Chapter 10
Date Palm Status and Perspective in Qatar

Nazir H. Muhammed, Osman E. Ahmed, Talaat A. Ahmed, and Mohammed S. Al-Yafai

Abstract Qatar ranks as the 16 largest date-producing country in the world. There are 581,336 date palm trees growing in an area of 2,469 ha with date production of 21,491 mt as of 2010. It is the major fruit tree grown in the country, and date production is 7.2 % of the total agricultural production. No specialized institution exists for date palm research and development. Average recorded yield for 2010 was 8.7 mt/ha, the second highest in the region and higher than the world average of 6.3 mt/ha, for the same year. Yield has progressively increased since 1980. It is essential that this status should not only be maintained but also increased to reach a higher production rate similar to that being achieved in Egypt and other countries. Good potential exists to expand the area and production of dates, providing existing agricultural lands and water resources are used efficiently. Like other countries, the major constraints of yield are scarcity of good quality water, soil, and water salinity, low-yielding cultivars, poor agronomic practices due to a limited number of knowledgeable growers, insects and diseases, and weak research support. Tissue culture is in initial stages. Many research and development efforts are required to enhance date palm cultivation in the country to increase yield and economic return. For this purpose, several research and development projects have to be planned and implemented. A date palm-based industry needs to be set up to decrease imports of this commodity.

Keywords Constraints • Date palm • Future research activities • Imports • Production • Research • Yields

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10.1 Introduction

Qatar is not an agricultural country and has to import over 90 % of its food requirements, amounting to QAR 4.68 billion or USD 1.3 billion in 2010. Sovereignty of a state is based on its food security. In 2011, Qatar's self-sufficiency in vegetables, cereals, fruit, and oilseeds was 13.38, 5.78, 13.4, and 0, respectively (Table 10.1). These values are not encouraging. Therefore, the Government of Qatar, because of its critical role in the nation's food security, declared agriculture as a strategic sector. Like other Middle East countries, Qatar faces serious water scarcity and its associated consequences. Hence, a countrywide National Food Security Program was established to increase domestic production, which will lead to scientific and technological development in the following three agricultural areas: (a) water management and desalination technologies, (b) agricultural development, including adoption of technologies such as hydroponics and water-efficient techniques such as drip irrigation, and (c) food processing through the establishment of an agro-industry.

It must be kept in mind that water scarcity and food shortages are likely to increase around the world with climate change, population growth, and rapid economic expansion of different regions. Therefore, risks must be perceived in a way that leads to investing how to cope successfully with future threats to food security of the nation. The Government of Qatar has diagnosed the situation very wisely, and its efforts are very clear and headed in the right direction. The government is now keen to increase the level of self-sufficiency in agricultural produce and livestock and to reduce the dependence on foreign countries for agricultural products. Nearly

Table 10.1 Important characteristics of Qatari agriculture

	Year		
Important parameters	2009	2010	2011
Total arable area, ha	65,000	65,000	65,000
No. of registered farms	1,245	1,275	1,281
Total area of registered farms, ha	43,730	44,422	43,047
Total arable area of registered farms, ha	26,238	26,653	25,828
Number of active farms	795	822	831
Total arable area of active farms, ha	37,010	35,958	34,598
Area of active farms under cultivation, ha	22,206	21,575	20,759
Cropped area in active farms, ha	9,112	10,506	9,021
Crop intensity (ratio net area sown to total cropped area)	41	48.7	43.5
Self-sufficiency of vegetables, %	16.41	15.92	13.38
Self-sufficiency of cereals, %	5.53	5.39	5.78
Self-sufficiency of fruits, %	15.38	14.23	13.4
Self-sufficiency of oil seeds, %	0	0	0
Quantity agricultural commodities imports, million mt	1.342	1.593	1.590
Value agricultural commodities imports, million USD	1.572	1.588	2.031

Source: Annual Bulletin for Areas and Production of Agricultural Crops, Qatar (2011)

50 % of farms are underutilized, and government plans and programs are being implemented to utilize them more fully. Technical and material support to develop farms for poultry and agriculture will be provided. It will not be possible to explore all the natural resources to produce food without addressing the challenge of water. Plans are afoot to reduce exploitation of groundwater and increase the use of sewage water (Qatar Tribune 2014).

Water-saving and water-conserving technologies like mulching, using soil conditioners, application of manure, and improved irrigation systems should be top priorities as well (El-Bably 2002; Erskine et al. 2004; Jaradat 2005; Mulumba and Lal 2008; Ramakrishna et al. 2006; Xie et al. 2005).

10.1.1 Qatar Agriculture

Qatar has a total of 650,000 ha of arable land (Table 10.1). The number of registered farms is 1,281 occupying 43,047 ha, of which 25,828 are arable. The average size of a productive farm in Qatar is 27 ha; on average, about 8 ha are used for crop production. Roughly, equal areas are devoted to fruit trees (mostly date palm), vegetables, and fodder crops. Barley is the most frequently grown cereal crop, but altogether cereals typically occupy less than 1 ha on a typical farm. There are two types of agriculture in the country: open fields and greenhouses. Open field agriculture is currently the core of farming. Farmers do not cultivate the entire available hectarage on their farms. The proportion of cultivated land is on average 30 % of total farmland. The cropping system is dominated by fodder crops occupying 41 % of the cultivated area, followed by vegetables (34 %) and fruit trees (9 %). Cereal crops occupy only 1.2 % of the cultivated land. Farmers use cattle, sheep, and goat manure along with chemical fertilizers for fertilization of crops. Approximately 43 % of water resources are used for fodder crops, about 37 % for fruit trees, and 19 % for vegetables. More than 70 % of farmers use flood irrigation for fodder, while the remaining 30 % use sprinkler or drip irrigation. Date palms, which are one of the best-adapted crops to the desert climate, can contribute to food security. At present, 65 % of farmers use flood irrigation to irrigate their palms. Approximately 12 % of farmers are using protected farming, with greenhouses being the dominant technology, and their numbers ranging between two to 98 units per farm, with 40 % of farms containing only five greenhouses.

10.1.2 Constraints to Qatari Agriculture

Agriculture in Qatar is facing a number of problems. The most obvious is insufficient good quality water due to the absence of surface supplies in the form of rivers, canals, or lakes. The traditional system of flood irrigation loses a lot of water to evaporation and to leaching because of porous sandy soils. The only available water is either saline groundwater or seawater. Alternative water sources like treated sewage water or industrial water currently are not much used. Lack of a trained working force, adaption of new technologies, and above all the lack of interest of the farm owners are the other conspicuous constraints. The consequence is very low yields of crops including date palm.

