Chapter 9
Date Palm Status and Perspective in Kuwait

Chellan Sudhersan, Jibi Sudhersan, Jawad Ashkanani, and Lateefa Al-Sabah

Abstract Date palm (*Phoenix dactylifera* L.) has been one of the major agricultural crops of Kuwait for over 90 years; however, large-scale cultivation began only 25 years ago. The Kuwait Institute for Scientific Research (KISR), Public Authority for Agriculture and Fish Resources (PAAFR), and Kuwait University are currently involved in date palm research in Kuwait. Traditional propagation methods by seed and offshoot were practiced initially for cultivation. Tissue culture propagation was developed at KISR in 1995 and the technology used for commercial-scale clonal plant production since 2000. Research activities including date palm cultivar introduction and evaluation, cultivation practices, irrigation and fertilization, pest and disease management, fruit production and postharvest technology, and germplasm maintenance were carried out. Major date palm biotechnological research also is being undertaken. Germplasm maintenance, micropropagation of elite cultivars for farmers, cultivar identification through DNA technology, pest and disease management, crop improvement, irrigation technology improvement, and biodiversity conservation of date palm are in practice. Approximately 601,563 trees are planted in 4,181 registered farms located in the Abdhally, Wafra, and Sulaibia regions of Kuwait. Six major cultivars are used for fruit production with Barhi ranking first in the number of trees. Current annual date production is about 45,000 mt. Monoculture is spreading in Kuwait posing a threat to date palm diversity. A national date palm award was developed by KISR to encourage farmers to diversify planted cultivars.

Keywords Biodiversity • Conservation • Cultivation • Date palm • KISR micropropagation • PAAFR

C. Sudhersan (✉) • J. Sudhersan • J. Ashkanani • L. Al-Sabah
Biotechnology Program, Environment and Life Sciences Research Center Kuwait Institute for Scientific Research, Box 24885, Safat 13109, Kuwait
e-mail: schellan@kisr.edu.kw; sjibi@kisr.edu.kw; neenmod@yahoo.com; lsabah@kisr.edu.kw

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9.1 Introduction

In Kuwait, date palm (*Phoenix dactylifera* L.) was introduced from neighboring countries about 90 years ago. The first known introduced cultivar, Braim (Fig. 9.1), was planted in Kuwait in 1920 and is still alive. The ancient peoples of Kuwait had knowledge of date palm cultivation; however, the delay in cultivation was due to the lack of irrigation water. In ancient times, pearl fishing was the major source of income for Kuwaiti families. When pearl fishing declined after 1950, date palm cultivation was initiated for income generation and livelihood. Since 1810, 45 Kuwaiti families have owned date palm farms in Basra, Iraq, with a total area of 46,632 ha planted with 1,865,000 date palm trees (Al-Nisf 2010).

Date palm is given priority in the agriculture system, greenery, and landscape programs in Kuwait due to its high level of tolerance to the harsh arid environment and elevated soil salinity. Date palm is cultivated mainly in the Wafra, Abdhally, and Sulaibia agricultural areas. In addition, it is also grown on farms at Al-Jahra, in residential areas, and along beaches and roadsides all over Kuwait for its fruits and ornamental value (Fig. 9.2). Date palms are the main fruit crop in Kuwait, and about 601,563 date palm trees are planted on 4,181 registered farms (information from PAAFR in 2014). Of the total number of date palms, 386,273 belong to six major cultivars, namely, Barhi, Khalas, Medjool, Nebut Seif, Suckari, and Um Al-Dehn, for fruit production (PAAFR 2003). However, a total of 40 cultivars are reported growing throughout Kuwait (Al-Mudaires 1992).

Due to the recent expansion for commercial production, annual date fruit production in Kuwait has increased from 7,894 mt in 1999 to 15,610 mt in 2003 and 45,000 mt in 2012 (FAO 2013). The date fruit production increase was mainly due to the plantations recently established with micropropagated palms. The unavailability

Fig. 9.1 Date palm cultivar Braim

Fig. 9.2 Kuwait map

of good quality date palm planting material to establish commercial plantations in Kuwait was the major constraint on date fruit production a decade ago, but the problem was solved through developing micropropagation technology. The current annual date production of 45,000 mt. is insufficient to meet domestic demand. Therefore, date fruits are imported, mainly from Saudi Arabia.

Currently, the date cultivation and fruit production in Kuwait is affected mainly by soil salinity, insufficient fresh irrigation water, climate change, pests and diseases, high cost of production, lack of trained manpower for appropriate cultivation practices, and poor postharvest technology.

9.2 Cultivation Practices

Kuwait is a desert country with a harsh and prolonged summer season extending from April to October. The average monthly temperature in summer is 46.2 °C, whereas the winter is mild with an average monthly temperature of 6.9 °C. Rainfall is highly erratic, averaging about 110 mm/yr. Strong winds prevail during the

Fig. 9.3 Date palm tissue culture laboratory at KISR

summer months (MOP 2006). Date palms occupy a unique place in the agriculture systems in Kuwaiti farms and greenery programs due to their high tolerance to adverse climatic conditions. The palm is cultivated extensively in Kuwait for fruit production and ornamental value. Commercial date palm plantations have recently begun to emerge in Kuwait. A 1987 survey in Kuwait indicated that there were about 275,000 date palms, with about 56 % being located in home gardens, 34 % on farms, 1 % at beach houses, and 9 % in public parks. Of the total, only 40 % were at the fruit production stage, and the remaining 60 % were at young growth stages. The total annual production in 1987 was 1,500 mt. A major constraint on commercial plantations was the lack of good quality planting materials on a large scale. A few local nurseries imported tissue culture-derived date palms from the UK and France; the majority of the imports were Barhi cv. Other cvs. such as Khalas, Medjool, Nebut Seif, and Suckari were imported in small quantities. Commercial plantations using tissue culture-derived plants began in 1995 after the Gulf War. In order to overcome the shortage in commercial cultivars for production, KISR gave priority to research and development of micropropagation technology development.

