

## THE HISTORY OF PALM CULTIVATION IN IRAQ

**Imad Jabbar Wadi AL-SUWAID, Ana Cornelia BUTCARU,  
Cosmin MIHAL, Florin STĂNICĂ**

University of Agronomic Sciences and Veterinary Medicine of Bucharest,  
59 Mărăști Blvd, District 1, Bucharest, Romania

Corresponding author email: emadjabbar74@yahoo.com

### **Abstract**

*The date plant with the scientific name of Phoenix dactylifera L. has a history of cultivation of more than 5000 years. The date palm tree is used for various purposes such as food, shelter, fibers and fuel. Dates are one of the top 5 products produced in the world and after wheat, tomatoes and barley it is the fourth product produced in the world. Arab countries have more than 70% of date palm trees. More than 67% of dates are produced in Arab countries. The cultivation of dates in Iraq has a long history. Iraq has been one of the top ten date producing countries for a long time (the last two decades). Dates are Iraq's second export product. However, various factors such as war, sanctions, environmental tensions, and pests and diseases reduced the production of dates and destroyed a wide area of date orchards. Fortunately, nowadays, according to various management programs for the production and export of this product, as well as various research conducted with the aim of increasing the productivity and quality of the fruit, date production in Iraq has been progressing. So, in 2022, Iraq was the first exporter of dates in the world.*

**Key words:** export, fertilization, pollination, production.

### **INTRODUCTION**

The date palm plant with the scientific name *Phoenix dactylifera* L. has a history of cultivation of more than 5000 years (Zohary & Hopf, 2000; Zaid & Arias-Jimenez, 2002; Al Farsi & Lee, 2008). The word "phoenix" is probably derived from the Greek word for the red or purple fruit, and the "dactylifera" from the Greek daktulos, which means finger like (Zabar and Borowy., 2012). This species has economic, symbolic and cultural importance in all cultivated areas such as Morocco, Arabian Peninsula and India (Fuller and Stevens, 2019; Tengberg, 2012). The palm tree is used for various purposes such as providing food, shelter, fibers and fuel (Plotkin & Balick, 1984; Mallaki & Fateh, 2014). Palm has been repeated about 64 times in the holy books of Torah, the gospel and the Qur'an. Due to the fact that the palm is in the group of evergreen plants, the ancient Egyptians considered them a symbol of immortality. The palm tree is a symbol of peace, victory and fertility in many cultures and has a special place in ancient Egypt (Farmhand, 2019). The date palms are cultivated due to the production of carbohydrate-rich fruits in tropical and arid areas where plants have little ability to

grow (Shrinath Baliga et al., 2011). In addition to being consumed as food, the sweet date fruit has long played a role as an important product in agricultural livelihood and economic prosperity (Fuller and Stevens, 2019; Tengberg, 2012). The total number of date palm trees in the world is estimated at 120 million trees. Arab countries have more than 70% of date palm trees. Therefore, 67% of the world's date production is in Arab countries (El-Juhany, 2010). It should be mentioned that the date palm also has ornamental importance (Abdel Fattaah et al., 2017). According to the FAO statistics in 2022, the total production of dates in the world and Iraq was 9,747,570 and 715,293 tons, respectively (FAOSTAT, 2024).

### **ORIGIN AND DISTRIBUTION**

The date plant has been cultivated since ancient times (Riad 2006). The dates appear to be one of the few plant species that have been domesticated in their native desert environment (Zohary and Hopf, 2000). Dates were cultivated in North Africa and Central Asia nearly 1,500 years ago (Zabar and Borowy, 2012). It is probable that the Middle East was a region for the date to become native in the fourth period

before Christ. It was probably later transferred to North Africa during the Roman period (Munier, 1973; Nixon, 1951; Tengberg, 2012). In Christianity, the leaves of the date palm tree are used during the Easter celebrations (Zohary and Hopf, 2000). In Islam, the date palm tree is mentioned repeatedly in the Qur'an and has a special importance in religion and Islam (Zabar and Borowy, 2012). The date palm tree is depicted in the ancient Babylonian and Assyrian tablets. In addition, this tree is also mentioned in the Palestinian, Libyan, Syrian and Egyptian writings (Zabar and Borowy, 2012). Recent studies have shown that *P. dactylifera* was not the result of hybridization between two wild *Phoenix* species. Based on genetic studies, it has been reported that *P. dactylifera* was probably domesticated from the same wild population (Pintaud et al., 2010). In confirmation of this hypothesis, another study found that *P. dactylifera* grown in the enclosed area of the Hajar Mountains, Oman, was wild (Gros-Balthazard et al., 2017). Ancient evidence of wild date palms has been found in the ancient remains of West Asia. In the Shanidar cave in Iraq, more than 50 kg of pollen and ca. 46 kg phytoliths associated with date palms have been observed (Henry et al., 2011; Solecki and Leroi-Gourhan, 1961). Date palms Phytoliths found in Iraq have been from sediments dating back to 10,000 BC (Altaweel et al., 2019). From excavations in the Levantine region, a nearly 19,000-year-old stem burned and 69-69 Ka phytoliths were discovered (Henry et al., 2004; Liphshitz and Nadel, 1997). It is thought to have originated in the Mesopotamian region (southern Iraq) or western India (Zabar and Borowy, 2012). Today, the date palms are grown and cultivated in the Middle East, North Africa, parts of southern and central America, southern Europe, India and Pakistan (Zaid & Arias-Jimenez, 2002; Al-Shahib & Marshall, 2003).

## BOTANICAL

About 19 species have been identified in the *Phoenix* genus (Zabar and Borowy, 2012). Date palm is a monocotyledonous, perennial, diploid and dioecious plant ( $2n=2x=36$ ). This plant belongs to *Arecaceae* family (Barrow, 1998). The morphology of male and female date palm

inflorescences is different from each other. In both inflorescences, there is a fibrous and hard covering called spots, which protect the flowers from direct sunlight in the early stages of growth (Chao and Krueger, 2007). This plant grows in arid areas. The length of the tree reaches 30 to 36 meters. The trunk diameter of date palm is more than 50 cm. The trunk of the plant is covered with upward, woody and resistance leaves. After 6 to 16 years, the offshoots grow around the main trunk (Zabar and Borowy, 2012).

## THE IMPORTANCE OF THE DATE PALM

Date fruit is a rich source of nutrients such as antioxidants, minerals, carbohydrates, protein and fiber (Noutfia and Ropelewska, 2023). About 72-88% of date fruit is made up of carbohydrates, which are mainly glucose, sucrose and fructose. In addition to carbohydrates, dietary fiber, a small amount of protein and fat, vitamins such as riboflavin, thiamin, biotin, folic acid and ascorbic acid are present in date fruit. The energy value per 100 grams of date fruit is equal to 314 kcal (Al-Farsi and Lee, 2008). Mesocarp is rich in various minerals such as iron, calcium, cobalt, copper, fluorine, magnesium, manganese, potassium, phosphorus, sodium, sulfur, boron, selenium and zinc (Ali Mohamed & Khamis, 2004; Al Farsi & Lee, 2008). In addition, there are abundant amounts of compounds in it, such as: antioxidant, antimutagenic, anthocyanin, phenolic and free and bound acids (Vayalil, 2002; Al-Farsi et al., 2005), 16 types of amino acids, vitamins A, B, B2, dietary fibers and fatty acids (Karasawa et al., 2011; Al-Shahib & Marshall, 2003; Ahmed et al., 1995).