10.1.3 Date Palm Status in Qatar

The date palm, as in other Arabian countries, is a popular and traditional fruit in Qatar. It occupies the largest area among the fruit trees grown in the country. The production of dates is 7.2 % of the total agricultural production. However, when the area and production are compared to larger countries of the region like Saudi Arabia, UAE, and Oman, it seems to be scanty. Nevertheless, a huge potential exists to increase cultivation area and date production to achieve self-sufficiency in Qatar.

10.2 Cultivation Practices

10.2.1 Present and Recommended Practices

Cultivation practices for date palm in Qatar are an admixture of local traditions and those adopted from the region. As such, there has been little systematic research conducted to devise local techniques based on locally generated data. Present cultivation practices recommended for each calendar month are given in Table 10.2.

10.2.2 Cultivation Practices Research in Qatar

Systematic research is required to formulate recommendations specifically for Qatar conditions. Some recent work has been conducted by the Ministry of Environment and Qatar University in this regard. A brief summary of this research is presented here.

10.2.2.1 Effect of Soil Conditioner

Zeolite is a soil conditioner that can hold moisture in sandy soils for longer periods, lessening loss of irrigation water through evaporation and leaching. A 5-year study began in 2010 at Rawdat Al-Fars Experimental Farm of the Ministry of Environment to investigate the efficiency of Zeolite for safely using saline water to irrigate date palm (cvs. Khalas and Barhi). Zeolite was applied at three rates: 20, 30, and 40 kg/

Table 10.2 Yearly calendar of agricultural operations for date palm in Qatar

Month	Agricultural operations
January	Trimming and pruning and removal of thorns
	Application of compound chemical fertilizer
	Preventive spraying of fungicide and insecticide (to control red palm weevil and pollen disease)
February[a]	Start pollination for early cultivars
	Application of urea fertilizer
	Continue spraying of fungicide and insecticide (greater pollen worm)
March[b]	Continue pollination
	Start fruit thinning
	Start thinning and curving
	Continue spraying of fungicide and insecticide (lesser date moth)
April	Pollination for late cultivars
	Thinning and curving of fruits
	Removal and planting of new cuttings
	Continue preventive spraying of fungicide
May	Preventive spraying for spiders
	Covering and bagging of fruits at turning green color.
June	Continue the same above operations
July	Stop application of pesticides spraying
	Start harvesting fruits of early cultivars
August	Continue harvesting fruits
	Full stop of pesticides spraying
September	Harvesting late cultivars Start establishment of new date palm farms
October	Removal of fruits falling on the ground
	Removal of old fronds and cleaning of the palm
November	It is possible to start application of chemical and organic fertilizer to trees
	Preventive spraying of fungicide and insecticide
December	Application of fermented compost
	Protect newly planted cuttings from cold by sackcloth wrapping

Remarks:
Control of red palm weevil by inoculation method the year-round
Spreading of red palm weevil pheromone traps can be done year-round
Date palm trees should be irrigated year-round by modern irrigation (bubbler) method
Timing for carry out of these operations may vary according to area
[a]Pollination should be repeated if it rains
[b]The period between pollination operation and spray should not be less than 1 week

plant/5 years in addition to control with zero application. Data on plant parameters, soil characteristics, and heavy metal accumulation were recorded. However, only yield data are presented in Table 10.3.

The application of Zeolite soil conditioner increased the fruit yield of date palm significantly in all 4 years of the study. The average of 4 years indicated an increase of 8.8, 7.6, and 5.1 % date yield of Barhi for application of 2, 3, and 4 % Zeolite by

Table 10.3 Date yields (kg tree^{-1}) 2010–2013

	Barhi					Khalas				
Treatments	2010	2011	2012	2013	Mean	2010	2011	2012	2013	Mean
T0 (No Zeolite)	75.6	60.7	86.5	80.6	75.84d	97.4	67.0	88.4	80.4	83.29b
T1 (Zeolite 2 % in 15 cm soil)	85.5	65.3	95.3	84.2	82.57b	100.1	71.0	91.6	87.2	87.47a
T2 (Zeolite 3 % in 15 cm soil)	86.7	65.7	88.3	85.7	81.6b	100.4	71.4	82.8	85.5	85.0 a
T3 (Zeolite 4 % in 15 cm soil)	91.6	69.7	83.5	74.1	79.73c	103.3	71.6	74.2	77.8	81.7 b
Mean for cultivars	84.9 b	65.4 c	88.4 b	81.1 b	–	100.3a	70.3c	84.2b	82.7b	–

Source: Hussain et al. (2014)
Means are of six values in each year
Means for cultivars were compared for all the 4 years together
Means for treatments for 4 years and compared together for both cultivars
(a-d) indicate interactions of cultivars and treatments in each year separately

volume, respectively. The increases were 5.0 and 2.1 by 2 and 3 % application of Zeolite, while 4 % did not produce a positive response. It can also be noted that responses were higher in the initial 3 years revealing effectiveness of the soil conditioner for a 3-year period after which a fresh application may be required. There were no negative effects of Zeolite application on soil and plants because no accumulation of heavy metal was noted. There were slightly more salts in the soil during first year.

10.2.2.2 Appropriate Irrigation Water Requirements

Studies of appropriate water requirements of date palm were conducted under a project entitled Improvement of Date Palm Production and Quality under Qatar Conditions (NPRP3-09-705-4-025) sponsored by the Qatar Foundation and implemented collaboratively by the Ministry of Environment (MoE) and Qatar University (QU). In this experiment, standard irrigation levels (presently recommended in Qatar) were compared with 15, 30, and 45 lesser water quantity per irrigation as well as 10 % more for two date palm cultivars: Naboot Saif and Khalas. Reducing the quantity of applied water per irrigation by 30 % of conventional practice but without disturbing the frequency did not affect the Naboot Saif date yields significantly (Hussain and Ahmad 2014). The yields were reduced by 0 and only 1.7 % for 15 and 30 % water reduction per irrigation (Table 10.4).