A research project on tissue culture technology development for the micropropagation of date palms was conducted in 1990–1995 at the KISR Biotechnology Department. Followed by the successful completion of this project, a tissue culture facility with laboratories, growth rooms, hardening rooms, greenhouses, and lath houses was established at the KISR main campus at Shuwaikh in 1995 (Fig. 9.3).

Intensive research and development studies on micropropagation of many date cultivars were carried out on a pilot scale in the newly developed tissue culture facility in 1996–2004. A unique culture media and protocol were developed for the

Fig. 9.4 Ten-year-old tissue-cultured date palm plantation

commercial production of clonal plantlets through somatic embryogenesis. A total of 30 cvs. (in alphabetical order), Al-Hammed, Al-Heifi, Anbarah, Ashgar, Awaidi, Barhi, Boyer, Braim, Dayri, Fard, Fersi, Garvis, Ghannamy, Hilali, Jouzi, Khalas, Khasab, Khyarah, Lolwi, Maktoomi, Medjool, Nebut Seif, Quantar, Shekar, Shiek Ali, Shishi, Siwi, Suckari, Sultana, and Um Al-Dehn, were produced via the KISR-owned micropropagation method and all cvs. maintained in two date palm orchards located on the KISR campus at Shuwaikh. All the cultivars produced by KISR were proven to be true to type through DNA fingerprinting and field evaluation (Al-Shayji et al. 1994; Sudhersan and AboEl-Nil 2004). After the pilot-scale plant production study, five major commercial cultivars, Barhi, Khalas, Medjool, Nebut Seif, and Suckari, were multiplied on a large scale and supplied to the farmers for the establishment of commercial plantations. Many plantations established in 2000–2005 with KISR tissue-cultured date palms are in production without exhibiting any genetic malformations (Fig. 9.4). Currently, KISR is capable of commercial-level clonal plant production of any date cultivar for the farmers in Kuwait or neighboring Gulf Cooperation Council (GCC) countries on a contract basis.

Large-scale cultivation of date palms started recently in Kuwait and is identified as a priority crop for commercial production in the Agriculture Master Plan of Kuwait (KISR 1995). The government is encouraging farmers to plant selected commercial cultivars by offering subsidies. Date palm farms are located at Wafra, Abdhally, and Sulaibia regions; there were 2,065 registered farms in Wafra, 1,990 in Abdhally, and 126 in the Sulaibia areas. Currently, about 601,563 date palms are growing in Kuwait (Personnel Communication from PAAFR 2014). Of the total

Table 9.1 The number of date palms in Kuwait

Cultivar	Total no. of trees
Barhi	318,785
Khalas	48,906
Suckari	10,929
Medjool	4,598
Nebut Seif	1,841
Um Al-Dehn	1,214
Other cvs.	194,714
Males	20,576

Table 9.2 Area of date palm cultivation and annual production in Kuwait in 1998–2011

Year	Area (ha)	Production (mt)
2011	5,099	33,562
2010	5,090	32,561
2009	4,665	29,849
2008	3,800	16,000
2007	3,200	16,000
2006	2,200	16,000
2005	2,000	16,000
2004	1,450	15,811
2003	1,350	12,577
2002	1,350	10,376
2001	1,350	10,155
2000	1,350	7,894
1999	1,050	6,484
1998	870	6,662

number of date palms, the majority are Barhi, followed by Suckari, Khalas, Medjool, Nebut Seif, and Um Al-Dehn (Table 9.1).

Cultivation area and annual production have increased gradually in Kuwait (Table 9.2, Figs. 9.5 and 9.6). The area under cultivation increased from 870 ha in 1998 to 5,099 ha in 2011, and annual production increased gradually from 6,662 mt in 1998 to 33,562 the same year (FAO 2013).

One of the major constraints to expanding date production in Kuwait was the lack of good quality planting materials of commercial cultivars. This problem was solved through the development of micropropagation technology for commercial production. Other constraints yet to be resolved are pest and disease management, soil salinity, insufficient fresh irrigation water, lack of modern postharvest technology, and trained manpower for cultivation (Abdul-Salam and Al-Mazrooei 2007).

Under Kuwait's climatic conditions, among 30 different cultivars tested at the KISR date orchard, Barhi, Medjool, Anbarah, Awaidi, Hilali, Khasab, and Siwi cvs. were found to be the highest yielding. Among them, Barhi ranked first and is well suited to Kuwait as compared to other cultivars. This cultivar has good economic

