Chapter 12
Date Palm Status and Perspective in Syria

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Abstract Date palm is one of the holy trees in Syria due to its cultural significance, in addition to its economic and environmental benefits. It is cultivated in the arid regions of the country around Palmyra and in some eastern areas along the Euphrates Basin. The Ministry of Agriculture and Agrarian Reform designed a plan for developing the date palm tree in Syria beginning in 1986 when it defined the optimal belt for this tree according to the environmental requirements of its cultivation and production. This belt constitutes about one-third of the total area of Syria and it includes the majority of the Syrian Badia lands. Since 1986, centers for date palm propagation have been established in provinces within the belt, focusing on elite lines and cultivars to collect offshoots from both elite lines and native and introduced cultivars to serve as mother orchards for selected genetic resources which are propagated to generate offshoots to be cultivated in suitable regions of the country. The Ministry of Agriculture also encouraged farmers to plant date palm within the specified belt to expand its cultivation area. Added to the various cultivars that are propagated within the date palm belt area, there are a set of lines of seedling origin in the Palmyra oasis and orchards that are being characterized for adoption as promising local Syrian cultivars. More research should be carried out for DNA-fingerprinting of date palm cultivars grown in Syria and their propagation by tissue culture.

Keywords Conservation • Cultivation • Date palm • Genetic resources • Syria

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12.1 Introduction

12.1.1 Historical and Current Agricultural Aspects

The date palm tree has been prominent in what is today Syria for centuries. Archaeological remains of dates have been found on a number of Neolithic sites, particularly in Syria and Egypt (El-Juhany 2010). Date palms and their culture are depicted in ancient Babylonian and Assyrian tablets including the famous Code of Hammurabi, which contained laws pertaining to date culture and sales (Popenoe 1973). In the first half of the third millennium BC, the date palm was one of the most cultivated trees in the ancient city of Mari in Syria. Babylonians developed planting of the tree along the Euphrates (known in Syria as Al-Furat) River banks about 5,000 BC. Phoenicians also paid great attention to date palm hence it was called Phoenix. This tree was holy to the population of Palmyra for several centuries BC. This is evidenced by the Arabic name of the city, Tad-Mour, which means in the ancient language of Palmyra the place of palm tree (Qatana online reference). In Syria, date palm is cultivated in the arid regions around Palmyra and in some eastern areas along the Euphrates Basin (from Deir Al-Zour to Al-Boukamal), in addition to some dispersed trees in other areas of the country (Kaakeh online reference). It is also cultivated in other Syrian cities as an ornamental tree (Shibli 2008). Date palm cultivation can be expanded in regions east and west of the Euphrates River, west and south of Palmyra, and in the coastal region.

The date palm belt constitutes 30 % of the total area of Syria and it includes the majority of the Syrian Badia lands in which the rainfall level does not exceed 200 mm/year. Statistics for 2009 estimated that 1,900 ha of land are planted with date palm and that the number of trees had reached 500,000, of which 250,000 were fruiting in private orchards. The Ministry of Agriculture and Agrarian Reform has also started to: (a) cultivate date palm instead of olive and pistachio trees in the Syrian Badia because date palm suits the environment of Badia better than the two other trees and has higher economic benefit and (b) establish date palm oases around existing wells in the Badia.

12.1.2 Importance to Syrian Agriculture

Date palm tree is one of the holy trees in Syria due to its cultural significance as well as its economic and environmental benefits. The threat to date palms in some areas has arisen because of their neglect for many years and the lack of effort made to expand cultivation. In 1986, the Ministry of Agriculture became aware of the situation and therefore designed a plan to direct more attention to the date palm and to expand its cultivation (Al-Baba 2009).

The date palm is considered as the life tree in dry regions of Syria because it is the most adapted tree in such regions to drought, high temperatures, dusty wind, and salinity of soil and water shortage to certain levels. It produces the highly nutritive date fruits, leaves, and other residues of the different parts of the tree which have various home and rural industrial uses. Date palm represents a source of income and nutrition to oasis inhabitants and it contributes to providing job opportunities for many rural women (Al-Baba 2009). Cultivation of date palm also creates favorable conditions for improving secondary crop culture such as cereals, alfalfa, and certain vegetables. In 1978, growers started to intercrop date palms (as windbreaks) with citrus in Al-Boukamal to protect the citrus trees from frost and strong wind. It has been also intercropped with other trees such as almonds. The date palm develops roots up to 10 m long which contributes to the maintenance of the soil against erosion (Zabar and Borowy 2012). Unripe dates, seeds, and leaves are used to feed livestock. Another use of the leaves is making compost.

Date palm also helps in creating oases near dry sand dunes in deserts to stop desert encroachment. In such oases, date palms provide shade for smaller trees and annual vegetables and cereals. This helps the farmers make the best use of the soil and water. Oases also provide habitat for animals and even humans if the area is large enough (http://en.wikipedia.org/wiki/Oasis). Since 2009, the Ministry of Agriculture has established several date palm oases in the Badia using offshoots of cultivars grown in the Palmyra and Al-Boukamal propagation centers in order to expand Syria's date palm cultivation. These are the oases of Al-Sawana (1,650 offshoots), Al-Talila (in Palmyra, 1,800 offshoots of major cultivars), Al-Tanf (3,000 offshoots of seedling origin), and Al-Manqoora protectorate (12,600 ha) which includes 1,500 date palm trees and is expanded every year to include 5,000 trees. In these oases and other private oases that are used as productive orchards, date palm trees are allowed enough space (10 × 10 m) and cultivated with other fruit trees such as citrus (Al-Boukamal oases), olives (Palmyra oases), peach, plum, and green plum (of 5–10 years production age) (private oases). The vegetables and cereals that are also grown in the oases are okra, tomato, eggplant, trefoil (clover), alfalfa, barley, cotton, and sugar beet. The private oasis in Deir Al-Zour and Raqqa are irrigated from the Al-Furat River, and those in Hasaka and Palmyra are irrigated from the Khabour River and artesian wells, respectively. During 2008–2011, 1,000 offshoots were planted at the site of well No. 17 in Palmyra Badia, and 20,000 offshoots of seedling origin were also planted around wells and protectorates of Badia in the different provinces within the date palm belt (Al Maalouf 2012). The Palmyra date palm oasis, which lies at the lowest point of the Syrian Desert, collects water from hundreds of kilometers in all directions (Serra et al. 2009); it has an area of 3,000 ha, where in addition to dates, figs and pomegranate are also planted. The Syrian General Commission for Al-Badia Management and Development is planning to establish a 200 ha oasis in Mahin town of Homs countryside to be planted with 5,000 date palm trees, along with 10,000 cactus offshoots as a source of forage for the animals in the Badia (Sana 2012). Since most date palm oases in Syria are recent, trees have not entered the production phase yet.

Table 12.1 Location, cultivation area, and the number of trees cultivated for each date palm propagation center

Center name	Date of establishment	Area (ha)	No. of trees in 2009
Date palm propagation center in Palmyra	1987	200	4,300
Date palm propagation center in Sabkhat Al-Moh	1999	400	6,000
Zanoobya palm oasis in Palmyra	2001	200	1,350
Date palm propagation center in Al-Boukamal	1987	800	19,500
Date palm propagation center in Qahtaniya in Raqqa	2000	400	2,500
Date palm propagation center in Saalo in Deir Al-Zour	2003	640	4,500
Date palm center in Al-Khabour, Hasaka	2005	420	3,400
Date palm propagation center in Al-Balash, Hasaka	2007	400	1,500
Date palm propagation center in Manqoora protectress in Damascus countryside	2007	400	1,000
Total	–	3,860	44,050

Source: Al-Baba (2011)

12.1.3 Production Statistics and Economics

There are several propagation centers in Syria for the production of date palm using traditional methods (offshoots). Table 12.1 shows their locations, land areas, and number of trees cultivated (Al-Baba 2011).

As for the annual date fruit production, it is estimated to be 5,000 mt according to the statistics of the Ministry of Agriculture in 2010. It is worth noting here that most date palm trees in Syria have been planted recently and therefore have not entered the production phase yet and that in 1986, the number of cultivated date palm trees was only 40,000 and the annual production was 500 mt (Al-Baba 2011).

12.1.4 Current Agricultural Problems

Until 2000, there existed a set of barriers to developing date palm cultivation in Syria; one was the unavailability of reliable offshoots that suit the environment in the date palm belt. Another barrier was the low number of qualified and trained technicians with knowledge of date palm cultivation requirements, because the crop had been neglected and had previously been regarded as a secondary tree crop for several reasons, such as (a) most of the old date palm trees were of seedling origin which had a low return and a below-average fruit quality, (b) rarity of cultivars of commercial value, (c) dependence on date imports, and (d) little awareness of the value of the date palm tree. It should be noted that date palm offshoots of

seedling origin are used in Syria only for ornamental purposes and as windbreaks around farms and orchards. Seeds are planted in plastic bags which are kept in the nursery until each seedling has 3–5 leaves. The seedlings (50 % will be females) are then transferred to the permanent location. Some elite male and female lines (0.3–0.5 %) can be selected from trees of seedling origin and adopted as local cultivars. Other problems were (a) the absence of involvement of the private sector in establishing date palm orchards for production and trade purposes; (b) the absence of an official decision-making body, with financial and technical independence, to deal with developing date palm in Syria at all levels (Al-Baba 2011; Electronic Economic Newspaper 2007); (c) poor general farm management; (d) pests and diseases and inadequate Integrated Pest Management (IPM) control; (e) underdeveloped harvesting, processing, and marketing practices; and (f) insufficient research and development.

The problem of planting material was resolved in 1995–1997 by importing a collection of high-quality date palm cultivars suitable for the date palm belt in Syria. These cultivars were introduced from Iraq, Iran, Egypt, Algeria, Morocco, UAE, and Saudi Arabia to the different propagation centers and entered the primary phase of fruit and offshoot production, beginning in 2000. The outcomes were superior fruit quality and quantity becoming available. Since then reliable offshoots of elite cultivars are being produced in centers of Palmyra and Al-Boukamal, most of which are sold to farmers at the nominal price of 500 SYP (Syrian pounds) per offshoot, while cost is 3,000–3,500 SPY on the open market. The program was aimed at encouraging farmers to expand date palm cultivation within the designated belt. Added to that, training courses and exhibitions have been carried out to introduce farmers to: (a) the value of the date palm tree, particularly in favorable regions where other fruit trees do not perform as well, and (b) date palm cultivation and care. This has led to an increase in farmers' demand for offshoots from propagation centers and to developing new date orchards, the number of which is continuing to increase each year. One of the other limiting factors for date cultivation in Syria is the shortage of irrigation water and the difficulty in digging wells in suitable regions within the belt designated for the date palm. Another barrier is prohibiting the planting of date palm trees in irrigated plain lands that are defined for growing other economic crops, such as wheat, cotton, and beets. This was resolved after the issuance of decree No. 20 in 2008 by the Prime Minister's Counsel that permitted planting date palm within the date palm belt, of which the eastern provinces lands and Euphrates River Basin constitute the majority, in addition to the Palmyra region and parts of Syrian Badia. The traditional methods used for propagation of date palm (offshoots) are a limitation which could be ameliorated through tissue culture. Added to what is stated above, many Syrians do not appreciate the value of the date palm because their views are influenced by the presence of old date palm trees of seedling origin (*deqel*) and hence of low productivity and producing fruit of below-average quality. This problem has been overcome by providing farmers offshoots at attractive prices.