However, reduction of irrigation by 45 % decreased the yields by 19 %. This water saving was due to decreased leaching and evaporative losses under Qatar conditions where soils are sandy with excessive drainage. Irrigation water requirements of Khalas

Table 10.4 Date fruit yield (kg/plant) for various water quantities

Treatments	Naboot Saif cv.			Khalas cv.			Treatment means		
	2011	2012	Means for 2 years	2011	2012	Means for 2 years	2011	2012	2011 + 2012
T1	24.94 a	20.97 a	22.96	11.03 c	10.5 c	10.77	17.99 A	15.73 A	16.86
T2	25.80 a	20.27 a	23.04	10.77 c	9.5 c	10.14	18.29 A	14.88 A	16.59
T3	25.63 a	19.47 a	22.55	8.49 d	9.03 c	8.76	17.06 A	14.25 A	15.66
T4	20.49 b	16.43 b	18.46	8.12 d	7.83 d	7.98	14.53 B	12.13 B	13.33
T5	25.94 a	21.93 a	23.94	11.40 c	10.70 c	11.05	18.67 A	16.31 A	17.49
Cultivar means	25.56 A	19.81 B	–	9.96 C	9.51C	–	–	–	–
Yearly means	–	–	–	–	–	–	17.31 A	14.66 B	–

Source: Hussain and Ahmad (2014)
Cultivars were compared in each year (2011 and 2012 separately)
Results are means of three replications
Means followed by different letters are significantly different. Capital letters are used to compare significant differences of the overall means

cv. were found to be higher than Naboot Saif. Yield decreases of 5.8, 18, and 26 % were observed due to reduction of applied water per irrigation by 15, 30, and 45 %, respectively. Hence, a reduction of 15 % was safer in the case of Khalas dates. Increasing water application by 15 % did not yield much of an increase, and the difference with conventional practice was nominal. No adverse effect on fruit quality was observed by decreasing irrigation water quantity per irrigation because drought, if any, did not persisted for longer periods. Soil health was not affected at all due to reductions in irrigation water quantity. Rather, there was less addition of salts when the total quantity of water usage was reduced. Decreasing irrigation water did not negatively affect water and nutrient uptake by plants, as indicated by flag leaf analysis.

Thus, irrigation water applied to date palm can be reduced by 30 % per application compared with conventional practice in the case of Naboot Saif cv., while by 15 % in Khalas cv. without significantly decreasing fruit yields. However, the present frequencies of water application must be observed. Water saving will come from partial control over leaching and evaporation losses occurring under Qatar conditions when a large amount of water is applied at one time.

10.2.2.3 Alternative Sources of Irrigation Water

The effects of diluted seawater and treated wastewater on date palm production and quality were compared. Irrigations with treated wastewater affected neither the date palm yields and fruit quality nor caused accumulation of heavy metals in comparison to groundwater (Table 10.5). Hence, it could be an alternative source of irrigation. Diluted seawater of either 10 or 15 dS/m affected the date palm yields significantly (28 and 45 % decrease, respectively) and salinized the soil indicating that a further dilution will be required to bring about safer usage. However, there is the possibility

Table 10.5 Date yield (kg plant^{-1}) due to diluted seawater and treated wastewater

Treatments	2012	2013	Overall treatment means of 2 years
Groundwater alone	41.68 a	38.45 a	40.06 A
Treated wastewater	36.46 ab	34. 68 a	35.57 A
Diluted seawater of EC ≈ 10 dS m^{-1} (Seawater + Groundwater = 1 + 4)	31.62 b	25. 87 b	28.74 B
Diluted seawater of EC ≈ 15 dS m^{-1} (Seawater + Groundwater = 1 + 2)	24.05 c	19. 79 c	21.92 C
Yearly means	33.45 A	29.70 B	–

Source: Hussain and Ahmad (2014)
Results are means of three replications
Means followed by different letters are significantly different. Capital letters are used to compare significant differences of the overall means

of using this water when diluted by proper ratios of seawater and groundwater. There was no heavy metal accumulation observed in leaves and fruits of date palm as well as the soil when seawater, groundwater, and treated wastewater were used for irrigations. Using diluted seawater for date palm irrigation by seawater, groundwater ratios of 1:2 (EC 15 dS/m) and 1:4 (EC 10 dS/m) may cause decrease in yields by 45 and 28 %, respectively. Nevertheless, these were still economical, as these were less than 50 %, the critical value. The losses may increase in later years. Therefore, a ratio of 1:6 or narrower could prove safer (Hussain and Ahmad 2014).

10.2.2.4 Effect on Growth with Seawater Irrigation

Salinity stress is known to retard plant growth through its influence on vital facets of plant metabolism, including disturbing the concentration of endogenous plant hormones. This disturbance can affect the growth and development of plants. At Qatar University, studies were undertaken to improve the endogenous hormone balance through application of exogenous hormones (Aljuburi and Maroff 2007). The experiment consisted of applications of growth regulators: indoleacetic acid (IAA) and naphthalene acetic acid (NAA), mixtures of IAA and NAA, and different concentrations of seawater alone or in combination with IAA and NAA. The application of NAA in combination with salts reduced accumulation of Na and Cl in leaves of date palm (*Phoenix dactylifera* L., cv. Hatamy) seedlings. Salinity in irrigation water reduced leaf and root Mn, Zn, Fe, and leaf K, Ca, Mg concentrations and the ratio of K/Na and Mg/Ca, but increased leaf N and leaf and root P, Cu, Na, and Cl concentrations, compared with untreated seedlings. Compared to seawater alone, growth hormone application reduced the adverse effects of salts (from seawater irrigation) by reducing Na and Cl accumulation in the leaves and roots. There was an increase of Ca, Mg, N, P, and Fe concentrations and the ratio of K/Na in the leaves and roots. Number of roots and shoot dry matter percentage of seedlings with applied hormone treatments were more compared to using seawater alone.

10.3 Genetic Resources and Conservation

There is no specialized institution or body in Qatar for conservation of date palm resources. Cultivars have been imported for growing in different areas. However, a study on genetic diversity was initiated under an ICARDA (International Center for Agricultural Research in the Dry Areas) Project comprised of 12 local cultivars of date palm. DNA markers were established to identify and detect the male date palms. Newly designed SSR (simple sequence repeats) markers developed by ICARDA were verified, and their efficiency in genetic characterization was confirmed.

10.4 Tissue Culture in Qatar

A tissue culture laboratory was established under the Ministry of Environment. A survey of the morphological and physiological diversity among the different date palm cultivars has already been conducted, although propagation methods, explant physiological behavior, and acclimatization of transplants are still under evaluation. A lower response of date palm explants for ontogeny in the media, the differentiation between the different species at the early stages in culture and prefruiting, and a lower percentage of success in rooting and acclimatization of the new transplants were the major constraints faced by the laboratory in early studies.