The therapeutic effects of this plant include antioxidant (Kchaou et al., 2013), anti-hot flushing and anti-cancer (Rahmani et al., 2014), antimicrobial (Shariati et al., 2010; Shakiba et al., 2011; Al-daihan & Bhat, 2012; Al-Zoreky & Al-Taher, 2015), antifungal, neuroprotective (Pujari et al., 2014) and hepatoprotective agents (Singab et al., 2015). Dates are traditionally used in the treatment of diabetes and blood pressure (Hifnawy et al., 2016). Spathe extract is used as a flavoring in drinks (Al-Taher, 2008a; Demricia et al., 2013). Phytochemical analysis

of Spathes has shown that Spathes contain various compounds such as sugar, furfural, calcium pectate, protein, wood ash, three types of coumarin, 1 and 0 Dimethoxys, 1 and 4 dimethylbenzene and plant sterols (Demrici et al., 2013).

## PROPAGATION AND POLLINATION

Dates are propagated by seeds, vegetative propagation (offshoots) and tissue culture (Zabar and Borowy, 2012). Seed propagation is mainly not done due to the production of different plants and the high probability of decreasing fruit quality (Moustafa et al., 2010). Date palm vegetative propagation is accomplished by offshoots grown in the mother plant (Alihourri and Dialami, 2010; Tengberg, 2012). This method of propagation in the palm is very old. The evidence suggests that the propagation of the date palm by this method is related to the second half of the third millennium BC (Tengberg, 2012). Tissue culture technique is one of the high-speed propagation methods in plants. Shoot tips, embryo culture, and bud culture are commonly used as the explants in this technique. It should be mentioned that leaves, inflorescences, stems and roots are also used as the explants (Al-Sakran and Muneer, 2006). Pollination of female flowers in date palm is one of the most important stages of plant growth (Janick, 2005; Moustafa et al., 2010). The ideal temperature for pollen seed germination is 35°C (Zirari, 2010). This process has probably been used in southern Mesopotamia since the late 4th millennium BC (Landsberger, 1967; Tengberg, 2003). It was first mentioned in the texts in the 18th century BC by the Babylonians. After that, it was also seen in the Assyrian iconography (Sarton, 1934). Dates flowering occurs at a temperature of 18°C and fruit formation occurs at a temperature higher than 25°C (Zaid and Wet, 2002a). The number of 4-10 male trees is sufficient to pollinate 10 female trees (IQBAL et al., 2004). Pollination is done during the flowering season (February and March). Pollination is done manually by placing two or three pollen-carrying filaments in the female flower cluster. Mainly, due to the high cost of the worker specializing in pollination, farmers allow pollination to be done with the wind,

which affects the fruit productivity and quality (FAO and AOAD, 2023). Date pollination is also possible through insects (Nixon and Carpenter, 1978; Zaid and Wet, 2002c). In general, there are few male trees in the date palm garden, whose pollen is used for manual pollination. The pollination of 60-80% of female date flowers produces a sufficient and appropriate amount of fruit (Nixon and Carpenter, 1978; Zaid and Wet, 2002c). Different types of pollen, affect the size and shape of seeds (Chao and Krueger, 2007). The Iraqi date male cultivars that are used to produce pollen, include Ghanami Ahmer, Ghanami Ahmer, Khakri Kratley, Khakri Smasmi, Khakri Wardi and Khakri Adi. The difference in these cultivars is determined by the size of the pollen grains. The largest pollen grain size was observed in Khakri Kratley and the smallest pollen grain was observed in Ghanami Ahmer. Ghanami Ahmer has better quality in bunches and pollen grains in each cluster compared to other cultivars. The use of pollen from Resasi in the rootstock of Khadrawy material increased the maturation period. However, no difference was observed in Maktoom fruits. The use of Ghanami Ahmer pollen in Halawy trees increased the percentage of maturity. However, it had no effect on Sukar cultivar (Ibrahim, 2008). In a study conducted in Iraq, which examined the pollen grains and the plant growth regulator in Sultani cultivar, it was found that the use of 50 mg.l<sup>-1</sup> NAA along with Ghannamiahmer cultivar had a positive effect on the fruit formation. However, compared to the other pollinator cultivars (Ghannamikhder and Ghannamiahmer), Khukri cultivar increased the fruit size and weight. In addition, it significantly improved the content of fruit dry matter and total sugar compared to other cultivars. Also, the use of Ghannamiakhder significantly increased the bunch weight in the rutab stage (Aubied et al., 2019).

## APPLICATION OF DATE PALM TREE

Date palms are used in the production of paper (Jonoobi et al., 2019). In addition, date palm is also effective in absorbing heavy and toxic elements. Dates Palm can be used in the absorption of lead toxic element (Muthusaravanan et al., 2018; Janani et al.,

2019; Alghamdi, 2016). The fibers and petioles of dates in aqueous solution have the potential to absorb lead (Al-Haidary et al., 2011). It should be mentioned that various factors such as PH of the solution, absorption dose, duration of exposure in the solution, ionic strength and temperature are effective on the amount of silver ion absorption. In general, the use of date palm waste in the absorption of lead ions is an efficient and low-cost method (Jonoobi et al., 2019). Another use of date palm is the production of Wood Composites (Jonoobi et al., 2019; Zadeh et al., 2017; Gheith et al., 2019). Among the various applications of date palm in composite production, Date palm propylene composite, Propylene reinforced with date palm fibers, Date palm fiber/polyester composite, Reinforced ethylene terephthalate composite, Starch-based biodegradable composite, Natural mortar reinforced with date palm, Wood-polymer composite with date palm and epoxy matrix, OSB from date palm, Date palm MDF, Particleboard from date palm, Wood-cement composite with date palm and Gypsum board from date palm (insulation board) can be mentioned (Jonoobi et al., 2019). The use of palm fibers has been effective in strengthening polypropylene and low-density polyethylene (Alzebdeh et al., 2016). Another use of date palm is the production of biochar and its use as a source of fuel and energy (Jonoobi et al., 2019).

## **PALM CULTIVATION IN IRAQ**

Dates are Iraq's second largest export crop after petroleum. As a result of the Iran-Iraq war, the main center of date palm cultivation in Iraq (Basra suburb) lost a large number of date palm trees and became a date tree desert. During the war in 2003, the date palm production industry suffered seriously. Today, several programs have been implemented by the Iraqi authorities to revive date palms (Khierallah et al., 2015). It has been said that the earliest cultivation of dates was done in Eridu, around 4000 B.C. Today it is known as Tell Abu Shahrain (Khierallah et al., 2015). The average economic life of the palm garden is about 40 to 50 years. Some of them have reproductive capacity for more than 150

years (Nixon and Carpenter, 1978). The war and various sanctions imposed on Iraq had a negative effect on crop production and genetic diversity (Khierallah et al., 2011). Understanding the amount and distribution of genetic diversity in the genetic pools plays a decisive role in breeding programs and genetic conservation (Jubrael et al., 2005). The use of morphological traits is used to describe genetic diversity in date cultivars (Barreveld, 1993). In a study conducted by Khierallah et al. (2011) in Iraq, it was found that the genetic diversity in 30 date palms (24 female and 6 male cultivars) by 22 microsatellite primers showed high polymorphism. The heterozygous rate for all cultivars was 0.503. The genetic distance between the cultivars varied from 0.171 to 0.938, which indicates diverse relationships. The results showed that the Ghanami Akhder cultivar was very different from the Ghanami Ahmer cultivar. While, two cultivars of Jamal Al-Dean and Qitaz were closely related to each other.