12.2 Cultivation Practices

12.2.1 Chronological Account of Research and Development

The Ministry of Agriculture designed a plan for developing date palm cultivation in Syria. It defined the cultivation belt for the palm (Fig. 12.1) in 1986, according to the environmental requirements necessary for successful cultivation and fruit production. Five priority areas were specified within the date palm belt: (a) Al-Boukamal and Deir Al-Zour, (b) Raqqa and Marqada in Hasaka, (c) Palmyra, (d) Al-Zulf and Al-Tanf in Badia of the Damascus countryside, and (e) Khanaser (in Aleppo Badia) and East Damascus. In the same year, centers for date palm propagation were established in Palmyra and Al-Boukamal in order to collect offshoots from elite lines and native and introduced cultivars. These centers function as mother

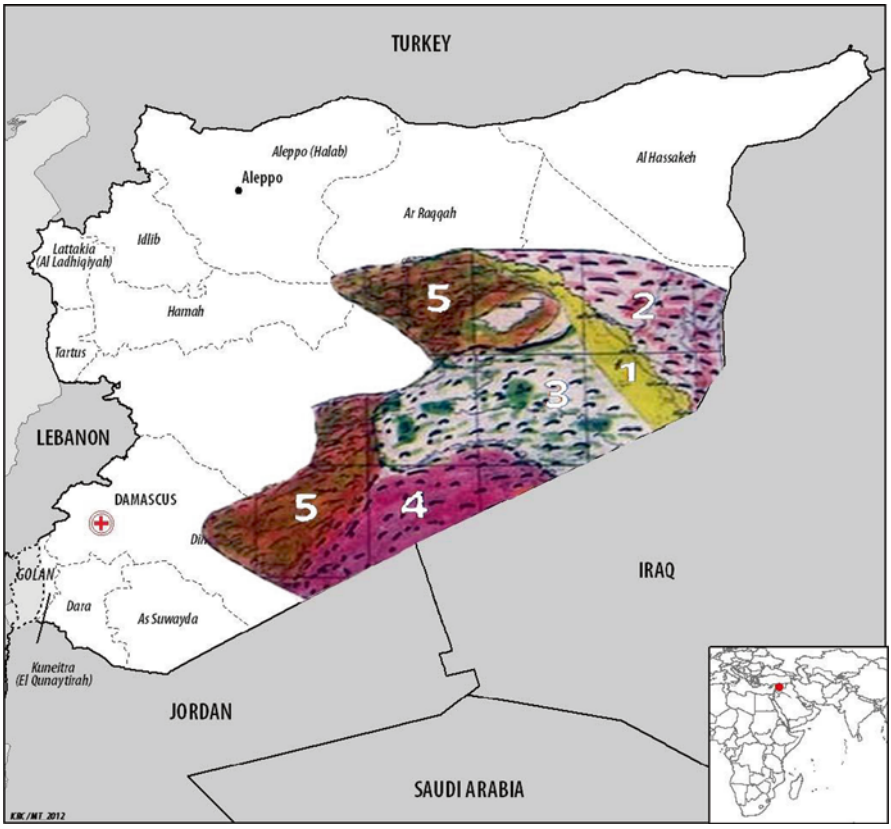

Fig. 12.1 A map of Syria showing the five priority areas in the date palm belt. *1* Al-Boukamal and Deir Al-Zour, *2* Raqqa and Marqada in Hasaka, *3* Palmyra, *4* Al-Zulf and Al-Tanf in Badia of the Damascus countryside, *5* Khanaser (in Aleppo Badia) and East Damascus (*Source*: Modified from Al-Baba (2000))

orchards of selected genetic resources which are propagated to generate offshoots for cultivation in suitable regions of the country. The centers also provide farmers with offshoots and guide them on how to cultivate and manage the date palm. National experts in date palm morphology also characterize and describe the female and male lines that are generated in those centers from seeds of the elite introduced cultivars to obtain local cultivars (Hakkar 2012). At that time, the number of offshoots and the cultivars that could be obtained from farmers' orchards in Palmyra and Deir Al-Zour was very limited because the farmers were neglecting the palms for several reasons, such as (a) imported dates were available in the local market at low prices; (b) the difficulty in dealing with date palm cultivation, pollination, and other services; and (c) the lack of awareness of farmers of the technical agricultural practices the date palm tree needs. In 2005, the number of offshoots generated from the centers of Al-Boukamal, Palmyra, and Sabkhat Al-Moh was 11,000 (Teshreen Newspaper 2005).

12.2.2 Description of Current Cultivation Practices

Date palm propagation in Syria is carried out through offshoots. The offshoots develop as suckers at the base of the mother plant, and consequently the fruits produced will be of the same quality as the mother palm (true to type). The season to separate offshoots either at the propagation centers or by farmers within the date palm belt takes place from April to June which is the best time for date palm cultivation in Syria. The disease- and pest-free offshoots (3–5 years old) are cut and properly separated from the mother palm. The offshoots are either planted in their permanent field location or spend a rooting period of 1 year in a nursery to ensure an optimum survival rate and to avoid uneven development of the plantation (Zaid and de Wet 2002a), as well as to reduce labor costs. In order to facilitate intercultural operations and proper development of the palms, planting is done, generally, at 8 m distance between rows and plants in a square system. A total of 156 palms are accommodated in 1 ha (8×10 m^2), 8 m in the rows and 10 m between rows, 8×8 m, or 10×10 m. Of the palms, 4 % should be males to provide adequate pollen grains. Offshoots are irrigated immediately after planting. Then for 45 days, they are irrigated every day in sandy soils, every 3 days for medium texture soils, and every 5 days in heavy soils, noting that date palm prefers the light soils. During the first year of planting, the irrigation quantity is 100 l per offshoot per irrigation. The irrigation interval, for drip or flood irrigation, is then gradually increased to two times a week and then once a week and then according to the need, growth vigor of offshoots, the environmental conditions, and soil type. In addition to irrigation, date palms need good nutrient management and pest and disease control (Grant online reference). The oasis should be kept clean by turning over the soil and weeding; and care for the date palm extends over almost the entire year according to specific needs, in order to have healthy and highly productive palms (Qatana online reference).

A sufficient number of green date palm leaves is necessary for growth, development, and yield. Insufficient number of leaves results in low-quality fruits and lesser inflorescence production the following spring (Pal online reference). Pruning of leaves is practiced by removal of old dead, infected, or broken leaves using sickle saws. The main purpose of pruning is to clean tree, to allow new leaves to grow and photosynthesize, and to facilitate fruit harvest and other activities. There are two periods for dry leaf pruning, during the pollination process in spring and during fruit harvest in autumn. Each fruit bunch needs nine leaves for normal growth.

Fruit thinning is necessary for several reasons, namely, to ensure adequate flowering in the following year, to improve fruit quality, to prevent delayed ripening, to reduce compacting of the fruit, and to increase ventilation of the bunches. Thinning parameters are the size of the bunch, density of fruits, tree age and vigor, and the cultivation practices (Al-Baba 2000). Only five bunches are left on each adult tree if it is weak due to poor cultivation practices. This number can be increased to 10–12 for a vigorous adult tree that receives proper care. Fruit thinning is done manually in July and August either by removal of some bunches (usually from the top and bottom of the crown) depending on the number of active leaves available for each bunch (9–10 leaves per bunch in full production phase) or thinning by removing a few strands from the middle of the crowded fruit bunches, or shortening the length of strands by cutting almost 1/4 of the female bunch to get rid of the weak terminal flowers (Pal online reference). The three methods of thinning might be carried out during the same thinning operation. From the fifth year onward, three to four bunches are left for each tree. In areas where production is possible, fruits are thinned by one-half for higher-quality fruits (e.g., Medjool). In the heavy production phase, 9–12 bunches are left on the tree.

Nutrient application is important for satisfactory production of quality date fruits. A dose of 50 kg N, 30 kg P, and 20 kg/ha K is recommended every year starting from the third year of offshoot planting. Amounts of P and K depend on the soil type and growth vigor. P and K fertilizers are added at the beginning of winter, while N fertilizer is added in March and April; alternatively, compound fertilizers NPK 20:10:10 are added in spring at the rate of 6 kg per tree in two equal applications. From the third to the eighth year of a plantation, the amount increases gradually to become 2 kg after the age of 15 years. Organic fertilizers (green manures) are also added in winter at the rate of 50 kg per adult tree and at a horizontal distance of about 50 cm from the base of the stem.

As for irrigation, it is done immediately after transplanting the palm for newly planted offshoots, to limit transplant stress. Once the plantation is established, a frequent irrigation schedule is followed to provide a sufficient water supply to the young date palms. In Al-Boukamal date palm propagation center, the irrigation is done by flood irrigation, while the drip system is applied in the remaining propagation centers. Irrigation requirements for palm tree range 15,000–28,000 m^3/year, depending on the age of the palms, soil type, and method used.