In vitro studies at the Tissue Culture Laboratory, Ministry of Environment, indicated that micropropagation of date palm cvs. Kapkap and Tharlaj could be successful in medium consisting of full MS and 0.1 mgl^{-1} NNA without charcoal. A mean of 5.5 and 1.0 root per embryo was recorded, respectively, for both cultivars. The other medium did not perform better in terms of root number. The type of medium also affected the root length. Medium containing charcoal at 3 g l^{-1} proved better in increasing root length (Alromaihi and Elmeer 2009).

Date palms are generally propagated by separating offshoots produced by individual trees. Somaclonal variation refers to the phenotypic and genotypic variation observed in plants regenerated through cell culture. On the other hand, some somaclonal variations have desirable agronomic and commercial advantages and on occasion lead to the release of new cultivars. Microsatellites or (SSRs) and Inter-Simple Sequence Repeat (ISSR) markers were used in this study to detect genetic variation based on DNA markers between the regenerated plantlet and its corresponding callus (Ahmed and Al-Qaradawi 2010; Ahmed et al. 2012a). Somaclonal variation between callus and more than one regenerated plant was observed in three cultivars: Kubkub, Merziban, and Dharlag.

SSR and ISSR markers provide a useful technique in the assessment of genetic stability in micropropagated date palm as well as in their genetic characterization, allowing the differentiation of cultivars with a relatively low number of primers, even those corresponding to the same family. SSR and ISR markers demonstrated the genetic stability observed in the date palm cultivars studied in this work and the importance of the genotype in the appearance of somaclonal variation (Fig. 10.1).

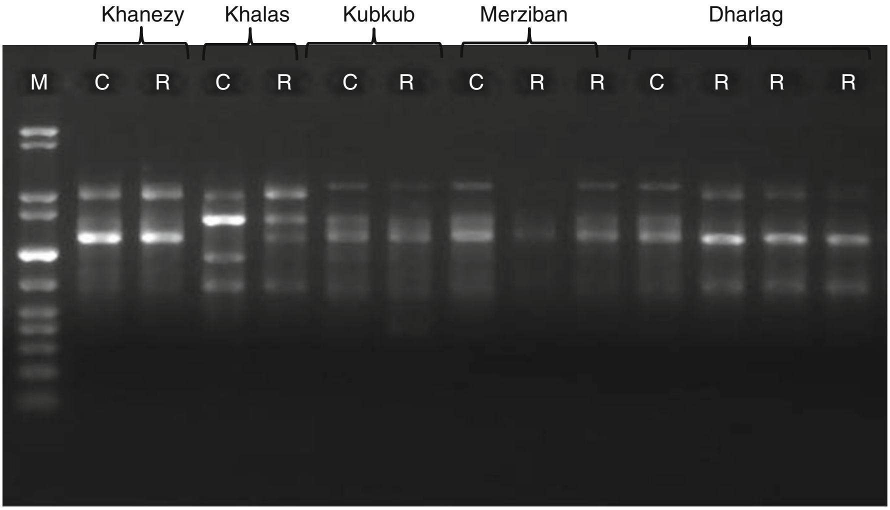

Fig. 10.1 ISSR pattern obtained with the primer ISSRBT23 in five different date palm cultivars during in vitro culture, *M*, *C*, and *R* denote for ladder marker, callus, and regenerated plantlet, respectively

10.5 Cultivars Description

Date palm cultivars have been widely exchanged officially and unofficially in the GCC (Gulf Cooperation Council) region. There has been an active exchange of date palm cultivars (local and exotic) from one country to another. As a result, almost all the cultivars are commonly grown throughout the Gulf. However, the area under each cultivar varies. There are two groups of cultivars in Qatar: cultivars grown in Qatar as well as other countries and cultivars only identified in Qatar. The first group includes cultivars Khalas, Barhi, Bin Saif, Jabri, Hitimi, Khunaizi, Rotanah, Shishi, Naboot Saif, Hilali, Hilaini, etc. The second group includes Azat, Berz, Bashbak, Tarahim, Disky, Zary, Taumai Aswad, Qashmak, Niqal, Ward, and others.

10.6 Cultivars Identification

10.6.1 Molecular Phylogeny Using SSRs

Recently developed techniques based on DNA markers offer new tools for genetic analysis. So far, no detailed research has been conducted to analyze phylogenic relationships among date palm cultivars native to Qatar using DNA markers. The objectives of this study were to analyze the genetic diversity among 15 different cultivars of date palm at the Qatar University Experimental

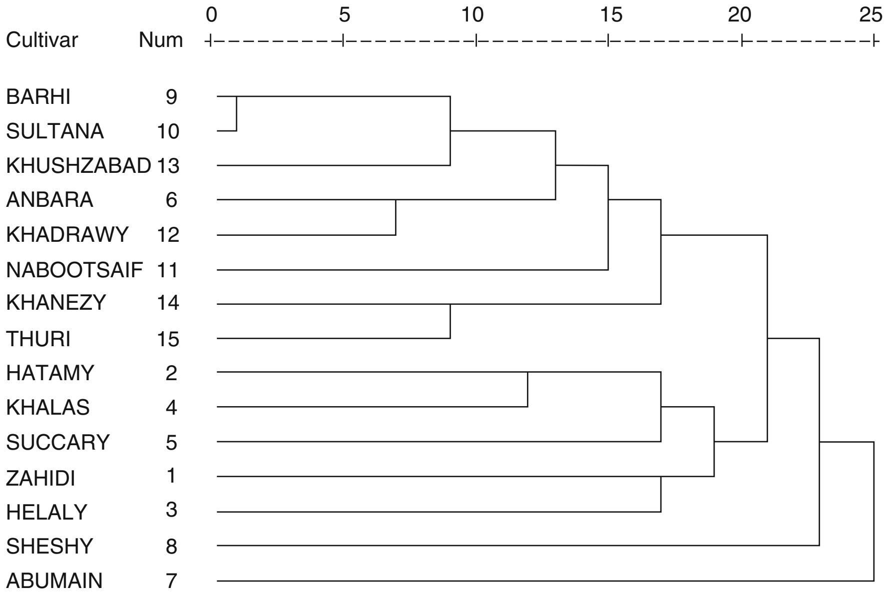

Fig. 10.2 Dendrogram of 15 Qatari date palm cultivars based on Jaccard genetic similarity coefficient using SSR data

Farm using SSR markers and to determine the genetic similarity and/or diversity among the well-known Qatari date palm cultivars. DNA was extracted from fresh young leaves. Among 16 primer pairs tested for their ability to generate expected SSR banding patterns in Qatari date palm genotypes, 10 primers successfully produced clear single bands in most of the studied genotypes. So far, 6 SSR primers did not amplify clear bands in our genetic materials even using different PCR (polymerase chain reaction) conditions. The amplified SSR band sizes ranged from 100 to 300 bp. A total of 40 alleles, with an average of 4 alleles per locus, were scored. A similarity coefficient matrix was computed to cluster the data and to draw precise relationships among the 15 Qatari date palm genotypes studied (Fig. 10.2).