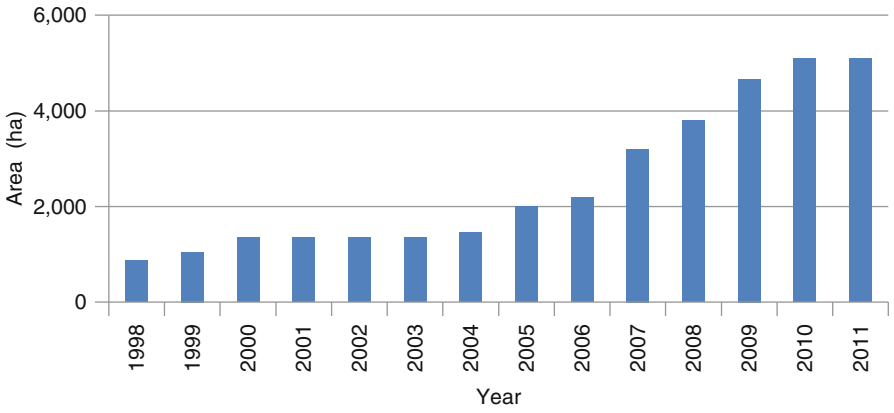

Fig. 9.5 Area of date palm cultivation in Kuwait in 1998–2011

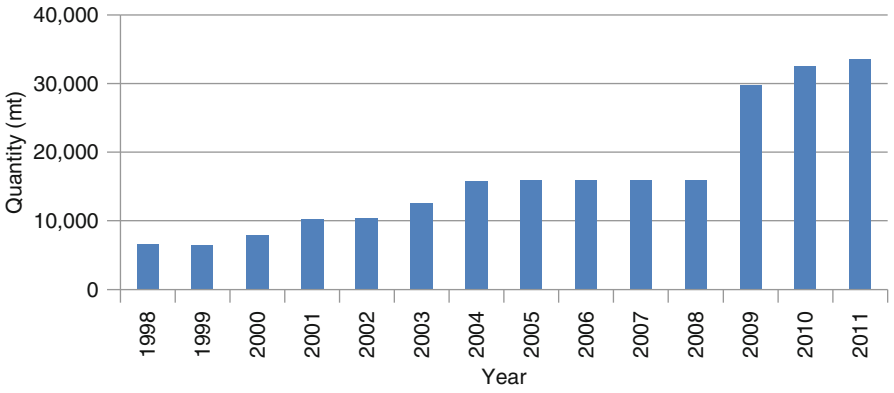

Fig. 9.6 Annual date fruit production in Kuwait in 1998–2011

returns when appropriate good management procedures are adopted and produces an average of 200 kg of fruit annually. However, such good yields cannot be achieved without proper pollination, pruning, irrigation, and fertilization.

Under Kuwait's harsh climatic conditions, potential evapotranspiration (ET_p) far exceeds annual precipitation. Soils are fragile, sandy with organic matter content below 0.1 % and low moisture and nutrient-holding capacities. Therefore, farmers must apply supplementary irrigation for crop production. The irrigation systems used for the date palms are flood (Fig. 9.7), bubbler, and drip irrigation. Although date palm cultivation is a viable agricultural option for Kuwait, current irrigation practices are very inefficient and unsustainable. Therefore, research studies were conducted to calculate the actual water requirements for date palms in Kuwait. The results of the study based on the annual evapotranspiration showed that the annual water requirement of date palms under Kuwait's environmental conditions ranged from 23,392 to 27,251 m^3/ha/y (Abdul-Salam and Al-Mazrooei 2007; Bhat et al. 2011).

Fig. 9.7 Intercropping with fodder crops under flood irrigation

Pruning of date palms is practiced throughout Kuwait and is the most important operation that is carried out regularly. Pruning removes old dead or broken leaves and areal shoots, locally known as *rakoob*. Two types of tools are used: a sickle which is a saw-toothed curved blade used to cut leaf bases and a slanting curved cutting blade with a slight outcurve attached to a wooden handle. The objective of pruning is to clean the tree, allow new leaves to grow and photosynthesize, reduce any rodent or insect infestations, facilitate harvesting, permit the use of leaves as a by-product material and utilize leaf-base fiber, and improve crop quality by reducing shade and avoid bruising of fruits. Thorns are also removed for pollination, bunch thinning, and fruit harvesting operations.

Several operations are performed after pollination and fruit set. These include thinning of heavily laden trees by the removal of unwanted bunches entirely or by bunch thinning, release of bunches from the tree crown, and protection from birds and rodents.

Fruit bunch thinning is commonly practiced in most date-growing regions of Kuwait in order to avoid alternative in fruit bearing and to enhance the fruit quality. Date fruit thinning is carried out by three ways: (a) reducing the number of bunches, (b) reducing the number of strands, and (c) reducing the number of fruits per strands. The common practice of fruit thinning is the removal of whole bunches followed by trimming the central strand of each allowed bunches using a sharp knife to reduce 30 % of the total number of strands. The number of bunches per tree is decided according to the age of the tree: 2–5 during 4–8 years old and 8–10 bunches above 10 years old.

Bunch hanging comes after the date fruits have developed but before the ripening. Three weeks after pollination, the fruit bunches are pulled under the lower leaves and tied to a leaf rachis with a rope or palm leaflets. The main purpose of bunch hanging is to protect the dates from being scratched or bruised by thorns or leaflets during windy conditions, to reduce fruit drop, and to facilitate harvesting.

Date palm yield depends on successful pollination. Male cv. Ghannamy is well known to Kuwaiti farmers, and the majority of farmers use its pollen on all types of cultivars. In addition, unknown seedling males are also used for pollination. Research studies are ongoing at KISR to identify superior male cultivars for specific female date palm cultivars to achieve high-quality date fruit production. Known male cultivars such as Boyer, Dayri, Fard, Ghannamy, Garvis, and a new male KW-1 were selected for the pollination study which involved Barhi, Khalas, Medjool, Nebut Seif, and Suckari cvs. Studies on the use of pollen of other *Phoenix* species (*P. pusilla* and *P. sylvestris*) are also being included in the selection of cultivar-specific superior males.

Although date palms are naturally pollinated by wind, it is not an effective method for maximum yield in cultivated orchards, especially since the groves are composed of predominantly female trees. One male is enough to pollinate 25–30 female palm trees. Therefore, it is recommended to grow one male for 25 female palms in Kuwait.

Date palm pollination is done artificially, either by hand or by mechanical means. As not all female flowers are produced at the same time, pollination of each inflorescence is repeated two or three times for better yield. Pollination starts with collecting male flower bunches. Most male and female trees normally flower during the period of late February to early April. Male inflorescences are collected within a few hours of the sheath splitting open, to prevent pollen loss, and then stored in a cool place. Early-appearing inflorescences are cut and hung upside down in a cool, dry airy area until needed, to prevent mold attack on the pollen. Pollen is collected as it is shed from the hanging inflorescences or extracted mechanically. Male flowers or the extracted pollens are used for pollination. Four types of pollination practices are used: traditional hand pollination by flower spikes, hand pollination by cotton puff, hand pollination with atomizers, and fully mechanized pollination. The first two methods are generally used in Kuwait.