12.2.3 Pollination, Fruit Quality, and Metaxenia

Date palm is highly cross-pollinating due to its dioecious nature. In all propagation centers in Syria, manual pollination by climbing the tree is used. For this, four male trees are enough to pollinate 100 female palms. Two methods for pollination are applied. In the first method, about 5–7 strands of selected male flowers are inserted between the strands of female flowers of each spadix within 3 months from start of opening (April to June). The pollinated bunches are tied for a month and then covered with perforated bags mainly to increase the rate of expansion. In the second method, extracted pollen are dried and then mixed with flour at a ratio of pollen/flour 1:9 g. A piece of cotton cloth is immersed in the mixture and then put inside the female bunch which is then tied and covered with a perforated paper bag. If the male spathes open earlier than the female, the pollen grains are dried at a location with low humidity and no wind and then stored for later use. If the pollen grains are to be kept for the next year, they are put in tightly closed glass containers and stored at 0 to −4 °C or −18 to −20 °C if they are to be kept longer. At the biser stage (the beginning of ripening), bunches are enclosed in a net to protect them from birds and insects and to prevent falling of the fruits. Several operations are performed after pollination and fruit set. These include thinning of heavily loaded palms, release of bunches from the tree crown, thinning of the bunches, and their protection from birds and rodents (Nizwa.NET online reference). Swingle (1928) reported on the direct effect of pollen from a male clone on the morphology and other characters of seed and fruit tissues surrounding the embryo and endosperm and defined the phenomenon as metaxenia, which is quite common in date palm; therefore selection of good pollinator is important. The quality of date fruits, particularly fruit size and time of ripening, is influenced by the quality of the pollen. Research is being conducted in the date palm propagation centers on the selection of the best pollinizers based on their effect on fruit quality and ripening time and their compatibility with female cultivars. The same pollinizer is tested on several female cultivars for several seasons. Thus far, no prominent male has been identified in these centers for pollination. Hence, a mixture of pollen grains from several elite date palm males is used for pollination of female trees.

In a study of the influence of elite date palm males on qualitative and quantitative characteristics of some date palm cultivars in Syria, it was revealed that the pollen used for pollination influenced the fruits quality of Khastawi, Birbin, and Zahidi cvs. and on the net rate of productivity. It also had a significant effect on weight, size, length, and width of the fruit (GCSAR 2012).

12.2.4 Pest and Disease Control

The date palm is subjected, during its different life stages, to various pests and diseases which have a pronounced effect on palm growth and date fruit yield and quality. The importance of these pest and diseases and the harm they cause depend on

the region where they are cultivated (Shibli 2008). Although each of date palm-growing countries has its own list of pests and diseases, many of them are common to all countries (El-Juhany 2010). The main insects and fungal diseases which affect date palms and dates in Syria are inflorescence rot (al-khamedj), alwijam disease, and black scorch. As for the insects, they are dubas bug (*Ommatissus lybicus* Deberg.), the lesser date moth (*Batrachedra amydraula* Meyr.), the large date moth (*Arenipses sabella* Hamps.), fruit stalk borer (*Oryctes elegans* Prell, *O. agamemnon* Arabicus, and *O. boas* Fab.), frond borer (*Phonapate frontalis* sub), and dust mite (*Oligonychus afrasiaticus* McG.). It is worth noting that there are no viral infections reported on date palms in Syria and that the date palms in the coastal region are grown only as ornamentals.

In 2005, a number of palm trees in the coastal region were infected with the red palm weevil (*Rhynchophorus ferrugineus* Olivier), which entered Syria with offshoots and trees imported illegally. The Ministry of Agriculture took strict quarantine precautions to prevent transfer of this insect to the optimal regions of date cultivation (Palmyra and Al-Boukamal). Therefore, the insect remains under control (Al-Baba 2009). One of the other precautions to control the insect is spraying healthy trees with the insecticide Decis (or Lentrak) once every 21 days during the period from the beginning of spring to the beginning of autumn. If the infection is discovered early, 4–6 Phostoxin disks are inserted within the holes formed in the trunk by the female insect, which is then covered by gypsum. The whole tree, however, is felled, burned, and then buried at a depth of 1 m, in those areas that are severely affected. Another crucial precaution is that wounds should be avoided, and in order to achieve that, pruning wounds and the tree offshoots separation areas are covered with a paste made of insecticide and gypsum. Trees are also sprayed with a selective insecticide after leaf pruning, offshoot separation, inflorescence appearance, and fruit harvest. Infection from the red palm weevil can be prevented by the use of noninfested seedlings which can be achieved through tissue cultivation propagation of seedlings (Mahmoudi et al. 2008). According to Jamal (http://tishreen.news.sy/tishreen/public/read/258450), traditional propagation of date palm through offshoots generates plants more resistant to the red palm weevil as compared to those derived from tissue culture.

These pests and diseases are controlled by using systemic chemical pesticides. Biological control was used only for the dubas bug. In 2009, a specialized committee, which included experts from the Ministry of Agriculture, the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Atomic Energy Commission of Syria (AECS), and the General Commission for Scientific Agricultural Research (GCSAR), was formed to survey local date pests and design efficient mechanisms for prevention and control. The committee plans to release an Atlas and develop an integrated pest control plan (Al-Baba 2011).

Kaakeh (online reference) reported the infection of date palm in Deir Al-Zour with three species of insects: the Parlatoria date scale (*Parlatoria blanchardi* Targ.), the saw-toothed grain beetle (*Oryzaephilus surinamensis* L.), and the lesser date moth (*Batrachedra amydraula* Meyr.). He defined the degree of infestation and studied the effects of various temperatures on some biological features of the insects

infesting stored fruits, in order to determine the life cycles of these insects to establish ideal date fruit storage conditions to avoid infestations.

A Syrian quarantine act issued on 6.5.1998 prohibits the import of date palm trees and offshoots; it only permits importation of tissue culture plantlets which are up to 6 months of age after initial hardening (25–35 cm length with 4–5 primary leaves), planted in peat moss and free of all pest and diseases (Afif 2006).

12.3 Genetic Resources and Conservation

In Syria, the date palm is distributed mainly in the northeastern region and some inland areas. The cities of Homs (Palmyra) and Deir Al-Zour (Fig. 12.1) are two traditional areas of seedling date palm gardens. In 2007, there were in Palmyra 60,000 domesticated date palm trees of seedling origin with high genetic diversity. Of these, 20,000 trees were female. Evaluation and selection of date palm genetic resources of seedling origin resulted in the description of a total of 120 new elite lines, some of which will be adopted as Syrian local cultivars after their characterization and evaluation of the stability of their characteristics (Electronic Economic Newspaper 2007). As for commonly grown cultivars (e.g., Zahidi, Deglet Noor), the majority are introduced. Some of these cultivars were recently introduced to Syria and have not begun to bear fruit.

12.3.1 Chronological Account of Research in Genetics, Breeding, and Conservation

Krueger (1998) believes that there are possibly no examples of wild *Phoenix dactylifera* due to the long history of exploitation and selection of date palm, although there may be a few apparently wild groves still growing around oases, springs, or seepage areas, most of which are the end result of an unknown number of acts of selection. In Syria, the Ministry of Agriculture gave special attention to date palm tree starting in 1986. It established three production centers in Palmyra, Al-Boukamal, and Sabkhat Al Moh and a department for date palm. The functions of these centers are to (a) collect, conserve, and breed native or introduced cultivars and new elite lines of date palm that are adapted to the environmental conditions in these regions to act as mother orchards to provide offshoots for the date palm belt and (b) expand date palm cultivation quantitatively within the date palm belt (Al-Baba 2000). Added to that, these centers function as model farms to train date palm technicians (Al-Baba 2009). Experts from these centers and the Ministry of Agriculture cooperated with date palm researchers from ACSAD and did a lot of work to develop date cultivation in Syria (Hakkar 2012). The number of elite adoptive cultivars in these centers is expected to reach 40, including native and introduced. A map was designed for the distribution of these cultivars in priority areas based upon the

Table 12.2 Date palm cultivars grown in Syria and the number of trees of each cultivar as of 2009

Cultivar	No. of trees	Cultivar	No. of trees
Asabe El-Arous	250	Khyara	250
Ashrasi	12,000	Lolo	9,500
Barhi	21,000	Maktoom	8,500
Birbin	28,000	Medjool	20,000
Deglet Noor	15,000	Mumtaza	2,400
Fard	250	Nabtat-seyf	20,700
Gish Rabi	10,000	Shahabi	4,000
Jwahir	2,800	Sheikh Ali	350
Kabkab (red)	7,000	Shishi	2,500
Kabkab (yellow)	7,300	Smitni	2,000
Khadrawy	2,500	Sukkari	2,000
Khalas	22,000	Tafsirt	2,000
Khashram	200	Tagiat	2,200
Khastawi	40,000	Zaghloul	8,000
Khineze	4,300	Zahidi	46,000
Khudri	2,300		

Source: Al-Baba (2011)
Local lines of seedling origin which constitute a large proportion of date palms in Syria. The elite lines of these are characterized and selected to be adopted as local Syrian cultivars

geographical location within the belt and the environmental requirements of each cultivar (Al-Baba 2011). Table 12.2 shows date palm cultivars grown in Syria and the number of trees of each cultivar, as of 2009. Of these, only six cultivars are native: Khastawi, Zahidi, Ashrasi, Birbin, Maktoom, and Asabe El-Arous (Al-Kamour 2006). Areas cultivated with date palm, number of bearing date palms, and cultivated offshoots, by province, as of 2009, are listed in Table 12.3 (Al-Baba 2011). The Ministry of Agriculture is encouraging farmers to expand date palm cultivation area within the specified date belt due to environmental and economic importance as well as observed superiority of date palm over other fruit trees.

Established cultivars were introduced as in vitro plants from Saudi Arabia, UAE, Iran, Libya, and Egypt (Al-Baba 2011). There are also other cultivars that were imported from the date palm tissue culture laboratories of the UAE which are being hardened at the present time for propagating them after they prove suitable for the date palm belt. Haider et al. (2012) assessed, for the first time, the genetic relationships among five prominent male date palm genotypes and 18 native and introduced female date palm cultivars clonally propagated in Syria.

There are three main types of Syrian date cultivars based on fruit moisture content: soft such as Birbin, semidry such as Zahidi, and dry such as Ashrasi. The most important cultivars are Medjool (Mujhoolah), Khastawi, Barhi, Khalas, Nabtat-seyf, Lolo, Gish Rabi, Zaghloul, Kabkab (yellow), and Shahanit.

In Syria, added to the various cultivars that are propagated within the date palm belt area, there are a set of lines of seedling origin in the Deir Al-Zour and Palmyra oases and in orchards. Research is being carried out on elite lines in all the centers

Table 12.3 Areas cultivated with date palm and the number of date palm fruiting trees and cultivated offshoots by province as of 2009

Province	Area (ha)	No. of fruiting trees	No. of offshoots
Aleppo	40	19,350	11,000
Al-Ghaab	Minor area	595	–
Damascus countryside	243	8,500	1,000
Daraa	12	750	–
Deir Al-Zour	3,278	166,000	75,000
Hama	36	1,200	500
Hasaka	162	4,600	4,500
Homs (Palmyra)	3,640	23,000	20,000
Latakia	32	6,000	1,500
Quneitra	Minor area	150	–
Raqqa	283	7,900	6,600
Swaida	Minor area	405	–
Tartous	Minor area	2,350	1,000
Total	7,726 plus minor areas	240,800	121,100

Source: Al-Baba (2011)

(Al-Baba 2000). A set of 32 elite local female lines and 6 males of high quality and quantity of pollen was selected in these centers. The number of individuals of each of these lines is still limited due to the traditional offshoot propagation method used in the centers. Morphological characterization of these lines is in progress for adopting them as Syrian cultivars.