In this study, SSR markers were used to assess the molecular characterization and the phylogenic relationships of Qatari date palm cultivars. Results provide evidence of a genetic diversity among the studied Qatari date cultivars and the ability of SSR markers to detect the genetic diversity in date palm. We may conclude that all date palm ecotypes are interrelated in spite of their agronomic divergence. Genetic similarities and a dendrogram could regroup the Qatari date palm cultivars in a way that one cultivar (Abu Main) was excluded from the group due to its dissimilarity with the others. Two cultivars (Barhi and Sultana) were much closer and could be considered as coming from a single origin. Some cultivars were grouped in different similar pairs (Ahmed and Al-Qaradawi 2009).

10.6.2 Inter- and Intraspecific Genetic Variations Using ISSR

Offshoots separated from individual trees are mainly used for date palm propagation, which maintains the genetic integrity of the cultivars such as fruit morphology and quality; however, some variations are observed. The objective of this study was to determine the genetic similarity or diversity among and within the well-known Qatari date palm cultivars using different 18 primers of ISSR markers. Five commonly cultivated cultivars in Qatar were selected, including Khalas, Sheshy, Rezezy, Barhi, and Khanezy, from three different cultivated locations (Al-Shamal, Al-Khor, and Al-Rayan). All primers have amplified polymorphic bands in the studied cultivars either among the cultivars or within each cultivar in different cultivated areas. These results revealed the existence of genetic variations among the cultivars studied as well as within each cultivar, supporting the observed variation in some morphological and quality characters for different trees that are grown in different environments and derived from the same cultivar. Results reported from this study will help the Qatari date palm community with intra- and inter-fingerprinting of different cultivars leading to identifying new lines or cultivars that are of a high quality and thus may be patented as unique Qatari cultivars (Ahmed et al. 2012b, 2013).

The ISSR marker analysis adopted as a tool to study the inter- and intraspecific genetic variations in date palm is easy and readable. In this current study, we used 18 ISSR primers and the genomic DNA of five date palm cultivars grown in three different locations. All primers have amplified polymorphic bands in the studied cultivars either among the cultivars or within each cultivar grown in different cultivated areas. The results indicate the existing genetic variations not only among well-known cultivars but also within each cultivar, explaining the variation in some morphological and quality characters from different trees within the same cultivar. In addition, data provide evidence of the possibility of using these powerful markers as descriptors in the certification and the control of origin labels of date palm material (Fig. 10.3).

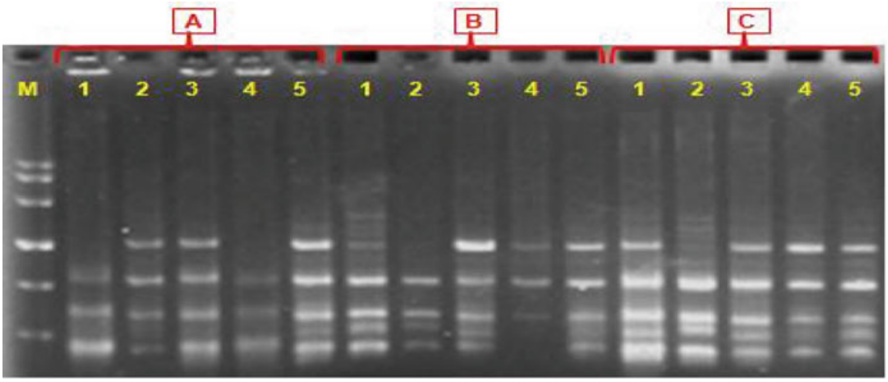

Fig. 10.3 Amplified band patterns of Primer 11 from five studied date palm cultivars in different cultivated areas. *Arrows* show the polymorphic bands within each cultivar

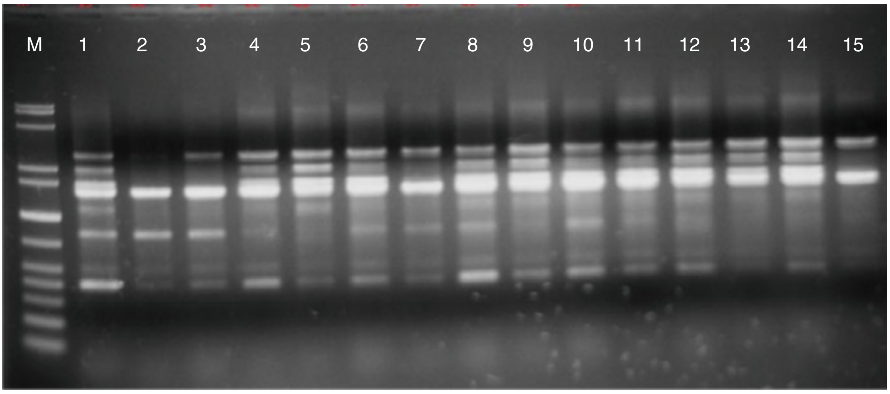

Fig. 10.4 Example of ISSR polymorphism-banding patterns in a subset of 15 Qatari date palm genotypes using primers # 10, M: 50 bp. Standard ladder marker; Lanes (1–15)

10.6.3 Molecular Characterization of Date Palm Using ISSR

To study the genetic diversity among date palm cultivars grown in Qatar, 15 date palm samples were collected from the Qatar University Experimental Farm. DNA was extracted from fresh leaves by using commercial DNeasy Plant System Kit (Qiagen, Inc., Valencia, CA). A total of 18 ISSR single primers were used to amplify DNA fragments using genomic DNA of the 15 samples (Ahmed et al. 2013). First screening was done to test the ability of these primers to amplify clear bands using date palm genomic DNA. All 18 ISSR primers successfully produced clear bands in the first screening. Then, each primer was used separately to genotype the whole set of 15 date palm samples. Total of 4,794 bands were generated using 18 ISSR primers for the 15 date palm samples. On average, each primer generated 400 bands. The number of amplified bands varied from cultivar to cultivar. The highest number of bands was obtained using Primers 2, 5, and 12 for the 15 (470 bands), while the lowest number of bands were obtained by Primers 1, 7, and 8 where they produced only 329 bands. Markers were scored for the presence and absence of the corresponding band among the different cultivars. A similarity matrix was constructed, and the similarity values were used for cluster analysis (Fig. 10.4).