## **PRODUCTION OF DATES IN THE WORLD AND IRAQ**

According to the data of FAO last 20 years (1999-2022), dates are one of the top 5 products produced in the world, and after wheat, tomatoes and barley are the fourth produced in the world. In 2022, date production came in the second place after wheat. This clearly shows the importance of this product. An investigation on FAO data (FAOSTAT, 2024) showed that from 1999 to 2022, more than half of dates are produced in Asia (59.9%) and then in Europe (39.9%) (Figure 1a). In the last 20 years, Egypt has produced the largest amount of dates (1,369,385 tons). In this ranking, Iraq is ranked fifth after Egypt, Saudi Arabia, Iran and Algeria. The amount of date production in Iraq in this period was 647,480 tons (Figure 1b).

The study of date production in Iraq showed that in 2022, Iraq will rank sixth after Egypt, Saudi Arabia, Algeria, Iran and Pakistan (Figure 2). In 2022, the total amount of dates produced in Iraq was 715,293 tons and the harvest area was 278,159 hectares.

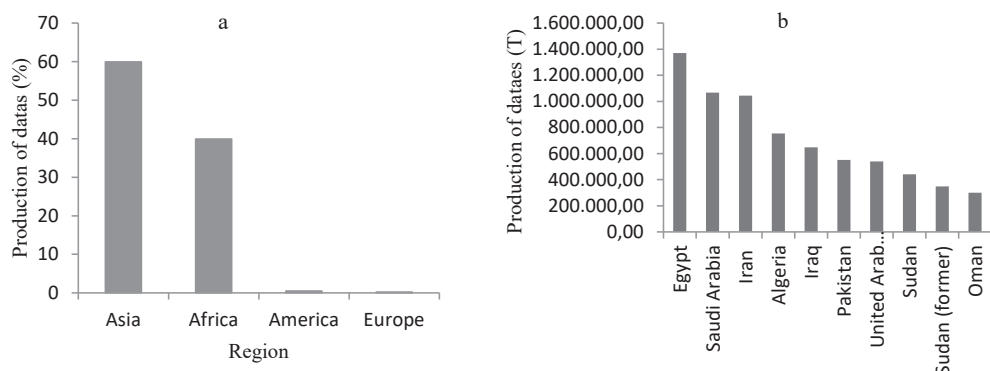


Figure 1. Production of dates by region (a) and top ten producers (b) from 1999 to 2022 (Source: FAOSTAT, March 14, 2024)

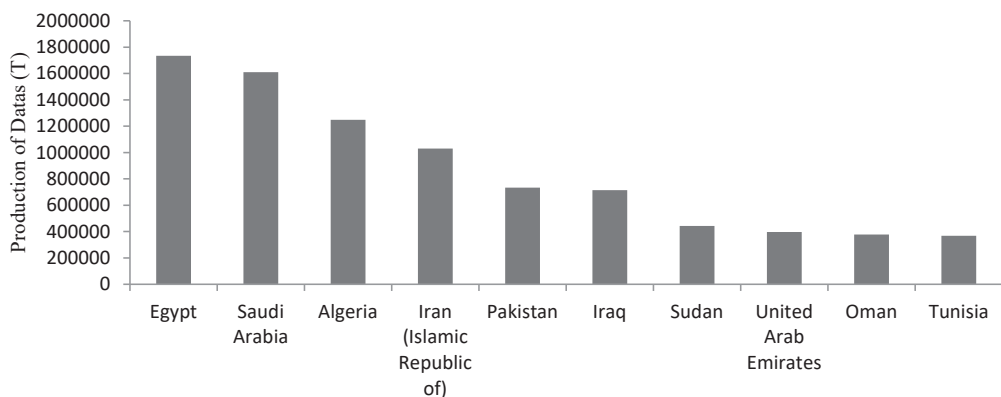


Figure 2. Top ten producers of dates in 2022 (Source: FAOSTAT, March 14, 2024)

## EXPORTING AND IMPORTING DATES IN THE WORLD AND IRAQ

The data related to the last 20 years show that Iraq was the second largest exporter of dates in the world after the United Arab Emirates (193,690 tons) with the export of 171,925 tons of dates.

Iran, Pakistan and Saudi Arabia are in the next ranks with 151,766, 109,370 and 97,126 tons respectively (FAOSTAT, 2024).

In contrast, five countries include India (289,800 tons), the United Arab Emirates (109,957 tons), Morocco (53,019 tons), Yemen (30,913 tons) and

France (30,760 tons) are the five importers of dates countries in the last 20 years.

In 2022, the amount of dates exported from Iraq was 274,179 tons and the amount of imported dates was 3469 tons.

In addition, in this year, Iraq was the first exporter of dates and India was the first importer (Figure 3). Table 1 shows the import and export of dates in Iraq from 1999 to 2022.

The import of dates in Iraq started in 2014 (Table 1). According to FAO data, the price per ton of dates in Iraq in 2022 was 826 dollars.

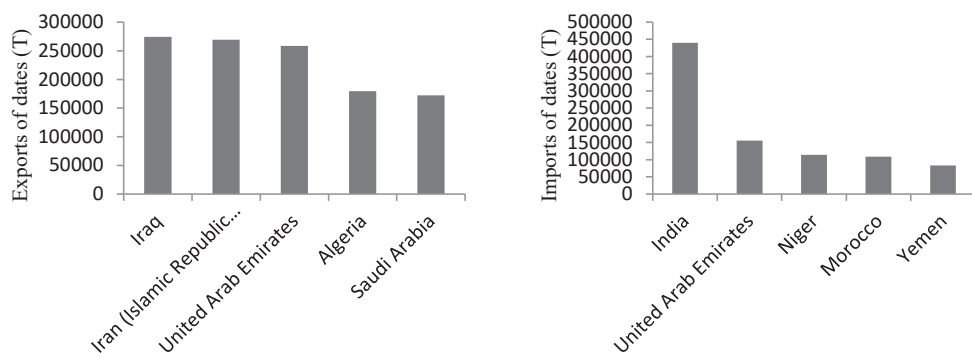


Figure 3. Top five export (a) and imports (b) of dates in 2022

Table 1. Exports and imports of Dates in Iraq from 1999 to 2022 (FAOSTAT, 2024)

Year	Exports (ton)	Imports (ton)
1999	30000	-
2000	30000	-
2001	4000	-
2002	8000	-
2003	5016	-
2004	23485	-
2005	149660	-
2006	42776	-
2007	221016	-
2008	296642	-
2009	198777	-
2010	126731	-
2011	138437	-
2012	177498	-
2013	144607	-
2014	362492	8440
2015	296979	10628
2016	321661	13528
2017	254752.2	13947.33
2018	263465.6	21926
2019	230152.7	14000
2020	208151.5	6162.28
2021	317736.9	2899
2022	274180	3469.57



## CULTIVARS CULTIVATED IN IRAQ

More than 400 different cultivars of dates are cultivated in Iraq. The difference between them is determined based on the appearance and texture of the fruit. Accordingly, dates are divided into three types: soft, semi-dry and dry types. This division is based on the texture or consistency of the fruit at the time of its ripening. The amount of moisture in soft, semi-dry and dry dates is more than 30%, between 20-30% and less than 20%, respectively. Khastawi, Barhee, Halawy, Hayany and Khadrawy cultivars belong to the soft date group. Halawi, Dayri and Khadrawy cultivars are classified as semi-dry cultivar and Zahdi and Sayer cultivars are classified in the dry cultivar group. The ripening of date fruit takes place in five phases: Hababouk, Kimri, Khalal, Rutab, and Tamar (Zabar and Borowy, 2012).