As for breeding of date palm to achieve the highest fruit quality and yield, the most serious drawback is the long time period from seed to flowering of about 6 years (Nixon and Furr 1965) and the 5-year minimum required to produce enough offshoots for trials and 10–15 years to reach full fruit production (Krueger 1998). There are currently some ongoing research projects on breeding of date palm in the propagation centers but there are no results yet.

12.3.2 Current Status and Prospect of Genetic Resources

Date palm germplasm should be better characterized and evaluated for successful utilization of its genetic resources (Krueger 2011). There are specialized committees in the Ministry of Agriculture which deal with characterization and classification of local date palm lines in order to select the elite lines and adopt them as Syrian local cultivars (Al-Baba 2000). Experts in the Ministry also characterize all date palm lines of seedling origin in all Syrian provinces, especially Palmyra, in order to select the elite date palms based on quantitative and qualitative measures, to adopt them as Syrian cultivars and give them distinctive local names. In 2001, the Ministry of Agriculture specified a portion of the offshoots produced from adapted

and reliable cultivars in date palm propagation centers for sale to farmers at low prices, and the number of these offshoots is increasing every year. This has led to an increase in the number of date palms in the entire country which has reached 500,000 (as of 2009) and expansion of areas of date palm cultivation within the belt. The number of offshoots produced by these centers reached 21,500 in the 2009 season, in addition to the offshoots produced by the farmers.

12.3.3 Germplasm Conservation

The Ministry of Agriculture is trying to develop the cultivation and production of date palm in Syria by expanding its cultivation via establishing propagation centers in provinces within the date palm belt, focusing on elite lines and cultivars. These centers serve as date palm germplasm banks (the same cultivars in all centers all from the Al-Boukamal center). For expanding date palm cultivation in Syria, currently about 25,000 offshoots are produced per year by the government centers. Some of these offshoots are cultivated in regions within the date palm belt. The Ministry also offers training courses and field days to instruct farmers and technicians in the best practices for planting and caring for date palm.

12.3.4 Threats and Degradation

The genetic diversity that exists in the cultivated date palms is being reduced by continued selection pressures by man and shifts to fewer and more modern cultivars (Krueger 1998). Collections of date palm germplasm are fewer 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. Ex situ collections of date palm (such as the Palmyra oasis) allow for a careful preservation of a specific genotype and documentation of characterization and evaluation data, reducing the chances of disease problems and permitting easier experimentation to be carried out (Krueger 1998). One of the main reasons for the degradation of date palm cultivation in the coastal region of Syria is the red palm weevil. In 2008, as a control measure, 1,228 trees and 4,090 offshoots in Latakia and 86 trees in Tartous were destroyed because of infestation (Syrianews 2009).

12.3.5 Quarantine Regulations

Unfortunately, pests and diseases have been spread with the expansion of trade and travel in the globalizing world system (UN Press Release 2004). Syrian quarantine regulations on the import of date offshoots are intended to prevent further red palm

weevils and bayoud disease from entering the country. The fungus that causes bayoud is transferred through the infected offshoots, palm tissues and products, and in infected soil on the roots. All of these materials that may carry the fungus are prohibited entry into Syria from countries where the pest and the disease are present (e.g., Algeria) (El-Melegi 2010). The red palm weevil is regulated through decree No. 389 that prohibits importing trees and offshoots that are propagated traditionally and allows only importing date palm plantlets propagated through tissue culture. Earlier regulations used to completely prohibit importing date palm trees to prevent transfer of this insect to the date palm in Syria (Syrianews 2009).

12.4 Plant Tissue Culture

12.4.1 Role and Importance

The application of tissue culture techniques for date palm propagation, also called in vitro propagation, helps produce the largest number of individuals from the minimum number of explants. Compared to the traditional techniques of date palm propagation, tissue culture has many advantages. It is easier and faster, dormancy problems are eliminated, and juvenile stage is reduced. It is also a suitable tool for propagation of clones that do not produce offshoots and viable seeds or that do not produce seeds at all (Alkhateeb 2008). Other advantages are production of genetically uniform plants which are usually identical to the mother plants and have almost 100 % survival rate, easy and fast exchange of plant material without risk of the spread of diseases and pests (e.g., bayoud and red palm weevil), and generation of disease and pest-free cultivars (UAE University 2005). Alkhateeb (2008) suggested that the development of propagation methods through tissue culture resulted in massive expansion of date palm plantations. Shubat (2012), however, argued that trees generated using this method is less resistant to the red palm weevil as compared to those generated using offshoots.

12.4.2 Research and Development

In 1989, a laboratory for date palm tissue culture propagation was established in the General Organization for Seed Multiplication (GOSM) in Aleppo (Al-Baba 2011). The goal was to develop date palm tissue culture techniques using somatic embryogenesis and direct organogenesis, which are the most popular techniques. In somatic embryogenesis, complete somatic embryos are formed from vegetative cells which behave more like sexually produced zygotic embryos. They are produced from in vitro–produced friable callus cells. As for direct organogenesis, adventitious shoots are developed from the undifferentiated callus masses or directly from the explants (Alkhateeb 2008). Due to the disadvantages of the two techniques, Amin (2001)

applied a new method by using the adventive buds for propagation of two cultivars grown in Syria, Khastawi and Zahidi. The method is based on generating renewed buds on the surface of the treated in vitro explants, which do not normally produce buds (Margara 1984). Amin believes that this method may be much safer than somatic embryogenesis in producing in vitro date palm plants identical to the mother plant in their vegetative specifications, because this method does not pass through the callus stage. Amin also mentioned that this technique is being improved now to be applied at a commercial level and for more than one cultivar. Al-Maarri (1995) referred to experiments he carried out on date palm tissue culture and also discussed several issues related to date palm tissue culture. These are (a) date palm tissue culture techniques (embryogenesis, organogenesis, and inflorescence tissue), (b) the role of hormones on date palm tissue culture, (c) some physiological disorders concerning date palm propagation, (d) genetic stability in date palm produced through tissue culture, (e) development of date palm vitroplants in the field, and (f) date palm tissue cryoconservation.

Al-Khayri and Al-Maarri (1997) studied the effect of seasonal variation on the regeneration capacity of date palm. Ibraheem and others also carried out a number of experiments on date palm tissue culture. Examples are: (a) somatic embryogenesis to propagate date palm cultivars of interest for Syria (e.g., Zahdi, Khistawi, Asabe El-Arous, and Barban) by using zygotic embryos (Pinker et al. 2009), (b) a comparative study between solid and liquid cultures relative to callus growth and somatic embryo formation in cv. Zaghloul (Ibraheem et al. 2013), (c) the effect of sodium chloride stress on Zaghloul somatic embryogenesis (Ibraheem et al. 2012a), (d) screening of some date palm cultivars to salt stress in vitro (Ibraheem et al. 2012b), (e) optimizing of date palm in vitro rooting protocol for cvs. Deglet Noor and Asabe El-Arous (Ibraheem et al. 2010a), (f) somatic embryogenesis approach for shoot tips of Zaghloul (Ibraheem et al. 2010b), and (g) propagation of date palm cultivars in vitro by using zygotic embryos and leaflet segments (Ibraheem et al. 2009).

12.4.3 Scaling-Up Production and Tissue Culture Applications

As mentioned above, research carried out by GOSM for optimization of tissue culture on date palm has not succeeded. Therefore, date palm plantlets propagated through tissue culture are imported from Gulf countries, Iran and Egypt. Some other cultivars were imported from the Maghreb countries, such as Medjool and Deglet Noor, which were propagated in other countries using tissue culture. The survival and success rate of these plantlets was 100 %. They are hardened and acclimatized in the propagation centers and then planted in permanent locations within the date palm belt. The cultivars were very successful and identical to the cultivars they originated from in the country of origin. Offshoots of these cultivars are used to expand the plantation of these cultivars in the date belt. So far, about 100,000 offshoots of the tissue culture-derived cultivars have been produced and planted in Syria.

12.4.4 Survey of Research and Commercial Labs

In addition to the study by Amin (2001) on in vitro propagation of date palm using adventive buds, the Department of Tissue Culture in GOSM conducted experiments for optimization of date palm tissue culture techniques (Al-Admeh et al. 2006). Unfortunately, these experiments failed and the laboratory was closed in 2003. Hardening the plantlets produced in tissue culture laboratory in Aleppo used to be one of the main objectives of the branch of GOSM in Latakia. A set of 2,259 hardened offshoots was sent to Al-Jalaa production center in Deir Al-Zour (Al-Wehda 2007). Jamal (http://tishreen.news.sy/tishreen/public/read/258450) mentioned that there are more than 15 protocols for propagation of date palm tissue culture that were developed in laboratories of the College of Agriculture in Damascus University, but they are not yet published. He believes that researchers can use these protocols in Syria.

12.4.5 Recommended Protocols

Various laboratories in the world have made attempts to propagate date palm by tissue culture techniques. According to Zaid and de Wet (2002a), success has been achieved at only a few international laboratories. Protocols of tissue culture of date palm in Syria have to be refined in order to develop a reliable method which can be used for large-scale propagation of date palm in the country.

12.5 Cultivar Identification

12.5.1 Role and Importance

Because the date palm plays an important role as an income and employment source for people living in the growing areas, date palm biodiversity requires a more comprehensive knowledge for its conservation and sustainable use (Jaradat 2011). The phenotypic and genetic description and determination of genetic variability of native and introduced date palm cultivars in Syria are of major importance in date palm breeding and improvement programs, germplasm characterization, and conservation to control genetic erosion (Munshi and Osman 2010). This also helps in collecting and cataloguing the germplasm in established germplasm banks (Bornet and Branchard 2001). Propagation of date palm cultivars using tissue culture provides thousands of plantlets from a single offshoot, which should be true to type to the mother plant. Molecular markers are needed to detect any genetic changes or traits in in vitro–propagated plants. For example, the frequency of somaclonal variation in the resultant plants from two tissue culture techniques, namely, organogenesis

and embryogenesis, was estimated and compared for ten date cultivars grown in the UAE using amplified fragment length polymorphism (AFLP) analysis (Al Kaabi et al. 2007). Similarly, randomly amplified polymorphic DNA (RAPD) markers were used to determine genetic changes between callus-derived plantlets of the Iranian cv. Khanizi and its mother plant (Eshraghi et al. 2005). Saker et al. (2006) employed both techniques (RAPD and AFLP) to assess genetic variations in tissue culture-derived date palm offshoots of cvs. Sakkoty, Gandila, and Bertamoda.