On most farms, fruit quality has not reached international standards. Poor quality fruit is linked to several factors such as improper pollination, poor pollen quality, frequent dust deposition, spider mites and other insect pests, diseases, and finally lack of trained manpower to handle the fruit production procedures properly. Research studies at KISR proved that pollen affects the quality fruit production. Pollen from *Phoenix pusilla* produced seedless fruits in Medjool and Sultana cvs. (Sudhersan et al. 2008, 2010). Further studies to identify superior male palms specific to high-quality date cvs. such as Barhi, Khalas, Medjool, Nebut Seif, and Suckari and pollen from other related species *P. pusilla* and *P. sylvestris* are being carried out at KISR.

Intercropping is a common practice (Fig. 9.7) in Kuwait to make the best use of the date palm farm. Fodder crops such as Rhodes grass, alfalfa, and fruits such as citrus, fig, olive, and pomegranate are intercropped between rows and under date

palms. The main objectives of intercropping are to produce other fruits which cannot survive on their own due to extreme temperatures if fully exposed, to generate additional income for farmers throughout the year, to grow fodder crops for livestock, and also to improve the soil nutrient and physical properties (Sudhersan 2013).

9.3 Genetic Resources and Conservation

Date palm is one of the pillars of sustainable agricultural development in Kuwait and plays a role in building and energizing agricultural production capabilities as well as related industries. There are about 40 date palm cultivars reportedly grown in Kuwait (Table 9.3). Although many date palm cultivars are available in Kuwait, date palm diversity is facing a threat due to: cloning and monoculture practices for high yield, new pests and diseases, introduced invasive exotic plant species, modern agricultural practices and techniques, climate change, desertification, and high salinity stress.

Date palm farmers practice de facto conservation and enhancement of date palm genetic diversity by maintaining and multiplying traditional varieties and conscious selection of clones for their various unique plant and fruit traits. However, a complex of interacting factors, mainly consumer preference and market forces, are negatively impacting maintenance of diversity and varietal composition of date palm groves.

Growing a single cultivar on a large scale is termed *monoculture*. Date palm monoculture of elite cultivars certainly enhances crop production. However, this practice will squeeze out the other well-known traditional cultivars and ultimately reduce date palm diversity. Date palm genetic resources are invaluable for present and future generations, providing food security, environmental sustainability, and economic stability. A wide range of genetic variation is needed within the date palm population to help them adapt to changing climate and related biotic factors.

Diversity is the basis of adaptation and is needed to meet the unpredictable environmental changes, including climate change. It is possible to select from diversity but not from uniformity. Therefore, an integrated system based on dynamic ex situ and in situ conservation is necessary for the maintenance and enhancement of date palm diversity to meet future biotic and abiotic challenges. Propagation and cultivation of only a few cultivars on a large scale for economic production is highly dangerous. Date palm cultivar diversification is necessary to guard against potential disease threats and habitat loss.

Kuwaiti date growers need encouragement to develop new cultivars and diversify existing genetic resources. To encourage Kuwaiti date growers toward cultivar diversification and germplasm maintenance, KISR has established a national date palm award for the producer of the best new local date palm variety. The new variety will be multiplied by tissue culture at KISR and 1,000 plants given to the owner as

Table 9.3 Date palm cultivars available in Kuwait

Cultivar	Maturity	Flesh texture	Quality	Origin
Abo Yousef	Middle	Soft	Excellent	Kuwait
Anbarah	Middle	Soft	Excellent	Saudi Arabia
Ashgar	Early	Soft	Excellent	Iraq
Asleyah	Middle	Soft	Good	Saudi Arabia
Awaidi	Early	Soft	Very good	Iraq
Barhi	Middle	Soft	Excellent	Iraq
Blyani	Early	Soft	Acceptable	Iraq
Bobaki	Middle	Semidry	Good	Iraq
Braim	Early	Soft	Excellent	Iraq
Dayri	Middle	Soft	Acceptable	Iraq
Esteraki	Middle	Soft	Excellent	Kuwait
Fersi	Middle	Semidry	Good	Iraq
Hadlah	Middle	Soft	Acceptable	Iraq
Halawi	Early	Semidry	Good	Iraq
Hasawi	Early	Soft	Excellent	Iraq
Hayany	Early	Soft	Acceptable	Egypt
Hilali	Late	Soft	Good	Iraq
Hulwa	Middle	Semidry	Acceptable	Saudi Arabia
Jouzi	Middle	Semidry	Acceptable	Iraq
Khadrawi	Middle	Soft	Good	Iraq
Khasab	Late	Soft	Good	Iraq
Khalas	Middle	Soft	Excellent	Saudi Arabia
Khyarah	Middle	Soft	Excellent	Iraq
Lolwi	Late	Soft	Acceptable	Iraq
Maktoomi	Late	Soft	Excellent	Iraq
Medjool	Middle	Semidry	Excellent	Morocco
Nebut Seif	Middle	Soft	Excellent	Saudi Arabia
Qantar	Early	Soft	Good	Iraq
Ruthana	Middle	Soft	Very good	Saudi Arabia
Sayer	Early	Soft	Acceptable	Saudi Arabia
Sherani	Middle	Semidry	Good	Iraq
Sherawi	Middle	Soft	Good	Iraq
Shishi	Middle	Soft	Good	Saudi Arabia
Shwathe	Late	Soft	Good	Iraq
Silaj	Middle	Soft	Good	Saudi Arabia
Suckari	Middle	Semidry	Excellent	Saudi Arabia
Um Al-Dehn	Late	Soft	Excellent	Iraq
Wannana	Middle	Dry	Acceptable	Saudi Arabia
Zaghloul	Middle	Soft	Good	Egypt
Zahdi	Late	Semidry	Acceptable	Iraq

a gift for further production. Every 2 years, new good quality cultivars will be identified through this award process and added to the KISR date palm germplasm collection bank.