## FERTILIZATION

Date palm shows a good response to chemical and organic fertilizers. In the modern date cultivation system, the amount of nitrogen used in the plant is 1.0 to 2.5 kg/tree/year. The amount of phosphorus required for the plant is 0.5 kg/tree/year and the amount of potassium required is 1.5 kg/tree/year. Animal fertilizers and chicken fertilizers are also used as organic fertilizers in the plant. Generally, phosphorus, potassium and animal fertilizers are used in November and nitrogen fertilizers are used in January, March and May (FAO and AOAD, 2023). It should be mentioned that the date palm, like other plants, has shown a good response to foliar application of nutrients. The use of urea (N 46%) at a concentration of 1% in Hellawi, Shahany and Khaidrawi cultivars improved yield, leaf nitrogen content, increased pulp weight, fruit length and diameter, fruit quality and reduced fruit drop, and increased dry weight biomass and the percentage of fruit ripening (Abbas et al., 2007; Khayyat et al., 2007; Shareef, 2011a; Shareef, 2011b). In Shany cultivar, spraying the plant in the Khalal stage using Zinc sulfate (300 and 600 ppm) had a significant effect on the pulp weight, fruit length and diameter, increase in total soluble solids, yield and quality of the fruit (Khayyat et al., 2007). The use of Boron in Zehdi and Khestawi

Medjool cultivars increased the concentration of B in the fruit, increased the seed weight, fruit flesh, cluster weight and total yield, bunch weight, fruit set, fruit quality and fruit physical characteristics (Al-Dulaimy and Al-Kraid, 2017; Al-Hajjaj and Ayad, 2018). Also spraying the plant with calcium in Behri and Sayer cultivars (Jasim et al., 2016), phosphorus in Shukar cultivar (Fasal et al., 2014) and sodium selenite in Zaghoul cultivar (Gad El-Kareem et al., 2014) were effective in improving the plant growth and performance indicators. It is noteworthy that the positive effect of foliar spraying in date palm by bio-stimulants has been reported in several studies (Shareef, 2020; Shareef et al., 2017; Attaha and Al-Mubarak., 2014; Taha and Abood, 2018; Al-Wasfy, 2013). In the research conducted in Iraq in Khastawi cultivar, the use of nanofertilizers and NPK improved the traits related to the fruit and the growth (Jubeir and Ahmed, 2019). The study of chemical, organic and biological fertilizers in Khastawi cultivar in Iraq showed that chemical fertilizers have been more successful in improving vegetative traits in the plant compared to other sources of fertilization. The use of humic acid had the greatest effect on leaves' dry matter percentage, the length and width of the leaflet, leaf length and leaf number (Kredi and Al-Ali, 2023). In another research in Zahdi cultivar in Iraq, it was found that the use of urea at the rate of 2 grams recorded the highest indicators related to the yield. On the other hand, the use of urea had no significant effect on the nitrate content in the fruit. In addition, foliar spraying of the plants using seaweed extract was also effective in improving growth indicators related to the fruit (Murad and Al-Dulaimy, 2021).

## FRUIT THINNING

Fruit thinning in the dates is one of the most important steps to improve the quality of the fruit in the plant. Fruit thinning is done manually, mechanically or chemically. Fruit size is directly affected by thinning (Dennis, 2000; Link, 2000). Thinning at least 30% of the bunch per date palm and the fruit thinning by removing 30% strand tips or removing 30% of the total number of strands from the center of each bunch significantly increases other fruits,

total soluble solids and fruit sugar content (Al-Wasfy and El-Khawaga, 2008). In Kur cultivar, thinning of 50% strands recorded the highest fruit size and improved fruit indicators related to fruit taste and flavor (Soliman, 2012). In Arab countries, this is done in two methods: 1) cutting and removing the weak bunches after ensuring successful pollination and 2) cutting and removing strands. In the second method, about one-third of the upper part of the flowering strands are removed during pollination. About one-third of half of the fruit-bearing strands after successful pollination are also removed during the fruit formation stage. This process increases fruit quality and reduces the fruit bunch weight (FAO and AOAD, 2023).

## PESTS AND DISEASES

In Iraq, a set of different factors such as biological and non-biological parameters are effective in reducing the growth and productivity of dates. One of the most important pests that damage date palm trees in Iraq are Old World date mite, borers, dubas bugs and lesser date moth. Rotting diseases are another limiting threat to date palm cultivation in Iraq (Al-Jboory, 1999; 2001). One of the important pests that involved the date palm is Red Palm Weevil (*Rhynchophorus ferrugineus* Olivier) (Vidyasagar and Aldosari, 2011). In 2000, according to the National Date-Palm Breeding and Improvement Program in Iraq, it was approved and tried to implement correct Mediterranean programs in all stages of planting, harvesting and catching. At first, this program achieved significant success, but with the political and administrative changes in 2003, there was a gradual decline in the production and productivity of dates in Iraq. Studies related to the date pests began in 1912, at the same time as the presence of aphids. Important date palm pests in Iraq include Longhorn date palm stem borer (*Jebusaea hamerschmidtii* Reich), Fruit stalk borer (*Oryctes elegans* Prell), Frond borer (*Phonapate frontalis* Fahraeus), Dubas bug (Old World date bug) (*Ommatissus lybicus* de Berg.), Lesser date moth (*Batrachedra amydraula* Meyrick), Greater date moth (*Arenipses sabella* Hampson), Termite (*Microceroterme diversus* Silvestri), Parlatoria date scale (*Parlatoria blanchardii* Targioni) and Ghobar mite (Old

World date mite) (*Oligonychus afrasiaticus* McGregor) (Khierallah et al., 2015). It has been reported that six different species of borers have attacked dates in Iraq, causing a lot of economic damage. Four of these six species belong to the oryctes species (Khalaf and Al-Taweel, 2014). Inflorescence rot (*Mauginiella scaetiae*), Black scorch (fool's disease) (*Thielaviopsis paradoxa*, *Chalaropsis radicialis*), Diplodia disease (*Diplodia phoenicum*), Graphiola leaf spot (*Graphiola phoenicis*), Bela disease (*Phytophthora* sp.) and Brown leaf spot (*Alternaria* spp.) are one of the most important pathogens of dates in Iraq. Among the important diseases of date palm in Iraq, neck bending, dry rot and growth stunting, frond malformation and dwarfing, and heart wet rot can be mentioned. These diseases are caused by different fungi (Khierallah et al., 2015).