12.5.2 Research in Morphological Descriptors

Traditionally, morphological characteristics (leaves, spines, and fruit characters) have been used widely for the description of date palm cultivars. The description of the fruit characters is considered more common than describing the vegetative characters for differentiation between date palm cultivars. Date palm cultivars introduced to Syria from other countries have accumulated changes in some of their features from the original cultivars, after they adapted to the new environmental conditions (Electronic Economic Newspaper 2007). In 2006, a committee of date palm experts from the Ministry of Agriculture and ACSAD was formed for morphological characterization of all local date palm cultivars and elite lines grown in Syria. The committee released an Atlas that can be regarded as the first reference for classification of date palm in Syria (Al-Baba et al. 2013). This Atlas includes an introduction to 40 cultivars and lines, i.e., name, description of vegetative, and fruit characters that differentiate each cultivar and line supported with photos, chemical composition of fruits, fruit-ripening date, stage of consumption, and quality of fruits. The Atlas covers only Palmyra and Al-Boukamal propagation centers because they are the only centers in which date palm trees have been fruiting since 2001. The most informative and reliable physical characters were selected and evaluated according to the states of the character that can be encountered in the cultivars examined in any locality. For each cultivar, the descriptors (see Table 12.5) were applied to 10 aged palm trees in each location. Haider et al. (2009) carried out a morphological characterization of 18 cultivars of those described in the released Atlas. The objective was to obtain an accurate description and knowledge of these genetic resources, based on the floral and vegetative morphometric characters. The results represent the first informative morphological description of Syrian date palm cultivars. The descriptors considered were fruit weight, production level, leaf length, leaf spines, leaf density, leaf color, bunch color, bunch length, bending degree of the bunch, size of inflorescence, flower density, flowering time, fruit ripening time, consumption level, seed color, color of ripe fruit, seed shape, rate of fruit weight and size, color of fruit cap, cap position, seed/fruit percentage, fruit type, fruit skin separation, and the number of offshoots each cultivar generates. In spite of these descriptors, it remains very difficult, however, to identify cultivars especially outside the fruiting period. Moreover, the evaluation of inter-cultivar genetic diversity on the basis of morphological markers, mainly those of the fruit, is difficult because a large

set of complex phenotypic data (Elhoumaizi et al. 2002) is required. It is worth mentioning that there is a joint project between the Ministry of Agriculture and ACSAD which is funded and supervised by the latter for selecting and evaluating elite local date palm lines in Syria, Saudi Arabia, and Egypt. The aim of this project is to establish gene banks for selected elite lines including farmers' lines in each country. These lines will be characterized and adopted as new cultivars that have high-quantity production of high-quality dates.

12.5.3 Research in Molecular Descriptors

Despite the outstanding agronomic and socioeconomic significance of date palm, attempts to improve knowledge about the biodiversity of date palm in Syria have been limited to the phenotypic description of those cultivars. Informative morphological characters for describing date palm cultivars can be observed only in mature trees, and they vary due to the environmental effects and stages of growth and development. DNA-based markers provide useful information on the genetic diversity of date palm cultivars, as they remain unaffected by environmental factors and the developmental stage of the plants. Using RAPD and inter-simple sequence repeat (ISSR) markers, Haider et al. (2012) conducted a study for: (a) the identification of five prominent male date palm genotypes and 18 native and introduced female cultivars clonally propagated in Syria and (b) evaluation of the genetic relationships among them. These cultivars are Deglet Noor, Medjool, Zahidi, Birbin, Ashrasi, Maktoom, Khastawi, Barhi, Khalas, Khadrawy, Nabtat-seyf, Lolo, Gish Rabi, Khineze, Zaghloul, Shahabi, and Kabkab (yellow and red). The results have produced the first informative DNA-based markers for the genetic characterization of date palm cultivars analyzed. RAPD data allowed the discrimination of five cultivars (Deglet Noor, Kabkab (yellow), Medjool, Khastawi, and Birbin) and one male genotype. The use of ISSR, however, could distinguish only one cultivar (Khadrawy) and the same male genotype distinguished by RAPD. There are no commercial labs for description or characterization of date palm in Syria. Research into accurate identification of date palm cultivars propagated in Syria using molecular markers is in progress. Therefore, there is as yet no recommended protocol.

12.6 Cultivar Descriptions

12.6.1 Growth Requirements

Growing date palm and successful ripening of fruits are achieved in regions that are free of frost and where the climate is hot and dry in summer and the temperature in winter does not go below −9 °C for long periods. There must be a long

and hot summer during fruit development from khalal (*balah* or *biser*, partially ripe showing a yellow or red color and crunchy) to rutab (fully ripe, light-brown, and soft) stage of development, then tamar (dark brown and soft, semidry or dry). Date fruits production is dependent on the availability of certain heat requirements according to the cultivar. Most dry cultivars are found in the drier areas, whereas soft and semidry cultivars are confined to the humid and semidry areas (Zabar and Borowy 2012). Date palm trees prefer temperatures above 23.89 °C and can tolerate temperatures as high as 43.33 °C. During winter, date palm tree can tolerate temperatures as low as −9 °C (http://www.convertworld.com/ar/temperature/%D9%85%D8%A6%D9%88%D9%8A%D8%A9.html). It is worth noting here that the biological zero for date palm growth is 9 °C, for flowering 18 °C, for fertilization 20 °C or higher, and for ripening is 32 °C or more. Date palms like the brightest available light, including full sun. It needs sufficient light to grow and produce fruits. In shaded regions, date palms grow very slowly at the early stages and take a very long period to flower and have poor fruit production. Date palms can tolerate drought but does better with regular water availability. Water requirements differ according to factors such as age of the palm, soil type, climate, cultivar, and season. Compared to other plant species, date palm shows no damage under windy conditions (Zaid and de Wet 2002b). As for mineral nutrients, fertilization should be carried out to prevent deficiencies rather than to treat deficiencies in date palm. The date thrives in sand, sandy loam, clay, and other heavy soils. It needs good drainage and aeration, and it is remarkably tolerant of alkali. Excessive salt will stunt growth and lower the quality of the fruit (Al-Bakr 1972) but a moderate degree of salinity is not harmful (Zabar and Borowy 2012).

12.6.2 Cultivar Distribution

The most important cultivars in Syria and their distribution are given in Table 12.4 (see also Fig. 12.1).

12.6.3 Cultivar Production Statistics and Economics

The production of date palm differs according to the cultivar, age of the tree, agricultural practices (irrigation, pollination, etc.), pest resistance, and the region of cultivation. The fruit yield (kg) of the most important cultivars per year is as follows: Barhi (150–300), Zahidi (250–350), Khastawi (250–300), Birbin (300–400), Nabtat-seyf (70–130), Lolo (150–200), Gish Rabi (150–250), Khineze (200–350), Zaghloul (150–250), Shahabi (300), Kabkab (yellow and red, 100–150), Deglet Noor (75–100), Medjool (70–90), Ashrasi (60–90), Maktoom (80–120), Khalas (150–250), and Khadrawy (150).

Table 12.4 The most important cultivars in Syria and their distribution in the five priority areas defined in the date palm belt

Cultivar	Priority area no. 1	Priority area no. 2	Priority area no. 3	Priority area no. 4	Priority area no. 5
Ashrasi	Deir Al-Zour	Palmyra	Raqqa	Hasaka	
Barhi	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia (Hama and Damascus countryside)
Birbin	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia (Hama, Damascus countryside and Aleppo)
Deglet Noor	Al-Boukamal	Mayadin	Raqqa	Hasaka	
Kabkab, red and yellow	Deir Al-Zour	Palmyra	Raqqa	Hasaka	
Khastawi	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia of Hama
Lolo	Deir Al-Zour	Palmyra	Raqqa	Hasaka	
Maktoom	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia (Hama and Damascus countryside)
Medjool	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia (Hama, Damascus countryside and Aleppo)
Nabtat-seyf	Deir Al-Zour	Hasaka	Raqqa	Palmyra	
Zahidi	Deir Al-Zour	Palmyra	Raqqa	Hasaka	Badia of Hama

Source: Al-Baba (2011), Holy Tree Magazine 3(3) Sept. 2011

12.6.4 Cultivars Description

Table 12.5 shows the morphological characters that were evaluated and used by (Haider et al. 2009) for morphological characterization of 18 important date palm cultivars grown in Syria (see Appendix A). Photos of the adult tree and fruits of some of these cultivars are given in Fig. 12.2.

12.7 Date Production and Marketing

12.7.1 Practical Approaches

Preharvest practices that influence date quality at harvest include covering fruit bunches with paper bags to protect them from dust, pests, and rain and fruit thinning to reduce fruit compacting within bunches and increase fruit size and quality (Kader and Hussein 2009). If diseases and/or pests occur in a date plantation, the overall situation has to be evaluated to identify and address the causes (Mahmoudi et al. 2008). Dates of Zahidi, Medjool, Deglet Noor, Khastawi, Lolo, Zaghloul and Barhi cvs. are marketed on branches (strands) or bunches. Dates are marketed whole, pitted, cut into small pieces, or macerated (ground or chopped). Whole unpitted or pitted dates may be marketed loose or pressed (compressed into layers using mechanical force) (Kader and Hussein 2009). The marketing and consumption of

Table 12.5 Morphological characters that were evaluated and used for morphological characterization of date palm cultivars cultivated in Syria

Character	Class	Cultivar																	
		Deglet Noor	Medjool	Zahidi	Birbin	Ashrasi	Maktoom	Khastawi	Barhi	Khalas	Khadrawy	Nabtat-seyf	Lolo	Gish Rabi	Khineze	Zaghloul	Shahabi	Kabkab (yellow)	Kabkab (red)
Leaf length	Long	√	–	–	√	–	√	–	√	–	√	√	√	–	–	√	√	√	√
	Medium	–	√	√	–	√	–	√	–	√	–	–	–	√	√	–	–	–	–
Leaf thorns	Dense	–	√	√	√	–	–	√	–	–	–	√	–	√	√	–	–	–	–
	Moderate	–	–	–	–	√	√	–	√	–	–	–	√	–	–	√	–	–	–
	Few	√	–	–	–	–	–	–	–	√	√	–	–	–	–	–	√	√	√
Leaf density	High	–	√	–	√	√	–	√	–	–	–	√	–	√	√	–	–	√	√
	Moderate	√	–	√	–	–	√	–	√	√	–	–	√	–	–	√	√	–	–
	Few	–	–	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–
Leaf color	Dark green	–	√	√	√	√	–	√	–	–	–	–	–	√	√	–	–	√	√
	Medium	–	–	–	–	–	√	–	–	–	√	√	√	–	–	√	√	–	–
	Faint	√	–	–	–	–	–	–	√	√	–	–	–	–	–	–	–	–	–
Bunch color	Green	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Yellow	√	√	–	–	√	√	–	√	√	–	–	√	√	–	–	√	√	√
	Brown	–	–	√	–	–	–	√	–	–	√	√	–	–	√	√	–	–	–
Length of bunch	Long	√	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–
	Medium	–	–	√	√	–	√	–	–	√	√	√	√	√	√	–	√	√	√
	Short	–	√	–	–	√	–	√	–	–	–	–	–	–	–	√	–	–	–
Bending level of bunch	High	√	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–
	Medium	–	–	–	√	–	√	–	–	√	√	–	√	√	√	√	√	√	√
	Low	–	√	√	–	√	–	√	–	–	–	√	–	–	–	–	–	–	–
Size of inflorescence	Big	–	–	√	√	–	–	√	√	–	–	√	√	√	–	√	√	–	–
	Medium	√	√	–	–	–	√	–	–	√	–	–	–	–	√	–	–	√	√
	Small	–	–	–	–	√	–	–	–	–	√	–	–	–	–	–	–	–	–