9.3.1 Germplasm Conservation

KISR maintains a date palm germplasm collection bank on the main campus at Shuwaikh. Currently the collection holds 34 female date palm cultivars Ajwa, Al-Hammed, Al-Heifi, Al-Shamy, Anbarah, Ashgar, Awaidi, Barhi, Braim, Deglet Noor, Fersi, Hilali, Jouzi, Khalas, Khasab, Khyarah, KF-1, KF-2, KFH-1, Lolwi, Maktoomi, Medjool, Nebut Seif, Qantar, Samaran, Shekar, Shiek Ali, Shishi, Sigai, Siwi, Suckari, Sultana, Um Al-Dehn, and Wannana and 6 male cultivars Boyer, Dayri, Fard, Garvis, Ghannamy, and KM-1. A new date palm gene bank has been proposed for the KISR research station at Kebad in 2015 to accommodate a greater number of cultivars. Among the total of 40 female and male cultivars, Al-Shamy, Al-Heifi, KF-1, KF-2, KFH-1, and KM-1 are new Kuwaiti cultivars; the others were introduced from neighboring countries.

9.3.2 Germplasm Utilization

Research studies are being carried out by the KISR Biotechnology Program to develop salt-tolerant date palm cultivars through plant cell and tissue culture methods. A few salt-tolerant cultivars have been selected and are being grown experimentally in a salt-affected area. Trials are also being undertaken at KISR to develop new hybrid date palms for the improvement of fruit quality and also to reduce the tree height, which is a major contributor to the high cost of production in orchards having dates more than 25 years of age. An interspecific hybridization between date palm (*P. dactylifera*) and a dwarf date palm (*P. pusilla*) was carried out to create a new interspecific hybrid in 2009 through in vitro embryo rescue method (Sudhersan and Al-Shayji 2010). The new hybrid is expected to be a dwarf type, but it will require a few more years to confirm the results. Meanwhile, the hybrid date palm has flowered and produced fruits, which are entirely different from the parents (*P. dactylifera* and *P. pusilla*). Fruit size is smaller than the date palm and much larger than the dwarf date palm. Further studies are progressing toward developing the F2 hybrids for the fruit quality improvement.

9.4 Plant Tissue Culture

Date palm cultivation began in Kuwait in 1950 using offshoots and seedlings. However, large-scale commercial plantations were not established due to insufficient numbers of offshoots of the desired cultivars and the high price for

offshoots. Most of the date palms and offshoots that were imported came from neighboring countries. In the 1990s, tissue-cultured Barhi cv. plantlets were imported from the UK and France for field trials. During the field growth stage of these palms, many physiological disorders were observed creating confusion among growers and researchers about date palm micropropagation in general. In order to reduce the palm importation, to clear up the confusion over the date palm micropropagation methods, and to make a large number of good quality cultivars available to the farmers on a year-round basis at an affordable price for establishing plantations, KISR has conducted research on date palm tissue culture since 1995. Plant tissue culture laboratory and greenhouse facilities were established in the same period.

Through intensive research carried out on various aspects of date palm clonal micropropagation in 1995–2004 at the plant tissue culture center of the Biotechnology Program of KISR, eight different methods of in vitro plant regeneration using different tissue explants from date palm shoot bud were standardized. The culture media, culture protocol, and acclimatization procedures developed at KISR are unique among laboratories worldwide. A common and simple protocol has been developed for many date palm cultivars (Sudhersan et al. 1993a, b, 2011). Thousands of plantlets of 30 cvs. Al-Hammed, Al-Heifi, Anbarah, Ashgar, Barhi, Boyer, Braim, Dayri, Fard, Fersi, Garvis, Ghannamy, Hilali, Jouzi, Khalas, Khasab, Khyarah, Lolwi, Medjool, Maktoomi, Nebut Seif, Awaidi, Quantar, Shekar, Shiek Ali, Shishi, Siwi, Suckari, Sultana, and Um Al-Dehn were produced through the protocols developed at KISR. Ten plants of each cultivar were planted and are being maintained in two date palm orchards on the KISR campus at Shuwaikh. All the cultivars produced by KISR were proven to be true to type through DNA fingerprinting and field evaluation (Al-Shayji et al. 1994; Sudhersan and AboEl-Nil 2004).

All the 25 female and 5 male micropropagated date palm cultivars began flowering after 3 years of field growth. No flowering abnormalities and genetic variations were observed except a few physiological disorders that are also common in traditionally propagated date palms (Al-Shayji and Sudhersan 2009; Sudhersan and AboEl-Nil 1999; Sudhersan and Al-Shayji 2009; Sudhersan et al. 2001). Among the eight different in vitro regeneration possibilities in date palm developed at KISR (Fig. 9.8), direct somatic embryogenesis from the leaf tissue explant was identified as highly economical and feasible. In 2004, the KISR date palm tissue culture laboratory began continuous production of plantlets of cultivars in demand such as Barhi, Khalas, Medjool, and Nebut Seif at the rate of 3,000 plants per month. During the past 5-year period, more than 100,000 tissue culture-derived date palm plantlets were produced and supplied to Kuwaiti growers.

The tissue culture-derived plants supplied to farmers showed uniform growth, early flowering, and high yield (Fig. 9.9). KISR has supplied tissue culture plantlets to more than 500 customers in Kuwait. The date palm tissue culture facility at KISR can produce and acclimatize 100,000 date palm plants at a time; it is the only laboratory in Kuwait for commercial-scale production and has been functioning since 2000.