## IRRIGATION

The date palm has a minimal water requirement and has a very high tolerance to harsh climates and high levels of salinity stress (Taha and Khalifa, 2022; Alhammadi and Kurup, 2012). However, proper irrigation is necessary for the production of high quality and yield crops (Bazza, 2008). Date palm irrigation is mainly done traditionally as floodwater irrigation (Ishfagh, 2002). One of the irrigation management methods is the use of deficit irrigation (Ghazzawy et al., 2022). In the study of the effect of regulated deficit irrigation in southern Iraq, it was found that the use of this irrigation system resulted in saving 5 to 39 percent of irrigation water. The best performance occurred in full irrigation. In general, it was found that the date palm required regular irrigation during its growth; however, the use of a deficit irrigation system (0-75% ETc) can be used in the study regions (Al-Mansor et al., 2021). Al-Baker (1972) reported the amount of water required for a mature palm to be between 115 and 306 m<sup>3</sup>. It should be mentioned that the water requirement of date palm is different in each country and even in different regions of each country (Al-Baker, 1972). The total amount of water required annually in southwestern Arabia is 136 m<sup>3</sup> per tree (Al-Ghobari, 2000). It has been explained that the annual water requirement of date palm



varies from 55 to 137 m<sup>3</sup> per tree in the eastern regions and from 78 to 195 m<sup>3</sup> per tree in trickle and surface irrigation in central regions (Alazba, 2004). Adul Naki and Aslam (2005) estimated the total annual water depth required by date palm to be 2700 and 3000 mm. In Mohammad et al. (2021) research, the annual water requirement of date palms in the controlled sub-surface drip system with sensor-based irrigation scheduling method (S-BIS), time-based irrigation scheduling method (T-BIS) and traditional surface irrigation (TSI) were 21, 22.8 and 58.7 m<sup>3</sup> per tree, respectively. It has been reported that the average amounts delivered to date palms were 108, 216 and 324 m<sup>3</sup>/tree/year for water regimes of 50%, 100% and 150% of evaporation rate, respectively (Al-Amoud et al., 2000). In the study of Taha and Khalifa (2022), which studied drip irrigation in the Barhi cultivar, it was found that with the decrease of ETo from 120 to 60%, the yield of the plant decreased by 9.2%. The date palm has the ability to tolerate water shortage in the middle and end of the growing season. Therefore, the use of deficit irrigation is effective in this plant (Molden, 2007). In a research conducted in the Basra region of Iraq, it was determined that the use of underground saline water in the date palm irrigation system is one of the best solutions considering the current drought and temperature conditions. In this study, the use of underground water with a salinity of 10 dS.m<sup>-1</sup> every four days in the Sayer cultivar improved the growth indicators such as leaf chlorophyll content, plant height, number of new leaves and relative leaf water content (Shareef et al., 2021). Date gardens in Basra are affected by the tides of the Persian Gulf (Zabar and Borowy, 2012). Salinity tolerance is higher in this fruit tree compared to other fruit trees (Alhammadi and Kurup 2012). Date palm can tolerate soil salinity up to 4 dS.m<sup>-1</sup> without reducing yield. However, water deficit may reduce yield (Taha and Khalifa, 2022).

## THREATENING FACTORS OF DATE CULTIVATION IN IRAQ

Various environmental factors such as biotic and abiotic stress (drought and salinity stress) and excessive harvesting are the factors that threaten date cultivation in Iraq (Jaradat and Zaid, 2004). In addition, the reduction and loss of vegetation

in some areas due to overgrazing and over-harvesting of wood by individuals causes destructive wind and storms, resulting in soil erosion, reducing the infiltration of rainwater into the soil and increasing the formation of floods and runoff. These factors affect the amount and quality of underground water and soil and ultimately increased the salinity of water and soil. The formation of fine dust and the movement of sand by wind and storm also significantly affect date palm cultivation in Iraq (Amer and Hussain, 2006).

## REFERENCES

- Abass, K.I, Taain, D.A., Wahid, A.M., 2007. Study the effect of nitrogen and iron application on productivity of date palm *Phoenix dactylifera* L. c.v. Hellawi. *Journal of Basrah Researches (Sciences)*, 15(3): 15–19
- Abdel Fattah, N., Rabou, A.B.D., Radwan, E.S. 2017. The current status of the date palm (*Phoenix dactylifera*) and its uses in the Gaza Strip, Palestine. 18(3): 1047-1061.
- Abdul Baki A. and S.N. Aslan (2005). Management of soil and water in date palm orchards of Coachella Valley, California. International Center for Agricultural Research in Dry Areas; 2005.
- Ahmed, I.A., Ahmed, A.W.K. & Robinson, R.K. (1995). Chemical composition of date varieties as influenced by the stage of ripening. *Food Chemistry*, 54(3), 305-309.
- Al- Baker, A. "The Date Palm". Ministry of Higher Education, Baghdad, Iraq, (1972), 225.
- Al Farsi, M.A. & Lee, C.Y. (2008). Nutritional and functional properties of dates: a review. *Critical Reviews in Food Science and Nutrition*, 48(10), 877-887.
- Al-Amoud A.I., M.A. Bacha, and A.M. Al-Darby. (2000). Seasonal water use of date palms in central region of Saudi Arabia. *Agric. Eng. J.*, 9: 51–62.
- Alazba A. (2004). Estimating palm water requirements using Penman-Monteith mathematical model. *Journal of King Saud University*. 16(2):137-152.
- Al-daihan, S. & Bhat, S. (2012). Antibacterial activities of extracts of leaf, fruit, seed and bark of *Phoenix dactylifera*. *African Journal of Biotechnology*, 11(42), 10021-10025.
- Al-Dulaimy, R.M.H., Al-Kraidi, E.H.M., 2017. Effect of spraying with salicylic acid and boron in some yield characteristics and its components for date palm (*Phoenix dactylifera* L.) cvs. Zahdi and Khestawi. *Anbar Journal of Agricultural Sciences*, 15, Special issue: 268–278.
- Al-Farsi, M., Alasalvar, C., Morris, A., Baron, M. & Shahidi, F. (2005). Comparison of antioxidant activity, anthocyanins, carotenoids, and phenolic of three native fresh and sun-dried date (*Phoneix dactylifera* L.) varieties grown in Oman. *Journal of Agricultural and Food Chemistry*, 53(19), 7592-7599.

