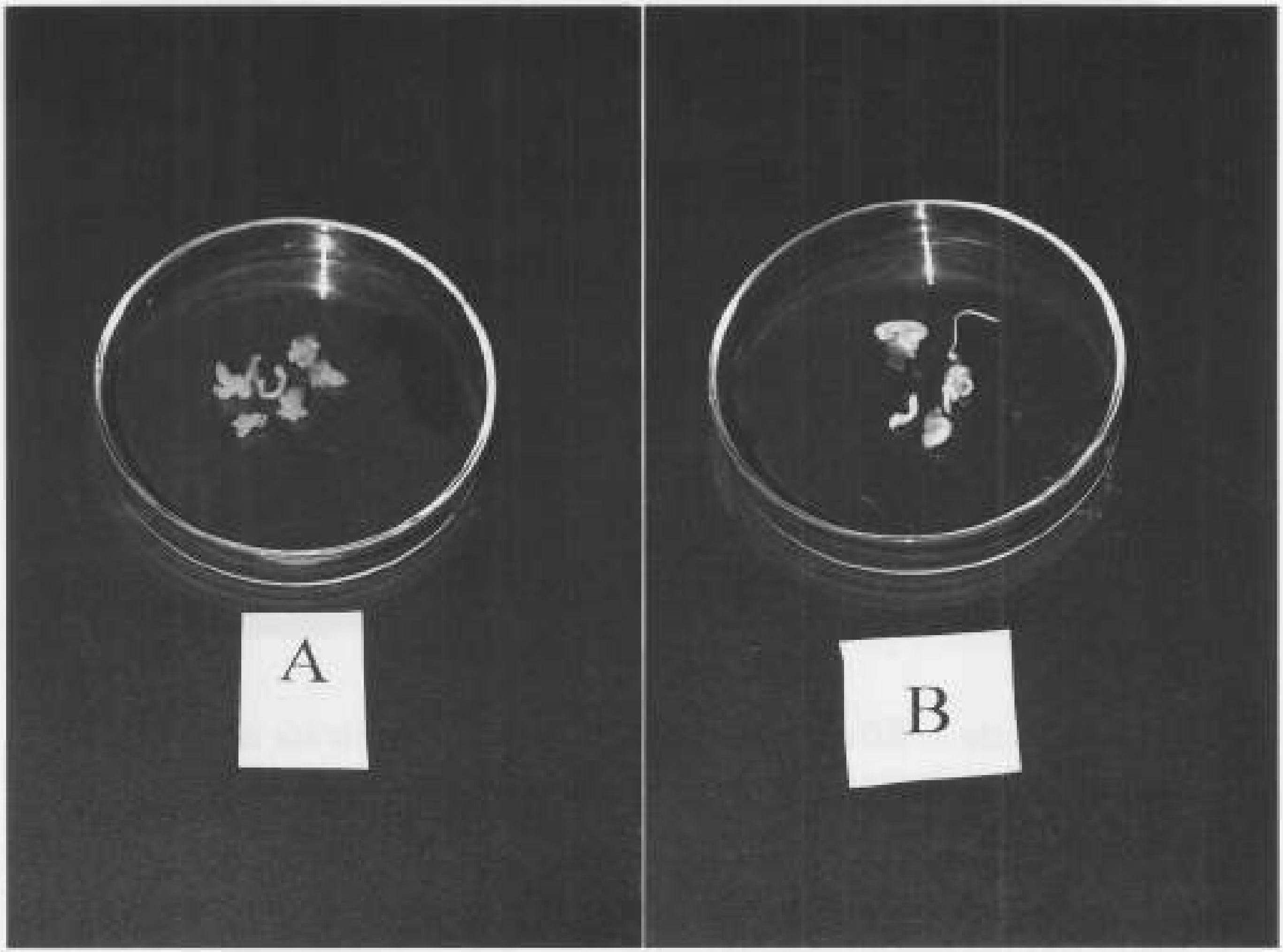

Plate 1. Kkalasa date palm somatic embryos. (A) normal and (B) vitrified embryos

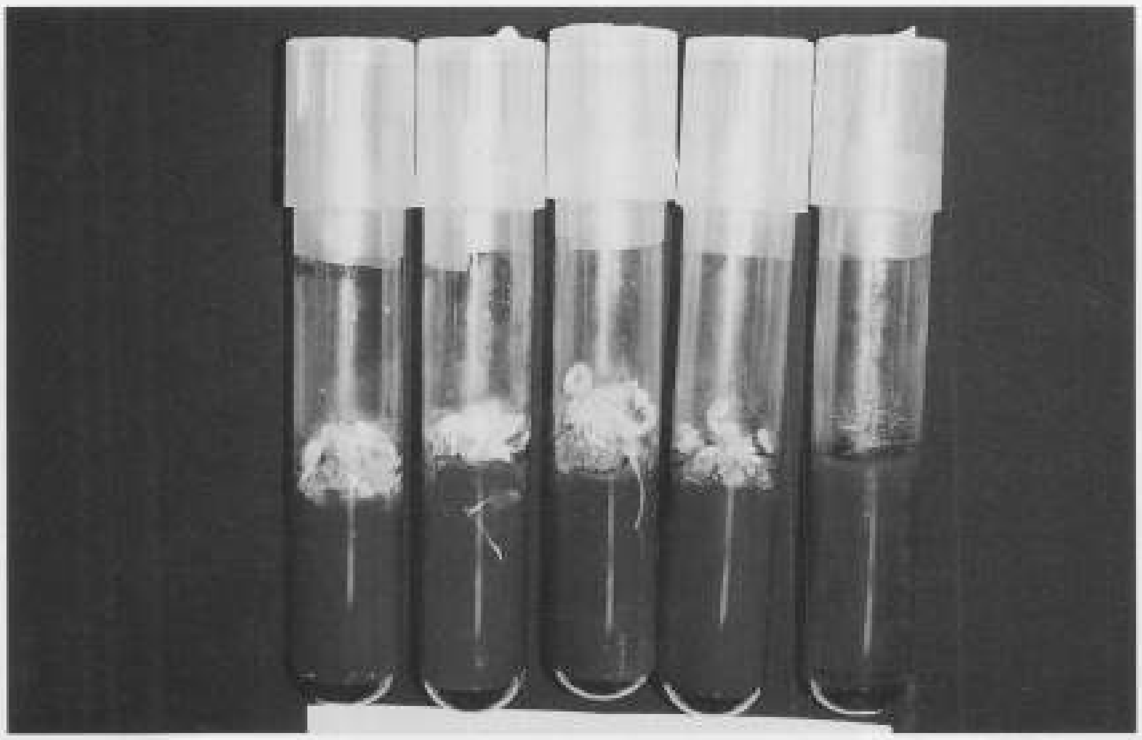

Plate 2. Effect of different levels of MS nitrate on development of somatic