10.6.4 De Novo Genome Sequencing and Comparative Genomics

Collaborative studies between Weill Cornell Medical College in Qatar and the Department of Genetics, University of Georgia, Athens, Georgia, USA, indicated long generation times (5–8 years) and dioecy (separate male and female trees), have complicated date palm cultivation and genetic analysis. A draft genome for Khalas cv. female, the first publicly available resource of its type for a member of the order Arecales, was carried out to resolve this issue. The ~380 Mb sequence, spanning mainly gene-rich regions, includes >25,000 gene models and is predicted to cover ~90 % of genes and ~60 % of the genome. Eight other cultivars, including females of Deglet Noor and Medjool and their backcrossed males were sequenced. More than 3.5 million polymorphic sites, including >10,000 genic copy-number variations, were identified in these studies. A small subset of these polymorphisms can distinguish multiple varieties. Al-Dous et al. (2011) identified a region of the genome linked to gender and found evidence that date palm employs an XY system of gender inheritance.

10.7 Date Production and Marketing

Qatar is a relatively new country where documented date production began in 1980, as compared with other countries of the Gulf region that were producing this commodity even before 1961 (the year after which data are available at FAO). Qatari date palm plantations represent 71 % from the total area planted under fruit trees. Major cultivation is in the north and middle areas of Qatar where environmental conditions are favorable, and the soil has a deep profile with low salinity as compared with other parts of the country. Initially, date palm was grown on 805 ha in 1980 (Table 10.6) with a production of 3,060 mt (Table 10.7). Since 1980, Qatar has made good progress in growing and producing dates. The harvested area achieved 2,469 ha in 2010, which gave a production of 21,491 mt.

In Qatar, the average yield for 2010 was 8.704 mt/ha, being the second highest in the region and higher than the world average of 6.277 mt/ha. Yield has increased progressively since 1980. However, the mean for 2005 (8.823 mt/ha) was slightly higher than in 2010 (8.704 mt/ha) (Table 10.8). Hence, it is vital that this status should not only be maintained but also increased to reach the maximum production being achieved in Egypt and other countries.

The area and production decreased slightly in 2011 (Table 10.9). The number of palms also decreased in 2011 (581,336) as compared to 2010 (617,375). The per

Table 10.6 Harvested area (ha) of date palm in Gulf countries in the last five decades

Years	Qatar	Kuwait	Bahrain	Yemen	Oman	Saudi Arabia	UAE
2010	2,469	5,089	1,603	14,955	31,353	171,975	197,400
2005	1,444	1,400	1,700	13,773	31,352	150,744	185,000
2000	1,931	1,350	823	22,755	35,508	142,450	185,330
1990	998	350	997	15,313	35,000	72,379	22,156
1980	805	0	4,000	11,618	20,100	60,353	5,564
1970	0	0	1,600	10,100	13,000	31,000	640
1961	0	0	1,600	10,456	13,000	22,000	500

Source: FAOSTAT (2010)

Table 10.7 Production (mt) of dates in Gulf countries in the last five decades

Year	Qatar	Kuwait	Bahrain	Yemen	Oman	Saudi Arabia	UAE
2010	23,500	16,700	14,000	57,849	276,400	1,078,300	775,000
2005	19,844	15,800	15,000	29,990	247,331	970,488	750,000
2000	16,116	10,155	16,508	29,834	280,030	734,844	757,601
1990	5,712	1,400	1,000	20,697	120,000	527,881	141,463
1980	3,060	0	38,000	14,240	70,000	342,286	51,157
1970	0	0	15,000	29,000	45,000	240,000	8,000
1961	0	0	15,000	38,100	40,000	160,000	6,000

Source: FAOSTAT (2010)

Table 10.8 Yield (mt/ha) pattern of date palm in Gulf countries during last five decades

Years	Qatar	Kuwait	Oman	Bahrain	Saudi Arabia	UAE	Yemen	World
2010	8.704	6.398	8.816	8.831	6.334	4.181	3.868	6.277
2005	8.823	11.286	7.888	11.286	5.58	4.054	2.177	5.85
2000	8.346	7.522	7.886	20.008	5.158	4.088	1.311	6.2
1990	5.723	4	4.8	5.729	7.293	6.385	1.351	5.496
1980	3.801	0	3.482	9.5	5.671	9.194	1.226	7.444
1970	0	0	3.462	9.375	7.742	12.50	2.871	7.137
1961	0	0	3.007	9.375	7.273	12.00	3.644	7.72

Source: FAOSTAT (2010)

Table 10.9 Some parameters showing performance of date palm in Qatar

	Year		
Parameters	2009	2010	2011
Total area, ha	2,237	2,469	2,366
Production, mt	20,815	21,491	20,696
Value of locally produced dates	374,670	343,861	525,895
Percent of total agricultural production	4.8	5.0	7.2
Number of plants	561,292	617,375	581,336
Average per capita availability, kg	19	18	14

capita availability of dates has been decreasing over time, as the reported values were 19, 18, and 14 kg per person in 2009, 2010, and 2011, respectively.

10.7.1 *Comparison of Qatari Production with Other GCC Countries*

The date palm-growing region of the GCC, comprising Saudi Arabia, UAE, Oman, Qatar, Bahrain, Kuwait, and Yemen, is the traditional and major home of this fruit tree (Al-Yahyal and Al-Khaniari 2008; Erskine et al. 2004). In 2010, the total

Table 10.10 Comparison of harvested area and production of GCC countries with the World total

	Production (mt)		Area (ha)	
Countries	2010	% of Gulf countries	2010	% of Gulf countries
Saudi Arabia	1,089,350	47.0	171,975	40.5
UAE	825,300	35.6	197,400	46.5
Oman	276,405	11.9	31,353	7.4
Yemen	57,849	2.5	14,955	3.5
Qatar	21,491	1.0	2,469	0.6
Kuwait	32,561	1.4	5,089	1.1
Bahrain	14,156	0.6	1,603	0.4
Total of Gulf countries	2,317,112	–	424,844	–
Total of world	7,683,432	–	1,224,139	–
Gulf % of world	30.16	–	34.71	–

Source: FAOSTAT (2010)

harvested area of date palm in these countries was 34.71 % of the world's total under this crop, while they produced 30.16 % of the total production of the world (Table 10.10). Qatar is not a significant country regarding date production. This crop was grown only in 0.6 % area of the GCC date palm area with a production of approximately 1 % of GCC in 2010 (Table 10.10). However, yield performance was better in comparison with the larger countries of the region: Saudi Arabia, UAE, and Oman. It was in second place (after Bahrain) in this regard in 2010. An interesting characteristic is the progress of yields over time, whereas three major countries were still lower than their respective yields of 1961. Although the total production of dates was also steadily increasing over time in Qatar, nevertheless, the area under this crop and total production could at least be doubled if the major constraint, scarcity of good quality water, is lessened. The government is taking wise decisions for boosting date production, and efforts are under way to develop alternative sources of water like treated wastewater and desalinized/diluted seawater. Research experiments have also been undertaken on this aspect.