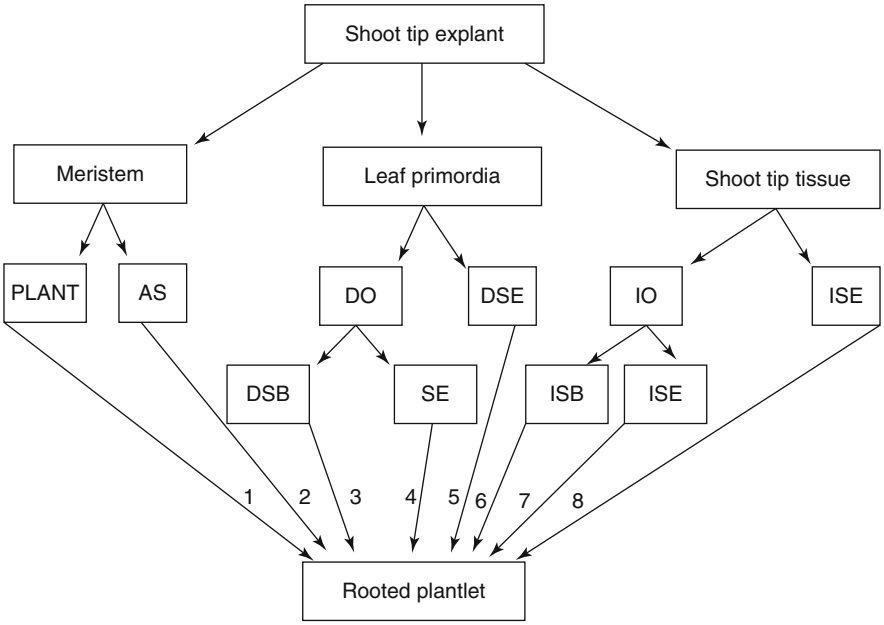

Fig. 9.8 Different regeneration methods of plantlet regeneration in date palm. *AS* axillary shoot, *DO* direct organogenesis, *DSE* direct somatic embryogenesis, *IO* indirect organogenesis, *ISE* indirect somatic embryogenesis, *DSB* direct shoot bud, *SE* somatic embryogenesis, *ISB* indirect shoot bud

Fig. 9.9 Tissue culture-derived date palm plantation of the cv. Nebut Seif

9.5 Cultivar Identification

The date palm holds enormous commercial potential for Kuwait. Date palms are in high demand for fruit production as well as for beautification. Importation alone cannot meet the high demand. Production and propagation of date palms through tissue culture is an alternative that can meet local demand as well as possibly capture a significant portion of the demand in neighboring GCC countries. To gain a market share of this highly profitable business, KISR has initiated a vigorous date palm tissue culture program. An economically successful date culture program is dependent on the ability to identify date cultivars as they are being multiplied. It also depends upon production and marketing elite, true-to-type date palm cultivars. Typed cultivars bring in more revenue than un-typed and allow novel germplasm to be propagated and marketed. The cost to date growers and nurseries can be enormous if errors are made in establishing trueness to type during tissue culture operations.

Traditional typing techniques (based on morphological and biochemical characters) are inefficient, tedious, and unreliable. Therefore, KISR has succeeded in developing true-to-type technology which is a prerequisite to obtain full economic benefits from any commercial date production operation. KISR has developed a rapid and sensitive typing method to correctly identify date palm cultivars.

In recent years, molecular techniques based on DNA assessment have been very successful in typing cultivars of a range of crop plants. At KISR, amplification fragment length polymorphism was revealed by randomly amplified polymorphic DNA (RAPD) and microsatellite or inter-simple sequence repeat (ISSR) assays that were utilized as DNA probes and markers for typing different date palm cultivars. The KISR study revealed that ISSR- and RAPD-based DNA probes were highly sensitive and more effective in revealing polymorphism in date palms. A number of ISSR and RAPD probes and their combinations produced cultivar-specific DNA fingerprints (Fig. 9.10) which allowed the identification and authentication of date palm cultivars. KISR has also developed an in-house procedure for genomic DNA isolation and purification from frozen date leaf material which is an essential prerequisite step for any DNA fingerprinting analysis. The microsatellite ISSR and RAPD fingerprinting technologies require the completion of the following steps: (a) tissue breakage to release the cellular DNA, (b) DNA extraction and purification, (c) DNA characterization and quantification, (d) assemble and optimization of primer amplification reaction, and (e) amplification product analysis.

The DNA fingerprinting technology developed at KISR (Al-Shayji et al. 1994) provides the date palm industry a sensitive and effective genetic marker system to identify, authenticate, and characterize cultivars as well as to ensure the genetic integrity and stability of the micropropagated date plants. DNA fingerprints are available at KISR to identify the date palm cultivars maintained in the KISR date palm orchard. Many Kuwaiti farmers identify cultivars through morphological characters of fruits.