Flower density	High	–	–	√	√	–	–	√	√	–	–	√	√	√	√	√	√	–	–
	Medium	–	–	–	–	–	√	–	–	√	√	–	–	–	–	–	–	√	√
	Low	√	√	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
Flowering time	Early	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Medium	√	√	√	–	√	√	√	–	–	–	–	√	–	√	√	√	√	√
	Late	–	–	–	–	–	–	–	√	√	√	√	–	√	–	–	–	–	–
Time of fruit ripening	Early	–	–	–	√	–	–	–	–	–	–	–	–	–	√	√	√	√	–
	Medium	–	–	√	–	–	√	√	√	√	√	–	√	√	–	–	–	–	–
	Late	√	√	–	–	√	–	–	–	–	–	√	–	–	–	–	–	–	√
Consumption stage	Biser	–	–	–	–	–	√	–	√	√	–	–	–	–	√	√	–	–	√
	Rutab	–	–	–	√	–	√	√	√	√	√	–	√	√	√	√	√	√	√
	Tamar	√	√	√	–	√	√	√	√	√	√	√	√	√	√	–	–	√	√
Color biser	Red	√	√	–	√	–	–	–	–	–	√	–	–	–	√	√	–	–	√
	Yellow	–	–	√	–	√	√	√	√	√	–	√	√	√	–	–	√	√	–
Color of ripe fruit	Black	–	–	–	√	–	–	√	–	–	√	–	–	–	√	√	–	–	√
	Dark brown	–	√	–	–	√	–	–	–	–	–	–	√	–	–	–	–	–	–
	Brown	–	–	√	–	–	√	–	√	–	–	√	–	–	–	–	–	–	–
	Yellow	√	–	–	–	–	–	–	–	√	–	–	–	√	–	–	√	√	–
Biser shape	Oval	–	–	√	–	√	√	–	√	–	–	–	–	–	–	–	–	√	√
	Cylindrical	√	√	–	–	–	–	–	–	√	√	–	–	√	√	√	√	–	–
	Globular	–	–	–	√	–	–	√	–	–	–	√	√	–	–	–	–	–	–

(continued)

Table 12.5 (continued)

Character	Class	Cultivar																	
		Deglet Noor	Medjool	Zahidi	Birbin	Ashrasi	Maktoom	Khastawi	Barhi	Khalas	Khadrawy	Nabtat-seyf	Lolo	Gish Rabi	Khineze	Zaghloul	Shahabi	Kabkab (yellow)	Kabkab (red)
Average fruit weight and size	Small	–	–	√	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–
	Medium	√	–	–	√	–	√	–	√	√	–	–	√	–	√	–	–	–	–
	Big	–	√	–	–	√	–	–	–	–	√	√	–	√	–	√	√	√	√
Color of fruit cap	Red	√	√	–	√	–	–	–	–	–	√	–	–	–	√	√	–	–	√
	Yellow	–	–	–	–	√	√	–	√	√	–	–	–	–	–	–	√	–	–
	Brown	–	–	√	–	–	–	√	–	–	–	√	√	–	–	–	–	√	–
Status of fruit cap	Gummy	–	–	–	–	√	√	√	–	√	–	–	–	–	–	–	–	–	–
	Superficial	–	√	√	–	–	–	–	√	–	√	√	–	–	–	–	√	√	–
	Embossed	√	–	–	√	–	–	–	–	–	–	–	√	√	√	√	–	–	√
Seed to fruit ratio	Big	–	–	–	√	–	–	–	–	–	–	–	–	√	–	√	–	–	–
	Average	–	–	√	–	–	–	–	–	–	√	√	√	–	√	–	√	√	√
	Small	√	√	–	–	√	√	√	√	√	–	–	–	–	–	–	–	–	–
Date ® classification	Soft	–	–	–	√	–	–	–	–	–	–	–	–	–	–	√	√	–	–
	Semidry	√	√	√	–	–	√	√	√	√	–	√	√	√	√	–	–	√	–
	Dry	–	–	–	–	√	–	–	–	–	√	–	–	–	–	–	–	–	√
Skin separation	Adherent	√	√	–	–	√	–	√	√	√	√	√	√	√	√	–	√	–	√
	Separate	–	–	√	√	–	√	–	–	–	–	–	–	–	–	√	–	√	–
Tree crown	Globular	–	√	√	√	√	–	√	–	√	√	√	√	–	–	√	–	√	√
	Elliptic	√	–	–	–	–	√	–	√	–	–	–	–	√	√	–	√	–	–
Economic importance	Good	√	√	–	–	√	√	–	√	√	√	√	√	–	–	–	–	–	√
	Moderate	–	–	√	–	–	–	√	–	–	–	–	–	√	√	–	√	√	–
	Few	–	–	–	√	–	–	–	–	–	–	–	–	–	–	√	–	–	–
Distribution	Rare	√	–	–	–	–	√	–	–	–	√	–	–	–	√	√	√	√	√
	Moderate	–	√	–	√	√	–	–	√	√	–	√	√	√	–	–	–	–	–
	Good	–	–	√	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–

√ refers to the presence of the character and – to its absence

dates in Syria is local because the majority of date palm trees are of recent production, especially the imported cultivars, and the annual production is insufficient to meet local market demands. Syria (along with Jordan, Morocco, Lebanon, and Yemen) has been identified by Al-Shreed et al. (2012) as belonging to a group of date-producing countries which are also date importers. Syria, however, does not export any dates.

12.7.2 Optimization of Yield

Pollination and fruit thinning are critical processes in date palm production. The pollen source in dates affects fruit quality, yield, and annual productivity. Different pollen sources are expected to affect fruit size, flesh/seed ratio, flesh and seed development, and time to fruit maturation. Hence, deciding on appropriate pollenizer cultivars is very crucial. A combination of both organic and inorganic fertilizers is recommended for higher yields and better physical and chemical fruit characteristics. Other

Fig. 12.2 Photos of tree and fruits of the most important date palm cultivars in Syria (*Source*: Al-Baba (2000))

Khalas

Barhi

Khsab

Fig. 12.2 (continued)

Lolo

Khineze

Gish Rabi

Fig. 12.2 (continued)

cultivation services such as fertilizers, irrigation, pest control, and regular pruning by leaving at least nine leaves per bunch are other crucial factors for optimization of date palm yield whose average values ranges between 70 and 150 kg of fruits per cultivar per year. It is worth noting here that the type, quantity, and time of fertilizer application vary according to the type of soil and the development stage of the palm.

12.7.3 Mechanization of Harvesting

This and the following section draw significantly from a study published by ICARDA (International Center for Agricultural Research in the Dry Areas), headquartered in Aleppo, on harvesting and postharvest handling of dates (Kader and

Hussein 2009). The study presents best practices to which Syrian date producers and processors should aspire to adopt.

Defining the time of harvest is important (Shibli 2008) and it depends on the cultivar. Dates are harvested at the end of August at the *biser* stage or in September to November at the rutab and tamar stages. Time of harvest is based on date fruit appearance and texture related to moisture and sugar content (Kader and Hussein 2009). Date bunches are usually enclosed in net covers to collect the fallen ripe fruits and to protect them from insects and birds (Kader and Hussein 2009). Harvest mechanism differs according to the stage at which the dates are harvested. When dates are *biser*, they are harvested manually by cutting the whole bunch such as in cvs. Barhi and Zaghloul. At rutab stage, fruits are harvested by hand, taking into consideration that the fruits of the same bunch do not ripen at the same time. As for tamar dates, they are harvested as whole bunches with a sharp knife by climbing the tree (when the majority of dates are ripe). Fallen dates on the ground are not collected or sold for human consumption (Kader and Hussein 2009). As for cultivars whose fruits differ in ripening time and take a long time to ripen like Deglet Noor cv., they are harvested before the fruits ripen and ripening is completed while the fruits are on the bunches after harvest. Artificial ripening is carried out either by heating fruits through exposure to sunlight for a few days until they ripen, or they are put in special chambers (27–38 °C) with high humidity (85–90 %) for a short time. The fruits that are consumed locally are collected when they reach the rutab or tamar stage; the entire bunches are cut and transferred to the place where they are ripened artificially (Qatana online reference). The fruits are packed in the field after harvest in special boxes or baskets made locally, or the bunches are taken to the shops to be sold directly. These latter dates should be cooled to 0 °C and transported under refrigeration (0–2 °C and 90–95 % relative humidity) to maintain their quality (Kader and Hussein 2009), or the ripe fruits are separated from the bunch and then sorted to remove infected or seedless fruits that are used as animal feed (Qatana online reference). Great care is given to the fruits that are consumed in tamar and rutab stages, regarding the time of collection, and they should be shipped quickly to the shops.