embryos. From left to right, 1.0, 0.75, 0.5, 0.25 and 0.0X MS nitrate.

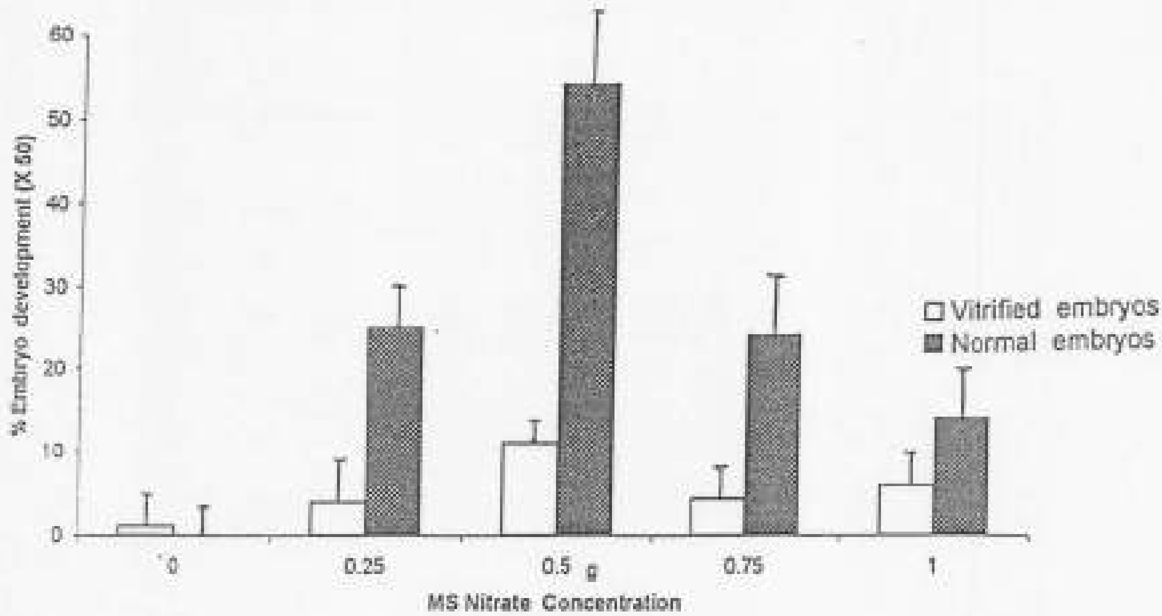

Figure (1) - Effect of nitrate on frequency of normal to vitrified embryo development (Bars indicate 95% confidence limit)