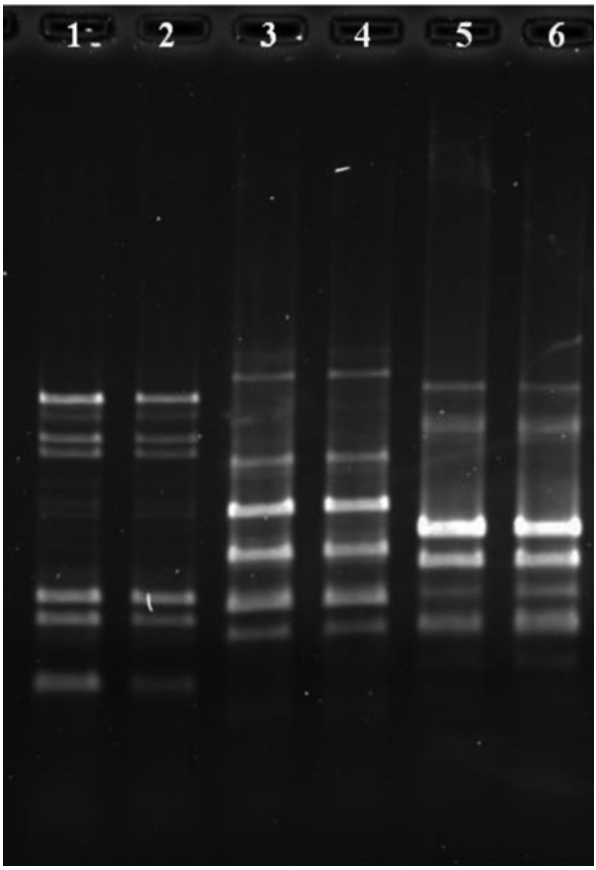

Fig. 9.10 DNA fingerprint of mother and in vitro clone

9.6 Cultivar Description

There are several date palm cultivars with commercial potential in Kuwait. However, Barhi, Khalas, Suckari, and Medjool are considered of superior quality for commercial production. Many attempts have been made to identify and characterize date palm cultivars worldwide (Nixon 1945, 1951; Mason 1915, 1928). Recently, molecular markers have been used for most of the cultivars maintained at the KISR date palm germplasm collection (Al-Shayji et al. 1994). A majority of the dates cultivated in Kuwait were introduced from Iraq, Egypt, Saudi Arabia, and Morocco and are already identified. Only a few cultivars are newly developed in Kuwait through a natural selection process.

Among the well-known cultivars, Barhi is the most important, the fruit yellow in color at khalal stage. Its fruits are mostly consumed at khalal or rutab stages in Kuwait. Fruits of Barhi are very soft and golden yellow in color at the beginning of ripening and later turn dark brown at the fully ripe stage. Barhi cv. originates from Iraq. Khalas is considered the best cultivar in Kuwait for long-term storage. It is

Table 9.4 Date palm cultivars growing in Kuwait and their fruit mean weight

Cultivar	Mean fruit weight (g)
Anbarah	35.1
Ashgar	20.4
Awaidi	21.8
Barhi	23.3
Braim	18.9
Fersi	19.1
Hilali	21.1
Jouzi	23.3
Khalas	24.1
Khasab	19.0
Khyarah	28.0
Lolwi	16.3
Maktoomi	28.3
Medjool	34.3
Nebut Seif	27.4
Shishi	23.4
Shishi	23.4
Siwi	23.6
Suckari	23.5
Sultana	29.2

yellow in color during khalal stage and golden yellow at tamar. This cultivar is of Saudi Arabian origin. Besides these two, other cultivars such as Anbarah, Ashgar, Awaidi, Braim, Fersi, Hilali, Jouzi, Khyarah, Lolwi, Maktoomi, Medjool, Nebut Seif, Suckari, and Sultana are important in Kuwait (Table 9.4).

Recently, three new high-quality female cultivars were identified from seedling populations in Kuwait: Al-Heifi, Al-Shamy, and KUF-1. The first two originated from a Barhi female and unknown males and the third from a Medjool female. The fruits of Al-Heifi and Al-Shamy are superior in quality to Barhi. Currently these two cultivars are being multiplied by tissue culture at KISR. The characteristic features of some of the date palm cultivars growing in Kuwait are shown in Fig. 9.11. Among these familiar cvs. in Kuwait, Awaidi ripens earlier than all others (late June to early August). Khasab and Hilali cvs. ripen late (October to January). If allowed, fruits of both these cvs. can be left on the tree until the next flowering season. This is due to the high humidity and low temperature during September to February. All other cvs. ripen in the middle period (late July to August).

The main features of common cultivars grown in Kuwait are summarized as follows:

Anbarah This is the most important tamar cv. in Madinah, Saudi Arabia. Fruits are dark reddish chestnut in color, very long, tasty, and soft. It matures to tamar stage late in the season.

Ashgar There are several Ashgar cvs. in Iraq and Saudi Arabia. It is early bearing in Kuwait; it ripens in July and is eaten in the khalal, rutab, and tamar stages. The

khalal fruit is very light yellow in color, sweet, and juicy. The fruit is shaped like an inverted egg.

Awaidi This originates from Iraq. The fruit is light rose in color, very large, oblong, and eaten at rutab and tamar stages.

Barhi This originates from the Mandali area of Iraq. Fruits are of excellent quality and can be eaten at khalal, rutab, and tamar stages. Barhi is the major cv. in Kuwait.

Braim This cv. originates from southern Iraq. Its khalal fruit is yellow with a tint of orange or apricot color and free of phenolic compounds. Its tamar fruit is light brown with amber flesh. It is early ripening and can be eaten at khalal, rutab, and tamar stages.

Fersi This cv. is one of the desirable medium-quality dates of Shatt Al-Arab, Iraq. The fruit is small, oblong, and light red in color. It matures mid-season and is eaten at rutab and tamar stages.

Fig. 9.11 The characteristic features of fruits of some date palm cultivars grown in Kuwait

Fig. 9.11 (continued)

Hilali It originates from Saudi Arabia. It is a heavy date producer, ripens late in the season, and is delicious at rutab and tamar stages.

Khalas This originates from Saudi Arabia. It is a mid-season cv. It is edible at rutab and tamar stages; at tamar the fruit is highly valued for its fragrance and light color.

Khasab It is a good cv. originating from Iraq. Khalal stage fruits are red in color and turn black upon reaching tamar stage. In Kuwait, it ripens very late and khalal stage fruits are available up to November.