12.7.4 Postharvest Operations

Postharvest operations carried out are: (a) initial sorting to remove defective dates and foreign materials; (b) cleaning to remove dust, dirt, and other foreign materials using air pressure and water followed by air-drying to remove surface moisture; (c) sorting by quality and size into grades; (d) packaging to protect the dates from physical damage and moisture absorption using moisture-proof packaging material; (e) use of insect-proof packaging to prevent reinfestation of the dates during their subsequent storage and handling steps; and (f) cooling the dates to below 10 °C (preferably to 0 °C) before transportation or storage under the same temperatures (0–10 °C) and 65–75 % relative humidity. Forced-air cooling is used

for cooling dates (Kader and Hussein 2009). *Biser* dates are stored at 0 °C and 85–95 % relative humidity to reduce water loss, delay ripening to the rutab stage, and maintain their textural and flavor quality. Packaging in well-sealed plastic bags or use of a plastic liner in the box helps in reducing water loss (Kader and Hussein 2009). Optimal temperature for storage of tamar dates is 0 °C for 6–12 months, depending on cultivar. For longer storage durations, temperatures below the highest freezing temperature of −15.7 °C are used. Dates with 20 % moisture or lower can be kept at −18 °C for more than 1 year, or at 0 °C for 1 year, or at 4 °C for 8 months, or at 20 °C for 1 month (relative humidity should be kept between 65 and 75 % in all cases) (Kader and Hussein 2009). The temperature of storage differs according to cultivar and moisture level. The highly moist soft cultivars are stored at 0 °C or less and the semidry cultivars at 0 °C. It may go less than 0 °C when the moisture in the fruits increases or the storage period increases (Shibli 2008).

12.7.5 Survey of Commercial Producers and Major Farms

Date palm propagation centers are the only commercial producers of date palm offshoots in Syria. Because commercial date palm cultivation in the country is relatively recent, there is no organized private sector for the production and commercialization of dates. The main commercial producers of dates are farmers in Deir Al-Zour and Palmyra (see Appendix B).

12.7.6 Marketing Status and Research

Several individual farmers grow, pack, and sell their fruit locally in roadside stands. Under the impact of rising labor costs and increasing height of the palms, cultural practices in particular the timing and method of harvesting need to be mechanized. The dates are left longer on the palm and are harvested in one operation (Mahmoudi et al. 2008) in order to reduce labor requirements. There is no marketing research on dates in Syria.

12.7.7 Current Import and Export

Date production in Syria up to 2010 provided only 10 % of the local market demand in the country. Annual date production is about 5,000 m, and the market demand is 50,000 m. Imported dates cover the shortage. This situation is temporary because most trees in the country are in the preproduction phase and have not yet reached full commercial production. Accordingly, there are no date exports.

12.8 Industry

Because more formal cultivation of date palm in the country is generally recent and the production is, therefore, insufficient even to meet local demand, the present date palm-based industry in Syria is limited to homemade fruit-based desserts and jam and leaf-woven baskets and plates.

12.9 Conclusions and Recommendations

The program of the Ministry of Agriculture in selecting the geographical locations suitable for cultivation and production of date palm was successful. According to the environmental conditions of each location, appropriate cultivars were imported from other countries. These cultivars performed well in date palm propagation centers established by the Ministry, and their yields and fruit quality were similar to those of the same cultivars in the country of origin. When these centers started to produce enough reliable offshoots and sold them to farmers at reduced prices, additional imports of offshoots and tissue culture plants ceased.

After 2001, when the imported cultivars entered the production phase, the farmers started to establish private orchards especially in Deir Al-Zour and Raqqa and planting them with elite and commercial cultivars.

The Ministry of Agriculture also formed a team of specialized and trained technicians on date palm cultivation and care. The duty of this team is to guide farmers on how to establish ideal date palm orchards and provide proper cultivation, protection, and pest control care for the palms. Due to the efforts of this team, a set of date palm male and female local lines of seedling origin were selected and then adopted as elite Syrian cultivars that suit the date palm belt. These cultivars have been propagated in the gene banks of date palm (i.e., date palm propagation centers). The Ministry is also trying to restore the tissue culture laboratories in Syria.

There are several barriers affecting date palm cultivation in Syria. The date-growing belt is located in the Badia and Euphrates River Basin (Fig. 12.1). Establishment of date orchards there is handicapped by the restriction on digging wells in Badia and by the fact that the lands in the Badia specialize in growing strategic crops; besides, there is the difficulty in providing water, the high level of salinity in well water, and the limited area that has freshwater available (Hakkar 2012). The most important requirements for developing date palm cultivation in Syria are permitting the digging of deep wells to reach fresh underground water, developing a mechanism for investing in new lands for date palm cultivation, after conducting a study of the water supply, and to expand the cultivation of date palm to increase yield. In addition, means should be developed to withdraw water from the Euphrates River and channel it to the Badia for irrigation; there is a need for tissue culture propagation laboratories to increase the yield and to provide disease-free offshoots from local elite lines and promote them as elite local cultivars and adopt biological control of diseases and pests (Hakkar 2012).

One of the main limitations to date palm cultivation in Syria is propagation of date palm using offshoots and not producing in vitro–propagated plantlets locally. Tissue culture techniques for propagation of date palm have to be developed in order to increase the yield of this tree (Agriculture World, Egyptian Agriculture Net 2012). Alkhateeb (2008), however, referred to problems that are often encountered during optimization of date palm tissue culture protocols. Some of these are at the laboratory level such as browning of cultured tissues, bacterial and fungal contaminations, early rooting of tissue-cultured buds, deterioration of embryonic callus and its inability to form embryos, and callus formation on bases of rooting plantlets. Other problems are at the field level such as failure to set fruit, dwarfism of the palms, abnormal growth and development of leaves and fruit strands, dryness of apical bud, terminal bud bending, albinism (variegation) of leaves, and changes in fruit quality. One of the common problems that also occur in plants propagated via tissue culture is somaclonal variation (El Hadrami et al. 2011; Jain 2012), defined as genotypic or phenotypic variation in tissue culture-derived plants. These plants may differ in genetic fidelity and are not always identical (Kaeppler et al. 2000). More serious research should be implemented to develop protocols for true-to-type multiplication of date palm by tissue culture and assessment of the behavior of generated plants in the field.

By the year 2000, date palm production in Syria was facing serious problems such as low yields due to the lack of research and the spread of pests and diseases. Expanding Syrian date palm cultivation requires financial support for farmers who are cultivating the tree, providing support for the success of cultivation especially by providing free or low-priced offshoots (Shubat 2012). The current status of date palm cultivation in Syria could be improved. There are extensive marginal lands in the priority areas Nos. 4 and 5 (Fig. 12.1) of date palm that are not exploited for date palm plantations due to a shortage of water. When expanding the cultivation of date palm, the Ministry of Agriculture should concentrate on agricultural assistance through the existing extension departments in the targeted regions, to provide good offshoots, and to develop mechanical methods of pollination (Shubat 2012). The date palm tissue culture system should be well established via somatic embryogenesis and organogenesis. The main processes to date cultivation such as propagation, offshoot planting, irrigation, fertilization, integrated pest control, pruning, pollination, fruit thinning, and harvesting techniques need to be improved (El-Juhany 2010). Suggestions raised by El-Juhany (2010) for rehabilitation of this sector are to mechanize the cultivation processes, organize training programs and workshops for the workers and farmers on all cultivation processes of date palm trees, and establish model date palm orchards and databases for date cultivation information.

There are no limitations for morphological characterization of date palm in Syria due to availability of local experts and equipment. Employment of molecular markers for genetic diversity of date palm cultivars in Syria began with the study by Haider et al. (2012). Although the RAPD and ISSR markers generated by the authors proved efficient to determine the genetic relationships in date palms grown in Syria, they were not sufficient for their full discrimination. For DNA-fingerprinting

of date palm cultivars cultivated in the country, research is currently in progress in laboratories of AECS to employ Elmeer et al. (2011) SSR primers that proved useful for assessment of genetic diversity in date palm.

The manual harvest of the fruits increases cost and incurs significant harvest loss. High postharvest losses are due to fermentation, insect infestation, birds, and mechanical damage. The following recommendations (as communicated personally with Mr. Munzer Al-Baba, Head of Date Palm Department, Ministry of Agriculture) will help develop date palm cultivation in Syria:

(a) Resuming research and experiments to define the ideal fertilizer and irrigation water requirements for each cultivar according to the geographical location, growth, and production phase. In addition, to study the metaxenia effect of selected males on the different lines and cultivars in order to identify pollinizers of known identity and characters, as well as to develop cultivar-specific molecular markers for accurate and reliable identification purposes.
(b) Developing environmentally and economically sustainable IPM programs and improvement of postharvest operations such as storage and artificial ripening of fruits for late season-ripening dates.
(c) Mechanization of services provided to date palm cultivation and production.
(d) Development of salinity-tolerant cultivars from selected local lines because the water of the majority of wells and soils in Palmyra and Tanf is highly saline. It is worth noting that there are at the moment in the Palmyra date palm propagation center three lines which were selected and characterized for their tolerance to high salinity (about 12–14 g/l).
(e) Encouraging establishment of small or home-based units for manufacturing date palm products other than the fruits such as leaves (e.g., hats, purses, and trays) and seeds (e.g., beverage, eyeliner, and animal feed).

References

Afif A (2006) The red palm weevil destroys date palm trees in the coastal region. Who is the responsible and how it entered? Teshreen Newspaper (in Arabic). http://91.144.8.68/tishreen/public/read/60449

Agriculture World, Egyptian Agriculture Net (2012) Syria is conducting experiments for date palm propagation in Raqqa to localize date palm cultivation and production of offshoots that are adapted to the region environment (in Arabic). http://www.agricultureegypt.com/NewsDetails.aspx?CatID=cf068128-c380-42dc-b634-ccbcdc6b3cc0&ID=869bd71c-8fb8-4e11-96f6-b0b043390fd6#.UcK8u9iphLQ

Al Kaabi HH, Zaid A, Shephard H, Ainsworth C (2007) AFLP variation in tissue culture-derived date palm (*Phoenix dactylifera* L.) plants. Acta Hort 736:135–159

Al Maalouf F (2012) Expansion of date palm oases and 35 % of the area of Syria is suitable. Al Thawra Newspaper, Syria. http://thawra.alwehda.gov.sy/_print_veiw.asp?FileName=26232180820120421220951

Al-Admeh F, Al-Tawil MW, Al-Bashir M (2006) The structure of scientific research and its primary institutions and their trends: the reality and development requirements. National Conference on Scientific Research and Technical Development, Syria (in Arabic). www.hcsr.gov.sy

Al-Baba M (2000) Date palm tree. http://www.reefnet.gov.sy/reef/index.php?option=com_content&view=article&id=361:2008-06-18-10-27-03&catid=49:farms&Itemid=150

Al-Baba M (2009) A dialogue with the head of date palm department in the Ministry of Agriculture: date palm tree has economic benefits and it lives in harsh environmental condition. Al Orobah Newspaper, Homs, Syria (in Arabic). http://ouruba.alwehda.gov.sy/_print_veiw.asp?FileName=6058266252009061422451O

Al-Baba M (2011) The current status of date palm cultivation and dates production in Syrian Arab Republic (in Arabic). http://abudhabienv.ae/?p=4308