- Alghamdi, A. A. (2016). An investigation on the use of date palm fibers and coir pith as adsorbents for Pb (II) ions from its aqueous solution. *Desalination and Water Treatment*, 57(26), 12216-12226.
- Al-Ghobari H.M. (2000). Estimation of reference evapotranspiration for the south region of Saudi Arabia. *Journal of Irrigation Science*, 19: 81-86.
- Al-Haidary, A. M. A., Zanganah, F. H., Al-Azawi, S. R., Khalili, F. I., Al-Dujaili, A. H. (2011). A study on using date palm fibers and leaf base of palm as adsorbents for Pb (II) ions from its aqueous solution. *Water, Air, and Soil Pollution*, 214(1-4), 73-82.
- Al-Hajjaj, H.S., Ayad, J.Y., 2018. Effect of foliar boron applications on yield and quality of Medjool date palm. *Journal of Applied Horticulture*, 20 (3): 181-188.
- Alhammadi M.S, Kurup S.S. 2012. Impact of salinity stress on date palm (*Phoenix dactylifera* L.) - a review. In: Sharma P, Abrol V (eds). Crop Production Technologies (eds.). InTech, Croatia
- Ali Mohamed, A.Y. & Khamis, A.S. (2004). Mineral ion content of the seeds of six cultivars of Bahraini date palm (*Phoenix dactylifera*). *Journal of Agricultural and Food Chemistry*, 52(21), 6522-6525.
- Al-Jboory IJ (1999) Date palm Old World date mite (Ghobar mite) *Oligonychus afrasiaticus* (McGregor), vol 9, Tech Broch. Ministry of Agriculture, Bagdad, Iraq (in Arabic)
- Al-Jboory IJ (2001) New record of entomopathogenic nematode for Iraq. Arab Near East Plant Prot Newsl 32:6 (in Arabic)
- Al-Mansor, A.N., Nedawi, D.R., Al-Mosawi, K.A. 2021. Effects of regulated deficit irrigation on water productivity of date palm (*Phoenix Dactylifera* L.) in the arid environment of South Iraq. Nat. Volatiles and Essent. Oils. 8(6): 2164-2182.
- Al-Sakran M.S., Muneer S.E., 2006. Adoption of Date Palm Tissue Culture Technology Among Date Palm Producers in the Central Region of Saudi Arabia. Research Bulletin No. 145, Agricultural Research Center, Faculty of Food Sciences and Agriculture, King Saud University, pp. 1-20.
- Al-Shahib, W. & Marshall, R.J. (2003). The fruit of the date palm: Its possible use as the best food for the future. *International Journal of Food Science and Nutrition*, 54(4), 247-259.
- Al-Taher, A.Y. (2008a). Possible anti-diarrhoeal effect of the date palm (*Phoenix dactylifera* L.) spathe aqueous extract in rats. *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, 9(1), 131-138.
- Altaweel, M., Marsh, A., Jotheri, J., Hritz, C., Fleitmann, D., Rost, S., Lintner, S.F., Gibson, M., Bosomworth, M., Jacobson, M., Garzanti, E., Limonta, M., Radeff, G., 2019. New Insights on the Role of Environmental Dynamics Shaping Southern Mesopotamia: From the Pre- Ubaid To the Early Islamic Period. Iraq 1-24. <https://doi.org/10.1017/irq.2019.2>
- Al-Wasfy, M.M., 2013. Response of sakkoti date palms to foliar application of royal jelly, silicon and vitamins b. *Journal of American Science*, 9 (5): 315-321.
- Alzebeleh, K., Nassar, M., Al Rawahi, H., Al-Hinai, N. (2016). Characterization of mechanical properties of date palm fronds reinforced composites: a comparative evaluation. *ASME 2016 International Mechanical Engineering Congress and Exposition. American Society of Mechanical Engineers*.
- Al-Zoreky, N.S. & Al-Taher, A.Y. (2015). Antibacterial activity of spathe from *Phoenix dactylifera* L. against some food-borne pathogens. *Industrial Crops and Products*, 65, 241-246.
- Amer J., Hussain F.A., 2006. Iraqi Date Industry Marketing and Post-harvest Issues. <http://www.iraqi-datepalms.net>, p. 64.
- Attaha, A.H.M., Al-Mubark, N.R.A., 2014. Effect of spraying seaweed extract Kelpak and NPK fertilizer on nitrogen, phosphorus, potassium and total protein concentrations of leaves and fruits of *Phoenix dactylifera* L., cv. Barhi. *Journal of Basrah Researches (Sciences)*, 40 (1): 65-84.
- Aubied, I. A., Hamzah, H.A. 2019. Effect of Pollen Grains and Growth Regulator NAA on Some Fruit Characterization of Date Palm *Phoenix Dactylifera L Cultivar*. Sultani. QJAS Al-Qadisiyah Journal For Agriculture Sciences. 9(1): 136-142.
- Ayub, M., Saeed, S., Ahmed, A., 2023. Morphological characterization of nine date palm varieties (*Phoenix dactylifera* L.) of Panjgur, Balochistan, Pakistan. *Pure Appl. Biol.* 12 (1), 252-260
- Barreveld, W.H. 1993. Date palm products. FAO Agr. Serv. Bul. 101. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Barrow, S.C. (1998). A monograph of *Phoenix* L. (Palmae: Coryphoideae). *Kew Bulletin*, 53(3), 513-575.
- Chao, C.C.T. & Krueger, R.R. (2007). The date palm (*Phoenix dactylifera* L.): Overview of biology, uses, and cultivation. *Horticultural Science*, 42(5), 1077-1082.
- Chao, C.T., Krueger, R.R. 2007. The Date Palm (*Phoenix dactylifera* L.): Overview of Biology, Uses, and Cultivation. *HORTSCIENCE VOL. 42*(5).
- Demirci, B., Tsikolia, M., Bernier, U.R., Agramonte, N.M., Alqasoumic, S.L., Al-Yahya, M.A., Al-Rehaily, A.J., Yusufoglu, H.S., Demirci, F., Baser, K.H., Khan, I.A. & Tabanca, N. (2013). *Phoenix dactylifera* L. spathe essential oil: chemical composition and repellent activity against the yellow fever mosquito. *Acta Tropica*, 128(3), 557-560.
- Dennis, F., Jr. The history of fruit thinning. *Plant Growth Regul.* 2000, 31, 1-16.
- Dhahri, M., Sioud, S., Alsuhaymi, S., Almulhim, F., Haneef, A., Saoudi, A., Jaremko, M., Emwas, A.H., 2023. Extraction, characterization, and antioxidant activity of polysaccharides from ajwa seed and flesh. *Separations* 10 (2), 103.
- El-Juhany LI. 2010. Degradation of date palm trees and date production in Arab countries: causes and potential rehabilitation. *Australian J Basic Appl Sci* 4 (8): 3998-4010
- FAO and AOAD, 2023. Value chain study- Date palm in the Arab region. Cairo, FAO. <https://doi.org/10.4060/cb9917en>.
- Farahmand H. The use of ornamental palms for landscape design and xeriscaping. *FOP* 2019; 3 (2) :27-42. URL: <http://flowerjournal.ir/article-1-138-en.html>