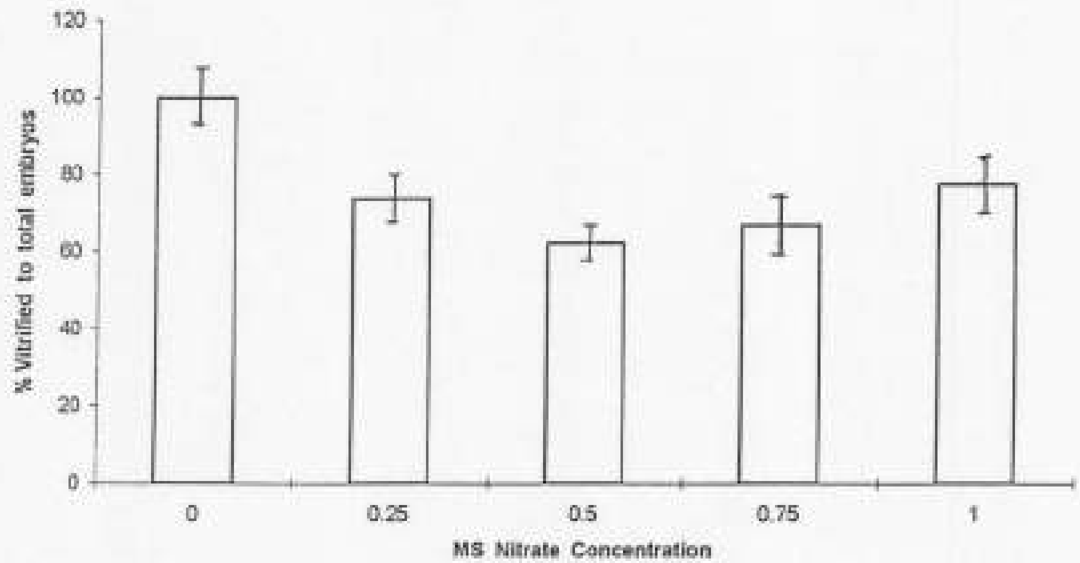

Figure (3) - Effect of nitrate concentration on percentage of vitrified embryos relative to total embryos (Bars indicates 95% confidence limit)

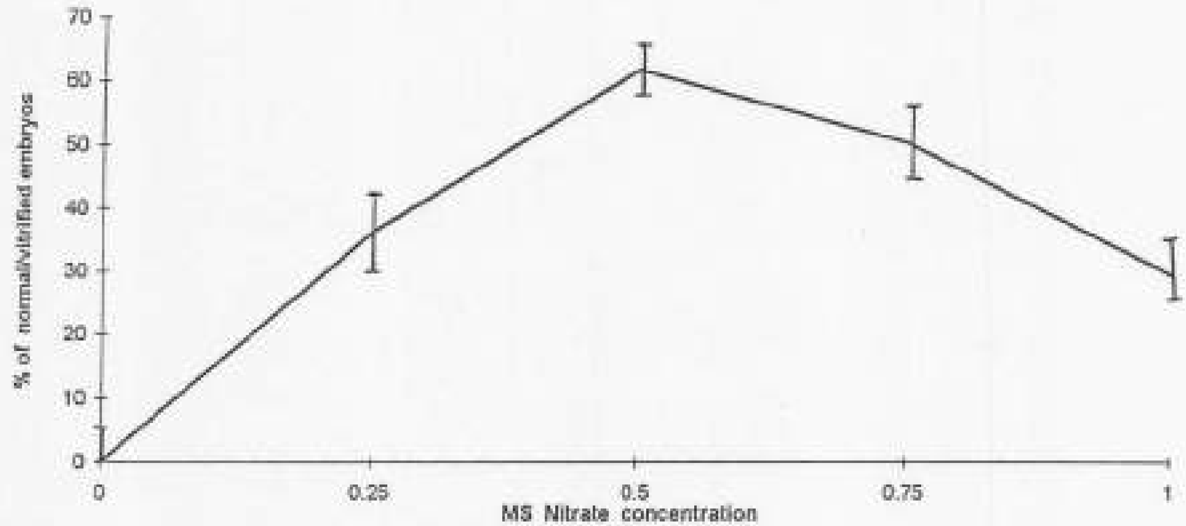

Figure (2) - Effect of Nitrate Concentration on percentage of normal embryos relative to vitrified embryos (Bars indicates 95% confidence limit)

THE SPEECH OF HIS EXCELLENCY
Mr. AHMAD SULTAN AL HALAMI
UNDERSECRETARY OF THE DEPARTMENT OF
AGRICULTURE & LIVESTOCK,

According to the annual statistical bulletin of the Ministry of Agriculture and Fisheries for the year 1996, total area of date palm was 310 thousand Dunums (31000 hectares) with 21 million date palms of which 8.6 millions are bearing.