Al-Baba M, Qadmani MA, Ziyada S et al (2013) Atlas of date palm in Syria. The Ministry of Agriculture and Agrarian Reform and ACSAD, Damascus

Al-Bakr A (1972) The date palm. Its past and present status. Alani Press, Baghdad

Al-Kamour B (2006) Date palm propagation center in Al-Jalaa town is the first unit for collecting date palm cultivars in Syria (in Arabic). Al-Furat Newspaper, Deir Al-Zour. http://furat.alwehda.gov.sy/_archive.asp?FileName=16952239420060322150536

Alkhateeb AA (2008) The problems facing the use of tissue culture technique in date palm (*Phoenix dactylifera* L.) – a review. Sci J King Faisal Univ (Basic Appl Sci) 9(2):85–102

Al-Khayri JM, Al-Maarri KW (1997) Effect of seasonal variation on the regeneration capacity of date palm. In Vitro 33(3):22–26

Al-Maarri KW (1995) Date palm propagation through tissue culture technique. Photographic typesetting Foundation (Dibs), Damascus (in Arabic)

Al-Shreed F, Al-Jamal M, Al-Abbad A et al (2012) A study on the export of Saudi Arabian dates in the global markets. J Dev Agric Econ 4(9):268–274

Al-Wehda (2007) The branch of the General Organization for Seed Multiplication in Latakia. Duties, productivity and marketing. What about it. Latakia. http://wehda.alwehda.gov.sy/_archive.asp?FileName=56437005320071028122635

Amin T (2001) In-vitro propagation of date palm by formation adventive buds. In: Proceedings of the second international conference on date palms, Al-Ain, pp 568–587

Bornet B, Branchard M (2001) Nonanchored inter simple sequence repeat (ISSR) markers: reproducible and specific tools for genome fingerprinting. Plant Mol Biol Rep 19:209–215

El Hadrami A, Daayf F, Elshibli S et al (2011) Somaclonal variation in date palm. In: Jain SM, Al-Khayri JM, Johnson DV (eds) Date palm biotechnology. Springer, Dordrecht, pp 183–203

Electronic Economic Newspaper (2007) Invitations to benefit from date palm residues for wood industries (in Arabic). http://www.aleqt.com/2007/08/21/article_105232.html

Elhoumaizi MA, Saaidi M, Oihabi A, Cilas C (2002) Phenotypic diversity of date-palm cultivars (*Phoenix dactylifera* L.) from Morocco. Genet Res Crop Evol 49(5):483–490

El-Juhany L (2010) Degradation of date palm trees and date production in Arab countries: causes and potential rehabilitation. Austr J Basic Appl Sci 4(8):3998–4010

Elmeer K, Sarwath H, Malek J et al (2011) New microsatellite markers for assessment of genetic diversity in date palm (*Phoenix dactylifera* L.). 3 Biotech 1(2):91–97

El-Melegi M (2010) Bayoud disease in date palm. Plant health. http://www.meleigi.com/news.php?action=view&id=147

Eshraghi P, Zarghami R, Ofoghi H (2005) Genetic stability of micropropagated plantlets in date palm. J Sci Islam Rep Iran 16(4):311–315

GCSAR (2012) The annual report of the General Commission for Scientific Agricultural Research for 2011 (in Arabic). http://www.gcsar.gov.sy/gcsarAR/spip.php?rubrique70

Grant BL. Date palm tree care: tips on how to grow date trees. http://www.gardeningknowhow.com/edible/fruits/date/date-palm-tree-care.htm

Haider N, Nabulsi I, MirAli N (2012) Phylogenetic relationships among date palm (*Phoenix dactylifera* L.) cultivars in Syria using RAPD and ISSR markers. J Plant Biol Res 1(2):12–24

Haider N, Nabulsi I, MirAli N, Al-Baba M (2009) Morphological and molecular characterization of Syrian date palm varieties (native and introduced) (in Arabic). AECS-B\RSS 858

Hakkar F (2012) Cultivation and multiplication of date palm in Raqqa. New scientific research and experiments bodes new production. http://thawra.alwehda.gov.sy/_print_veiw.asp?FileName=3141138412012081421145I

Ibraheem YM, Pinker I, Böhme M (2009) Propagation of date palm (*Phoenix dactylifera* L.) varieties in vitro by using zygotic embryos and leaflet segments. BHGL – Tagungsband 26, S. 91, http://www.dgg-online.org/tagungsbaende/Tagungsband_45_2009.pdf

Ibraheem YM, Pinker I, Böhme M (2010a) Optimizing of date palm (*Phoenix dactylifera* L.) rooting protocol in vitro for cv. Deglet Nour and cv. Asabe El-Arous. BHGL – Tagungsband 27, S. 85. http://www.dgg-online.org/tagungsbaende/Tagungsband_46_2010.pdf

Ibraheem YM, Pinker I, Böhme M (2010b) Somatic embryogenesis approach for shoot tips of 'Zaghlool'. Acta Hort 882:883–890

Ibraheem YM, Pinker I, Böhme M (2012a) The effect of sodium chloride-stress on 'Zaghlool' somatic embryogenesis. Acta Hort 961:367–374

Ibraheem YM, Pinker I, Böhme M, Al-Hussin Z (2012b) Screening of some *Phoenix dactylifera* cultivars to salt stress in vitro. Acta Hort 961:359–366

Ibraheem Y, Pinker I, Böhme M (2013) A comparative study between solid and liquid cultures relative to callus growth and somatic embryo formation in *Phoenix dactylifera* L. cv. Zaghlool. Emir J Food Agric 25(11). http://ejfa.info/index.php/ejfa/article/view/16661

Jain SM (2012) *In vitro* mutagenesis for improving date palm (*Phoenix dactylifera* L.). Emir J Food Agric 24(5):400–407

Jaradat AA (2011) Biodiversity of date palm. Land use, land cover and soil sciences. Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford. Available: http://www.eolss.net [1 Apr 2013]. http://afrsweb.usda.gov/SP2UserFiles/Place/36450000/Products-Reprints/2011/1579.pdf

Kaakeh N. Preliminary biological studies on some date-palm insects in Syria. www.pubhort.org/datepalm/datepalm1/datepalm1_22.pdf

Kader AA, Hussein AM (2009) Harvesting and postharvest handling of dates. ICARDA, Aleppo

Kaeppler SM, Kaeppler HF, Rhee Y (2000) Epigenetic aspects of somaclonal variation in plants. Plant Mol Biol 43:179–188

Krueger RR (1998) Date palm germplasm: overview and utilization in the USA. In: Proceedings of the first international conference on date palms, Al-Ain, pp 1–37

Krueger RR (2011) Date palm germplasm. In: Jain SM, Al-Khayri JM, Johnson DV (eds) Date palm biotechnology. Springer, Dordrecht, pp 313–336

Mahmoudi H, Hosseininia G, Azadi H et al (2008) Enhancing date palm processing, marketing and pest control through organic culture. J Org Syst 3(2):29–39

Margara J (1984) Bases de la multiplication vegetative. Les meristemes et lorganogense. I.N.R.A, Paris

Munshi A, Osman G (2010) Investigation on molecular phylogeny of some date palm (*Phoenix dactylifra* L.) cultivars by protein, RAPD and ISSR markers in Saudi Arabia. Austr J Crop Sci 4(1):23–28

Nixon RW, Furr JR (1965) Problems and progress in date breeding. Date Growers Inst Rep 42:2–5

Nizwa.NET Dates. Oman agriculture. http://www.nizwa.net/agr/dates/dates/palm/datepalm3.html

Pal RN. Date palm (*Phoenix dactylifera*). http://www.fruitipedia.com/Date%20Palm.htm

Pinker I, Ibraheem YM, Böhme MH (2009) Propagation of some date palm cultivars by using tissue culture methods. Acta Hort 839:71–77

Popenoe P (1973) The date palm. Field Research Projects, Miami

UN Press Release (2004) Global date palm production at risk due to pests, diseases. SAG/276, FAO, Rome. http://www.un.org/News/Press/docs/2004/sag276.doc.htm

Qatana H. Date palm. Arab Encyclopedia. p 535 (in Arabic). http://www.arab-ency.com/index.php?module=pnEncyclopedia&func=display_term&id=1653

Saker MM, Adawy SS, Mohamed AA, El-Itriby HA (2006) Monitoring of cultivar identity in tissue culture-derived date palms using RAPD and AFLP analysis. Biol Plant 50(2):198–204

Sana (2012) Homs province, date palm oasis in Badia of Homs within the plan of development of the Syrian Badia during the current year. Sana Newspaper (in Arabic). http://sana.sy/ara/346/2012/01/09/393275.htm

Serra G, Nahaz MM, Idan M, et al. (2009) Assessment and characterization of the ibis protected area in the Palmyra desert: a proposed 5-year management and development framework. http://www.gianlucaserra.com/IPA_Assessment_2009.pdf

Shibli S (2008) A complete course on date palm (in Arabic). http://www.alkherat.com/vb/showthread.php?6579-%CF%E6%D1%C9-%E3%CA%DF%C7%E3%E1%C9-%CD%E6%E1-%C7%E1%E4%CE%ED%E1-%E3%DD%ED%CF%C9-%CC%CF%C7%F0

Shubat A (2012) The environmental belt can accommodate five million trees but the cultivated are only 500 thousands! Teshreen Newspaper (in Arabic). http://tishreen.news.sy/tishreen/public/read/258450

Swingle WT (1928) Metaxenia in the date palm, possibly hormone action by the embryo or endosperm. J Hered 19:257–268

Syrianews (2009) Steps the Ministry of Agriculture is taking to control the red palm weevil (in Arabic). http://www.syriandays.com/index.php?page=show_det&id=12817

Teshreen Newspaper (2005) Preparation of 11 thousands date palm offshoots to plant them and a plan for developing date palm cultivation (in Arabic). http://www.tishreen.news.sy/tishreen/public/read/36050

UAE University (2005) Date Palm Tissue Culture Laboratory (DPTCL). http://datepalm.uaeu.ac.ae/subpages/Laboratory.html

Zabar AF, Borowy A (2012) Cultivation of date palm in Iraq. Ann Univ Mariae Curie Sklodowska 22(1):39–54

Zaid A, de Wet PF (2002a) Chapter V: date palm propagation. In: Zaid A (ed) Date palm cultivation. FAO plant production and protection paper, vol 156. Rev. 1, Rome. http://www.fao.org/docrep/006/y4360e/y4360e09.htm

Zaid A, de Wet PF (2002b) Chapter IV: climatic requirements of date palm. In: Zaid A (ed) Date palm cultivation. FAO plant production and protection paper, vol 156. Rev. 1, Rome. http://www.fao.org/docrep/006/y4360e/y4360e09.htm