- Fasal, H.A., Abdulwahid, A.H., Authafa, Q.J., 2014. Effect of spray phosphorus and proline on some physical and chemical characteristics and production for date palm *Phoenix dactylifera* L. Shuker cultivar Hassan. *Basrah Jurnal for Date Palm Research*, 13 (1-2): 2–8.
- Gad El-Kareem, M.R., Abdel Aal, A.M.K., Mohamed, A.Y., 2014. The synergistic effects of using silicon and selenium on fruiting of Zaghloul date palm (*Phoenix dactylifera* L.). *International Scholarly and Scientific Research & Innovation*, 8 (3): 259–262
- Ghazzawy, H.S.; Sobaih, A.E.E.; Mansour, H.A. The Role of Micro-Irrigation Systems in Date Palm Production and Quality: Implications for Sustainable Investment. *Agriculture* 2022, 12, 2018. <https://doi.org/10.3390/agriculture12122018>
- Gheith, M. H., Aziz, M. A., Ghori, W., Saba, N., Asim, M. et al. (2019). Flexural, thermal and dynamic mechanical properties of date palm fibres reinforced epoxy composites. *Journal of Materials Research and Technology*, 8(1), 853-860.
- Gros-Balthazard, M., Galimberti, M., Kousathanas, A., Newton, C., Ivorra, S., Paradis, L., Vigouroux, Y., Carter, R., Tengberg, M., Battesti, V., Santoni, S., Falquet, L., Pintaud, J.-C.C., Terral, J.-F.F., Wegmann, D., 2017. The Discovery of Wild Date Palms in Oman Reveals a Complex Domestication History Involving Centers in the Middle East and Africa. *Curr. Biol.* 27, 2211–2218. <https://doi.org/10.1016/j.cub.2017.06.045>
- Henry, A.G., Brooks, A.S., Piperno, D.R., 2011. Microfossils in calculus demonstrate consumption of plants and cooked foods in Neanderthal diets (Shanidar III, Iraq; Spy I and II, Belgium). *Proc. Natl. Acad. Sci. U. S. A.* 108, 486–491. <https://doi.org/10.1073/pnas.1016868108>
- Henry, D.O., Hietala, H.J., Rosen, A.M., Demidenko, Y.E., Usik, V.I., Armagan, T.L., 2004. Human Behavioral Organization in the Middle Paleolithic: Were Neanderthals Different? *Am. Anthropol.* 106, 17–31. <https://doi.org/10.1525/aa.2004.106.1.17>
- Nixon, R.W., 1951. The Date Palm: "Tree of Life " in the Subtropical Deserts. *Econ. Bot.* 5, 274–301.
- Hifnawy, M.S., Mahrous, A.M.K. & Ashour, R.M.S. (2016). Phytochemical investigation of *Phoenix canariensis* Hort. ex Chabaud leaves and pollen grains. *Journal of Applied Pharmaceutical Science*, 6 (12), 103-109
- Ibrahim AO (2008) Date palm the tree of life. Arab Center for the Study of Arid Zones and Dry Lands (ACSAD), Damascus.
- IQBAL, M., GHAFFOR, A., REHMAN, S. 2004. Effect of Pollination Times on Fruit Characteristics and Yield of Date Palm cv. dhakki. *international journal of agriculture & biology. Int. J. Agri. Biol.*, Vol. 6, No. 1: 96-99.
- Ishfaq, M. Water New Technology; GlobalWater Institute: Lahore, Pakistan, 2002; Volume 6.
- Janani, K., Sivarajasekar, N., Muthusaravanan, S., Ram, K., Prakashman, J. et al. (2019). Optimization of EDTA enriched phytoaccumulation of zinc by *Ophiopogon japonicus*: comparison of Response Surface, Artificial Neural Network and Random Forest models. *Bioresource Technology Reports*, 100265.
- Jaradat A. A., Zaid A., 2004. Quality traits of date palm fruits in a center of origin and center of diversity. *Food, Agric. Environ.*, 2, 1, 208–217.
- Jasim, A. M., Abbas, M. F., Shareef, H. J., 2016. Calcium application mitigates salt stress in date palm (*Phoenix dactylifera* L.) offshoots cultivars of Berhi and Sayer. *Acta Agriculturae Slovenica*, 107 (1): 103–112. <https://doi.org/10.14720/aas.2016.107.1.11>
- Jemni, M., Ramirez, J.G., Oton, M., Artés-Hernandez, F., Harbaoui, K., Namsi, A., Ferchichi, A., Artés, F., 2019. Chilling and freezing storage for keeping overall quality of “Deglet Nour” dates. *J. Agric. Sci. Technol.* 21, 63–76.
- Jonoobi, M., Shafie, M., Shirmohammadli, Y., Ashori, A., Zarea Hosseinabadi, H., Mekonnen, T. 2019. A Review on Date Palm Tree: Properties, Characterization and Its Potential Applications. *Journal of Renewable Materials*. 7(11): 1055-1075.
- Jubeir, S.M. and Ahmed, M.A. 2019. Effect of nano fertilizers and application methods to yield characteristics of date palm. *Plant Archives* Vol. 19 No. 1, 2019 pp. 1881-1886
- Jubrael, J.M.S., S. Udupa, and M. Baum. 2005. Assessment of AFLPbased genetic relationships among date palm (*Phoenix dactylifera* L.) varieties of Iraq. *J. Amer. Soc. Hort. Sci.* 130:442–447.
- Karasawa, K., Uzuhashi, Y., Hirota, M. & Otani, H. (2011). A matured fruit extract of date palm tree (*Phoenix dactylifera* L.) stimulates the cellular immune system in mice. *Journal of Agricultural and Food Chemistry* 59(20), 11287-11293.
- Kchaou, W., Abbès, F., Blecker, C., Attia, H. & Besbes, S. (2013). Effects of extraction solvents on phenolic contents and antioxidant activities of Tunisian date varieties (*Phoenix dactylifera* L.). *Industrial Crops and Products*, 45, 262-269.
- KhalafMZ, Al-Taweel AA (2014) Palm borers in the Iraqi environment: species, damage and control. Ministry of Science and Technology, Agricultural Research Directorate, Bagdad, Iraq, p 31
- Khayyat, M., Tafazoli, E., Eshghi, S., Rajae, S., 2007. Effect of nitrogen, boron, potassium and zinc sprays on yield and fruit quality of date palm. *American-Eurasian Journal of Agricultural & Environmental*, 2 (3): 289-296.
- Khierallah, H.S.M., Bader, S.M., Baum, M., Hamwieh, A. 2011. Genetic Diversity of Iraqi Date Palms Revealed By Microsatellite Polymorphism. *J. AMER. SOC. HORT. SCI.* 136(4):282–287.
- Khierallah, H.S.M., Bader, S.M., Ibrahim, K.M., A;-Jboory, J. 2015. Chapter 4. Date Palm Status and Perspective in Iraq. Date palm genetic resources and utilization book. Volume 2: Asian and Europe. Springer Dordrecht Heidelberg New York London. Pp. 97-158.
- Kredi, E.H.M., Al-Ali, H.H. 2023. Response of Date Palm Trees *Phoenix dactylifera* L. Khastawi Cultivar to Chemical, Organic and Biological Fertilization. Fifth International Conference for Agricultural and Environment Sciences. 1158 (2023) 042011. doi:10.1088/1755-1315/1158/4/042011.