Jouzi This cv. originates from Shatt Al-Arab, Iraq. At khalal stage the fruit is large and dark red in color, turning dark black at tamar stage. It is eaten at khalal, rutab, and tamar stages.

Khyarah This originates from Basra, Iraq. It is a large-sized fruit, yellow at khalal, light amber color at rutab, and light brownish red at tamar stages.

Lolwi This originates from the UAE. Khalal stage fruit is yellow with a green tint. The fruit is very small and shaped like an inverted egg. Fruit bunch is very large and ripens very late. It is one of the high-yielding cvs. in Kuwait.

Maktoomi Soft large yellow fruit ripens late to an amber color; it originates from Iraq. It is an excellent quality tamar date.

Medjool This famous cv. originates from Morocco. The fruit is semidry, large, and orange yellow, ripening during mid-season to a reddish brown at tamar stage. It is an easy cv. to pollinate.

Nebut Seif This originates from neighboring Saudi Arabia. The fruit is large, light golden color, and tasty. The vegetative growth of this tree is better than all other cvs. growing in Kuwait. It grows to a large size within 15 years. The yield in Kuwait is less compared to Barhi.

Shishi This originates from Saudi Arabia. It is a good cv. for tamar dates. The fruits are soft in texture and eaten only at tamar stage.

Siwi This cv. was introduced from Egypt. It is slightly sweet and yellow in color at khalal stage, but the fruit is eaten commonly at tamar stage. It is a dry type and can be stored at room temperature. It is a heavy producer and a lesser-known cultivar in Kuwait.

Suckari This originates from Saudi Arabia. It is a semidry type and of excellent quality for commercial production. Fruits can be stored at room temperature.

Sultana This originates from Saudi Arabia. The fruits are larger than cv. Nebut Seif. It bears a soft fruit eaten at tamar stage.

Um Al-Dehn This originates from Iraq. It is a good cv. eaten during rutab and tamar stages. Khalal stage fruits are yellow in color, small, and elongated.

9.7 Dates Production and Marketing

Date production in Kuwait is lagging behind the neighboring GCC countries due to various physical and physiological factors (Abdul-Salam and Al-Mazrooei 2007). However, date production has been improving due to government subsidies and interest of the growers. Current annual date production in Kuwait is reported as 45,000 mt according to FAO statistics. Although 45,000 mt of dates are produced annually, a majority of them are damaged due to the lack of proper postharvest technologies. Current annual date production is not self-sufficient. Therefore, most of the fruits are consumed as fresh dates, and chances for marketing are reduced. Most of the date fruits are fresh and processed, and other date products available in the local markets are imported from neighboring countries. Marketing of date fruits and their by-products in Kuwait needs more attention.

Saudi Arabia is the leading country for date fruit and by-product exports to Kuwait. Saudi Arabia, Oman, and the UAE produce surplus quantities of dates, while other countries such as Kuwait have to increase production to achieve self-sufficiency. Market and consumer research has to be undertaken to address consumer demands and develop an appropriate product mix. Quality standards to meet international market requirements are poor and need more attention to strengthen the date agro-industrial chain. Dates and their by-products need to be promoted in international markets. The Government of Kuwait is providing subsidies to growers for commercially viable high-quality cultivars. This will increase the number of good quality productive trees in the near future and will enhance the production of marketable quality dates. KISR is producing good quality date palm planting material through micropropagation as per growers' demand. Postharvest technology is in its infancy, and research is currently being focused on at KISR.

9.8 Processing and Novel Products

Current postharvest technologies including handling, processing, and storage need to be improved to enhance the value of date fruits and their products. In Kuwait, there are no proper facilities, know-how, or trained manpower to handle the fruits during field harvest. Improvement in fruit handling during harvest has to be strengthened. Concerning date processing, the quantity of fruits processed in factories into different products (packed fruits and by-products) represents only a small percent of the total quantity produced. There is also a need for the development of innovative products that cater to dynamic international market needs and demands on an industrial scale. Developments of an organized structure to collect the fruits from the farmers and transport them to processing factories need to be established. Pesticide application is very high, and research is needed to develop alternative eco-friendly natural products to control the pests and pathogens that affect the fruit quality. Production cost is very high due to the labor cost, and necessary steps have to be undertaken to reduce these costs. The development of useful industrial products from the date palm residues, which enhances farmer income, needs more consideration. Overall, date fruit processing and date product improvements are at their infancy in Kuwait at present. More attention is needed to improve postharvest technologies, processing, novel product development, and marketing.

9.9 Conclusion and Recommendations

Date palm is a high priority fruit crop in Kuwait due to its tolerance of the climatic conditions. The Government of Kuwait is providing subsidies for growing selected commercial cultivars. The status of date palm cultivation is improving in Kuwait and moving toward self-sufficiency. However, more support and encouragement are necessary for date palm research. The chief constraints on date production are scarce fresh irrigation water, increasing soil salinity, the high cost of production, insufficient removal of poor quality trees and replacement with high-quality trees, lack of postharvest technologies, a poor marketing system, lack of storage facilities, lack of processing factories, increase in low-quality varieties, lack of research on innovative products, increased losses during postharvest handling, and the absence of quality maintenance for international marketing. In order to improve the date crop in Kuwait, further research and development is required in areas such as cultivar improvement, farm management, environmentally friendly pest and disease management, biotic and abiotic stress tolerance, date fruit and by-product quality improvement, mechanization in crop management, fruit processing, and finally marketing. KISR has established a date palm micropropagation laboratory and developed protocols for commercial-scale plant production to meet the local demand for good quality planting materials. The quantity of imports of planting material is gradually being reduced due to the in vitro micropropagation carried out on a commercial scale. Date palm germplasm conservation and biodiversity improvement

are also being practiced at KISR. More attention and support are needed for post-harvest technology and developing eco-friendly pest and disease management research from the government and private sectors.

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