10.7.2 Major Constraints of Date Palm Production in Qatar

Date palm is perhaps the oldest cultivated fruit tree. Therefore, it could be the leading plant in the refinement of very advanced cultivation practices coupled with all the modern techniques and be at the peak in yield performance. Unfortunately, this is not so. Many countries have yields that are lower even than they were in 1961. This is surprising and tells the story of ignorance. All plants face one or more constraints in various countries, but some of these may be common to all, though their nature, extent, and impact may vary. Date palm yields progressed in Qatar (maximum 8.823 mt/ha in 2005) but are still far below the actual potential of the crop (34.736 mt/ha in Egypt in 2000, but the 2010 average was 32.255 mt/ha). Thus, not only gap to be bridged is indicated but also the major constraints that should be identified and addressed systematically.

Most of the current agricultural management practices depend on inherited experience and recommendations adopted from different locations outside the country. The most appropriate technologies are always devised by research under local conditions but that has been not the case in Qatar. No studies have been done due to the lack of special departments for irrigation water use (qualities and quantities), fertilizer application, pests and diseases, postharvest management and fruit handling, marketing, packaging, and utilization of by-products. Therefore, major constraints are low-yielding cultivars and many nonproductive male plants in the field, deficiency of good quality irrigation water, and inappropriate irrigation systems (still flood irrigation at many growing sites) and soil and water salinity. Insect and disease attack, poor agronomic techniques, harvest losses, and proper postharvest care are other important factors. Low awareness on the part of date palm growers, the need for training and hampered technology transfer to the end users, lack of advanced packing and processing techniques, and poor coordination/collaboration with high date-yielding countries also contribute to the poor performance.

10.7.2.1 Low-Yielding Cultivars

Cultivars popularly grown in different countries vary broadly not only in their characters but also in their yield potential. When date palm cultivar development work is closely examined, one can clearly infer that there has been no or very little breeding work without any clear-cut direction in the past. The main reason may be propagation through offshoots, also called suckers. A positive development was establishment of a tissue culture laboratory in Qatar a few years ago. Recognized deficiencies of present cultivars are perceived in terms of the following aspects:

(a) Yield potential is generally low, especially among old palms still in the orchards.
(b) Fruit quality keeping is mostly inferior.
(c) Low response to fertilizer therefore gives low yields.
(d) Low drought resistant, comparatively lower disease and pest resistance, and they have less salt tolerance with a threshold at 3–4 dS/m (soil and water salinity is generally higher than this value where these date palms are grown).
(e) Lack of capability to keep the plant height as a dwarf because tall trees have inherent problems like sprays and other agronomic operations.

In addition, there are certain other problems related to date palm cultivars.

(a) Replacement of old cultivars with newer ones is another prominent problem because an orchard is productive for at least 35 years.
(b) Nonproductive plant (mostly male) numbers are very high (reported to be 50 % or so) and pose another crucial problem.
(c) Absence of a gene pool of date palm although this is very important to maintain biodiversity and preservation of plant resources.

(d) Lack of a strong and systematic exchange of breeding material, information, and data with other date palm-growing countries.
(e) Complete genetic fingerprinting, information on ancestors, and enlisting of inherent characters are lacking.

10.7.2.2 Deficiency of Irrigation Water and Appropriate Irrigation

Qatar lies in the MENA (Middle East and North Africa) Region, which is the most water-scarce area in the world. This region is home of 5 % of the world's population, yet it has less than 1 % of the total global renewable freshwater. Qatar, like other GCC countries, depends almost entirely on groundwater and desalinized seawater. The sandy nature of most of the soils coupled with high drainage heightens leaching losses and reduces water-supplying capacity of the soils. High evaporation also requires applying more water for crops including the date palm. Therefore, a sufficient supply of good quality irrigation water has always been a significant problem contributing to lower yields, and this is expected to continue to be significant in the future because of the impact of expected global and regional climatic change. It will become very difficult to provide more water for agriculture given the competition with domestic consumption, which is projected to increase further as a result of increased population and expected development, such as the FIFA World Cup 2022 planned for Qatar.

Water requirements of the date palm vary greatly depending upon soil texture, soil and water salinity, age of the plant, temperature, humidity, evaporation, irrigation technique, and season of the year. On average, date palms require 15,000–35,000 m^3 ha^{-1} per year which is quite a high requirement and mostly difficult to supply in water-scarce countries. The irrigation system also plays an important role in achieving high irrigation efficiencies. The traditional irrigation system of flood irrigation of basin or furrow is less efficient but cheaper and with lower labor requirements. On the other hand, modern systems like bubbler or drip irrigation are more efficient but installation costs are high, and they require high labor inputs. Keeping in mind the water scarcity, the present irrigation systems need to be improved and converted into subsoil irrigation systems.

10.7.2.3 Soil and Water Salinity

Due to the scarcity of good quality water, the utilization of saline water is significant in date palm irrigation due to the general notion that date palm is a salt-tolerant tree. However, this blanket statement cannot be accepted in full because studies have indicated that growth and yield losses start occurring at water EC of 4–6 dS/m depending upon cultivar potential, soil texture, drainage, and climatic factors. Ayers and Wescot (1985) reported that in general, minimum ECe for 100 % yield of date palm was 4.0 dS/m while there was no yield at ECe of 32 dS/m. The respective values for irrigation water ECiw are 2.7 and 21.0 dS/m.

A 50 % reduction in yield can occur at ECe 18.0 dSm^{-1} and ECiw 12. 0. Date palm was regarded as tolerant by Maas (1990), having a threshold value at 4.0 dSm^{-1}. The quality assessment studies in Qatar indicated that the major portion of groundwater is saline, and there are hidden negative effects on date palm growth and yields. When saline irrigation water is applied to a field, a major portion of it evaporates, leaving a salt load on or just beneath the surface. Thus, the soil salinity, which often is called secondary salinity, slowly and gradually increases and starts to negatively affect the date palms when it exceeds the plant's tolerance potential. The end result is decreased fruit yield.