Referring to FAO production yearbook (1995, 1996), the annual average production of dates in UAE was 152 thousand tons for the years 1989-1991, then it increased to 237 thousand tons in 1995 which presented 5.3% of world production (4.4 million tons). In 1996, the production increased to 240 thousand tons.

Concerning the UAE trade of dates, although the UAE is a producer country it imports significant quantities of dates for re-export to international markets in consideration that the UAE is one of the world trade centers.

Hereunder are the main activities of the department of Agriculture and Livestock in Al-Ain:

1- It participates financially and practically in international, regional and local symposiums and conferences.

2- It provides, freely, each new farm with 100 good cultivar offshoots.

3- It has constructed a date processing factory in Al-Ain with a capacity of 20 thousand tons / year at a cost of 141 million dirhams (US$ 38.5 million) to absorb, process and market the surplus produce. The factory will start operation in May 1998.

4- The department has imported - through bidders - and planted in Al-O'ha project (25 Km north of Al-Ain) 23 thousands of good cultivar shoots (barhi and khalas) in the past year and 40 thousand shoots at the beginning of the instant month.

5- By virtue of the president of the state instructions, the department of Agriculture buys date production of the North Emirates at rewarding prices.

6- In September 1996, a joint project for four years was held between the department of Agriculture and Livestock in Al-Ain, the College of Agriculture of Sultan Qabus University of Oman Sultanate for a joint project to control the red palm weevil. The project will make a data base for date palm cultivars, the degree of infestation of the red palm weevil and study of the various means to control and eradicate the weevil.

May Allah protect our country under the leadership of the president His Highness Sheikh Zayed bin Sultan Al Nahyan.

Allah peace and blessings be upon you.

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WELCOME AND OPENING REMARKS

BY

HIS HIGHNESS SHEIKH NAHAYAN MABARAK AL-NAHAYAN

MINISTER OF HIGHER EDUCATION & SCIENTIFIC RESEARCH

CHANCELLOR OF UNITED ARAB EMIRATES UNIVERSITY

Ladies and Gentlemen:

It is my pleasure to welcome you as we inaugurate this first international conference on date palms. The United Arab Emirates University is pleased to sponsor this conference as part of its strong commitment to the role of scientific research in promoting development and progress. The United Arab Emirates University views research and discovery of new knowledge as vital to the well-being of humankind. The development of the practical implications of that research into usable technology is the engine of change in the modern world.

This conference will focus on a research topic of very high priority in the United Arab Emirates. To us, the date palm is a blessed tree. Indeed, it is a tree of life. Date palms have very deep roots in the history, traditions, and heritage of our region. We appreciate the role of the palm tree in shaping human activities in this area throughout history. And we recognize the harmonious relationship of the palm tree to the surrounding environment.

The tremendous interest in the scientific study of palm trees in the United Arab Emirates extends to the study of its biology, conservation, improved strains, and economic utilization. This clear interest reflects the importance that His Highness, the president, Sheikh Zayed bin Sultan Al Nahayan, attaches to agricultural development in general, and to date palms in particular. This special attention is clearly evident in the continued expansion in agricultural resources and investments, in the fast growth in the number of palm tress, in the continued increase in the size and variety of date products, in the extensive use of modern technologies, and in the important initiatives undertaken in the areas of manufacturing and marketing.

As part of your conference, I hope that you will have the opportunity to visit and explore some of the agricultural projects in this country. I am confident that you will appreciate our agricultural progress and achievements. You will observe the prominence of date palms in the agriculture of our country. And you will certainly notice our continued efforts, under the leadership of His Highness the President, to increase agricultural productivity, to make better use of available resources, and to produce an agricultural leap that is changing the face of the desert around us.

Ladies and Gentlemen:

The United Arab Emirates, its University, and this garden city of Al-Ain provide a very appropriate context for your conference. We believe that this conference will offer its participants a valuable opportunity for a stimulating exchange of ideas, experiences, and perspectives. It is reassuring to note that the palm tree is now a topic of important research in many parts of the world. This conference will focus attention on all these research activities, including the cultivation, development and commercial potential of date palms. At the same time, the conference will highlight the need for continuing studies in both basic and applied biology of date palms, as well as the special need to transfer the research results into practice on the farm. It is obviously critical that appropriate conditions for the successful implementation of research results be created.

I am very optimistic that this conference, and the select group of participating researchers, will make significant contributions to the field of date palms. Once again, welcome to the United Arab Emirates University. I express my appreciation for the careful organization of this important conference. In particular, I wish to thank the Department of Agriculture and Livestock, Al-Ain for their joint sponsorship of the conference.

Thank you all, and my best wishes for a successful conference.