- Link, H. Significance of flower and fruit thinning on fruit quality. *Plant Growth Regul.* 2000, 31, 17–26.
- Lipshchitz, N., Nadel, D., 1997. Epipalaeolithic (19,000 B.P.) charred wood remains from Ohalo II, Sea of Galilee, Israel. *Mitekufat Haeven, J. Isr. Prehist. Soc.* 27, 5–18.
- M Al-Wasfy, M.; S El-Khawaga, A.-A. Effect of different methods of fruit thinning on Zaghloul date palm production and fruit quality. *Assiut J. Agric. Sci.* 2008, 39, 97–106.
- Mallaki, M. & Fateh, R. (2014). Design of a biomass power plant for burning date palm waste to cogenerate electricity and distilled water. *Renewable Energy*, 63, 286–291.
- Mohammed M., K. Riad and N. Alqahtani (2021). Efficient IoT-Based Control for a Smart Subsurface Irrigation System to Enhance Irrigation Management of Date Palm. *Sensors*, 21: 3942
- Molden, D.J. A Comprehensive Assessment of Water Management in Agriculture; International Water Management Institute: Colombo, Sri Lanka, 2007; Available online: <http://www.earthscan.co.uk> (accessed on 3 March 2008).
- Moustafa A.A., Ibrahim Z.A., El-Yazel S.A.S., El-Anver M.A., 2010. Evaluation and Selection of Some Seedling Date Palm Males Grown in Fayoum Governorate, Egypt. *Acta Hort.*, 882, 69–79.
- Munier, P., 1973. *Le palmier-dattier*, Paris: Maisonneuve et Larose
- Murad, H.J., Al-Dulaimy, A.F.Z. 2021. Response of Date Palms Cv. Zahdi to Foliar Spray with Urea and Seaweed Extract. *IOP Conf. Series: Earth and Environmental Science* 761 (2021) 012052. doi:10.1088/1755-1315/761/1/012052
- Muthusaravanan, S., Sivarajasekar, N., Vivek, J. S., Paramasivan, T., Naushad, M. et al. (2018). Phytoremediation of heavy metals: mechanisms, methods and enhancements. *Environmental Chemistry Letters*, 16(4), 1339–1359.
- Nixon, R.W. and J.B. Carpenter. 1978. Growing dates in the United States. United States Department of Agriculture Bulletin no. 207, U.S. Department of Agriculture, Washington, DC.
- Noutfia, Y., Ropelewska, E., 2023. Innovative models built based on image textures using traditional machine learning algorithms for distinguishing different varieties of moroccan date palm fruit (*Phoenix dactylifera* L.). *Agriculture* 13 (1), 26.
- Plotkin, M. & Balick, M. (1984). Medicinal uses of South American palms. *Journal of Ethnopharmacology*. 10(2), 157–179.
- Pujari R.R., Vyawahare, N.S. & Thakurdesai, P.A. (2014). Neuroprotective and antioxidant role of *Phoenix dactylifera* in permanent bilateral common carotid occlusion in rats. *Journal of Acute Disease*, 3(2), 104–114.
- Rahmani A.H., Aly, S.M., Ali, H., Babiker A.Y. & Srikar, S. (2014). Therapeutic effects of date fruits (*Phoenix dactylifera*) in the prevention of diseases via modulation of anti-inflammatory, anti-oxidant and antitumour activity. *International Journal of Clinical and Experimental Medicine*, 7(3), 483–491.
- Riad M., 2006. The date palm sector in Egypt. CIHEAM – Options Mediterraneanes, 45–53.
- Shakiba, M., Kariminik, A. & Parsia, P. (2011). Antimicrobial activity of different parts of *Phoenix dactylifera*. *International Journal of Molecular and Clinical Microbiology*, 1(2), 107–111.
- Shareef, H.J., 2011a. Effect of spraying with urea and NPK on production of date palm *Phoenix dactylifera* L. cv. Khidrawi. *Basrah Journal for Date Palm Research*, 10 (1): 34–39.
- Shareef, H.J., 2011b. Effect of spraying with urea and NPK on some chemical characteristics and ripening of date palm fruits *Phoenix dactylifera* L. cv. Khidrawi. *Basrah Journal Research (Sciences)*, B15 (4): 13–25.
- Shareef, H.J., 2020. Organic fertilizer modulates IAA and ABA levels and biochemical reactions of date palm *Phoenix dactylifera* L. Hillawi cultivar under salinity conditions. *Asian Journal of Agriculture and Biology*, 8 (1): 24–30. <https://doi.org/10.35495/ajab.2019.02.062>
- Shareef, H.J., Alhamd, A.S., Naqvi, S.A., Eissa, M.A., 2021. Adapting date palm offshoots to long-term irrigation using groundwater in sandy soil. *Folia Oecologica*, 48 (1): 55–62
- Shareef, H.J., Jasim, A.M., Abbas, M.F., 2017. Molecular analysis of anti-salinity compounds on date palm offshoots (*Phoenix dactylifera* L.) cultivars using RAPD. *Journal of Environmental Science*, 6: 61–71.
- Shariati, A., Pordeli, H. R., Khademiyan, A & Kyaie, E. (2010). Evaluation of the antibacterial activity of the extracts of date palm (*Phoenix dactylifera* L.) fruits and pits on multi-resistant staphylococcus aureus. *Journal of Food Technology and Nutrition*, 4(28). 42–47. (in Farsi) .
- Shrinath Baliga, M., Vittaldas Baliga, B.R., Mathew Kandathil, S., Bhat, H.P. & Kumar Vayalil, P. (2011). A review of the chemistry and pharmacology of the date fruits (*Phoenix dactylifera* L.). *Food Research International*, 44(7), 1812–1822.
- Singab, A.N., El-Taher, E.M.M., Elgindi, M.R. & Kassem, M.E.S. (2015). *Phoenix roebelenii* O'Brien DNA profiling, bioactive constituents, antioxidant and hepatoprotective activities. *Asian Pacific Journal of Tropical Disease*, 5(7), 552–558.
- Solecki, R.S., Leroi-Gourhan, A., 1961. PALAEOCLIMATOLOGY AND ARCHAEOLOGY IN THE NEAR EAST. *Ann. N. Y. Acad. Sci.* 95, 729–739.
- Soliman, S.; Harhash, M. Effects of strands thinning on yield and fruit quality of Succary date palm. *Afr. J. Biotechnol.* 2012, 11, 2672–2676.
- Taha, A., Khalifa, H. 2022. Productivity of date palm as affected by irrigation in a sandy soil. *Mor. J. Agri. Sci.* 3 (2): 85–98, June 2022
- Taha, F.H., Abood, M.R., 2018. Influence of some organic fertilizers on date palm CV. Barhi. *Iraqi Journal of Agricultural Sciences*, 49 (4): 632–638.
- Tengberg, M., 2012. Beginnings and early history of date palm garden cultivation in the Middle East. *J. Arid Environ.* 86, 139–147. <https://doi.org/10.1016/j.jaridenv.2011.11.022>.
- Vayalil, P.K. (2002). Antioxidant and antimutagenic properties of aqueous extract of date fruit (*Phoenix*

- dactylifera* L. Arecaeae). *Journal of Agricultural and Food Chemistry*, 50 (3), 610-617.
- Vidyasagar PS, Aldosari SA. 2011. IPM of Red Palm Weevil. Chair of Date Palm Research (CDPR), Plant Protection Department, College of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia
- Zabar, A.F., Borowy, A. 2012. Cultivation of date palm in Iraq. *Annales Universitatis Mariae Curie-Skłodowska Lublin-Polonia*. VOL. XXII (1). SECTIO EEE.
- Zadeh, K. M., Inuwa, I. M., Arjmandi, R., Hassan, A., Almaadeed, M. et al. (2017). Effects of date palm leaf fiber on the thermal and tensile properties of recycled ternary polyolefin blend composites. *Fibers and Polymers*, 18(7), 1330-1335.
- Zaid, A. & Arias-Jimenez, E.J. (2002). *Date palm cultivation* in FAO.
- Zaid, A. and P.F. de Wet. 2002a. Climatic requirements of date palm, p. 57–72. In: A. Zaid (ed.). *Date palm cultivation*. Food and Agriculture Organization Plant Production and Protection Paper no. 156. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Zaid, A. and P.F. de Wet. 2002c. Pollination and bunch management, p. 145–175. In: A. Zaid (ed.). *Date palm cultivation*. Food and Agriculture Organization Plant Production and Protection Paper no. 156. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Zirari A., 2010. Effects of Time of Pollination and of Pollen Source on Yield and Fruit Quality of ‘Najda’ Date Palm Cultivar (*Phoenix dactylifera* L.) under Draa Valey Conditions in Morocco. *Acta Hort.*, 882, 89–94.
- Zohary D., Hopf M., 2000. Domestication of plants in the Old World. The origin and spread of cultivated plants in West Asia, Europe, and the Nile Valley. Oxford University Press, Oxon, UK.