10.7.2.4 Insects and Diseases

The date palm, like other tree crops, is attacked by a large number of insects, arthropods, fungi, nematode, and phytoplasma bacteria. Some of these cause serious crop damage and most often are difficult to control, thus threatening the very existence of plants in many cases. Considerable expense and effort are expended to control pests and diseases but most often success is limited, and a significant economic loss to the growers occurs.

Date Palm Insects The insects targeting date palm are of many types: insects, borers, scale insects, beetles, moths, and mites belonging to different orders and families. In the past, particular insect attacks were exclusive to individual countries or regions but with recent active exchanges of plant materials under somewhat loose quarantine measures; the situation has changed, and the pests have almost become common throughout the date palm-growing countries. It has been estimated that severe insect attacks cause a 50 % crop loss and in extreme cases, the entire crop may be damaged with ultimate death of the palms, especially during early stages of growth. Insects may infest all the plant parts: roots, stems, leaves, and fruit. For example, unripe fruits are attacked by *Coccotrypes dactyliperda*, which causes premature fruit fall. Ripe fruits are often attacked by nitidulids, *Carpophilus hemipterus*, *C. mutilatus* (*C. dimidiatus*), *Urophorus humeralis*, and *Heptoncus luteolus*, which cause decay. The red palm weevil, *Rhynchophorus ferrugineus*, bores into the leaf bases at the top of the trunk, causing the entire crown to wither and die. A tineid moth and a beetle, *Lasioderma testacea*, damage stored dates. Dates held in storage also are subject to invasion by the fig moth, *Ephestia cautella*, and the Indian meal moth, *Plodia interpunctella*.

Date Palm Diseases Date palms are susceptible to many diseases as well. Like insects, diseases can also cause significant yield losses, and fruit quality may also be damaged. For example, bayoud disease is caused by the fungus *Fusarium oxysporum*. Decay of the inflorescence is caused by *Manginiella scaeltae* in humid seasons. Date palm decline may be a physiological or the result of a species of the fungal genus *Omphalia*. Diplodia disease is a fungus manifestation on leafstalks and offshoots, and it may kill the latter if not controlled. The fungal-caused condition called *black scorch* stunts, distorts, and blackens leaves and adjacent inflorescences. Other fungal diseases include pinhead spot (*Diderma effusum*), gray blight (*Pestalotia palmarum*), and spongy white rot (*Polyporus adustus*). *Ceratocystis paradoxa* (*Thielaviopsis paradoxa*) causes rot of the terminal leaves (buds); if not properly controlled, it usually spreads and kills the palm. At some stage of its prognosis, the leaves of the infected palm are abnormal and grow in different directions creating the phenomenon called *Al-Majnouna*, followed by the death of the palm.

10.7.2.5 Agronomic Practices

The cultural and agronomic practices prevailing in Qatar for the date palm are either traditional or were devised elsewhere but directly adopted without any local research. The major deficiencies at present are as follows:

(a) Site-specific determination of optimum requirements of irrigation water, manure, and fertilizer for all the popular cultivars individually to obtain maximum possible yield using appropriate amount of inputs.
(b) Water conservation techniques for different areas have to be standardized so that scarce and dwindling resources are used appropriately while also being sustained for the future. This is very important to combat future climatic changes when even less water will be available.
(c) Narrow spacing among trees in old plantations makes it difficult for the introduction of mechanization, inefficient hand pollination, leaving many of the date palms unpollinated; minimal fertilization and minimal irrigation that results in lower yield and fruit quality. Little attention is given to fruit thinning and pruning.

10.7.2.6 Harvesting Losses and Postharvest Care

In one way per hectare yields of date palm are low and facing a decline with significant losses occurring either during picking or postharvest handling. Not only the quantity may decrease but quality of fruit may also be diminished. Fruit not harvested at the appropriate time leads to a decline in its quality during storage and for shipping and consumption. Extremely dry weather sometimes causes dates to shrivel on the palm. High humidity or cool temperatures during the maturing period may cause fruit drop or checking, splitting of the skin, darkening, black nose, imperfect maturation, and excessive moisture content or even rotting. Often, harvested fruit is not handled, transported, and stored properly. A tineid moth and a beetle, *Lasioderma testacea*, may damage stored dates. Dates held in storage are subject to infestation by the fig moth, *Ephestia cautella*, and the Indian meal moth, *Plodia interpunctella*. Very little research work is available on this storage problem, and even less has been adopted by growers and other stakeholders. Efforts need to be made to generate advanced harvesting techniques as well as avoiding postharvest losses so that minimum losses occur to the fruit during transportation and storage.

The improvement of keeping quality will ultimately increase the price of the fruit. Serious efforts are required to educate growers about effective handling techniques, adopted in other date palm-growing countries; however, they will not be accepted in Qatar unless or until locally developed recommendations become available.

10.7.2.7 Awareness of Date Growers, Training, and Technology Transfer

The developments of new techniques in date palm production, harvesting, and preservation have been very slow and insufficient to meet the real needs of the growers. In addition, the inadequacy of awareness/training programs is a weak link. Until a technology is adopted in the field, how much useful it may be, any investment of funds and resources goes to waste. An energetic stimulus is direly needed so that the efforts are clearly defined and implemented.

10.7.3 Research and Development Needs

Date palm research and development efforts must be systematic and strengthened to overcome and make up for past deficiencies. Not only site specific, economical, and practicable recommendations have to be formulated but these have to be transferred to the growers ensuring their field adaptation. The role of industry and private sector will also be highly important, especially in the development of new products and by-products, trade, and marketing. The following aspects of all the research and development strategies are recommended. A national level research institute for date palm has to be established. Another body should take responsibility for development work on date palm to create new areas for the crop and alleviate the constraints discussed above. Different research and development projects have to be undertaken keeping in view specified problems, the status of present work and future targets as well as needs. Good planning can provide the basis of the most appropriate and rapid development of date palm in keeping with the traditions and conservation of resources for the future and applying an environmentally friendly approach. These recommendations have been submitted to the government to take the necessary steps.

10.7.3.1 Date Palm Research

Keeping in mind the future requirements of growing date palms more effectively in Qatar, some research is either set to begin in 2014 or is approved and will start as soon as administrative formalities and technical requirements are completed. The ICARDA Project, Development of Sustainable Date Palm Production Systems in the GCC Countries of the Arabian Peninsula, is a research and development project aimed at generating new knowledge and practices for improving the production systems of date palm in the Gulf region. The activities are comprised of improving cultivar productivity, managing natural resources (land and water) for optimal performance, use of different inputs in the cropping process (fertilizers, pollinators, wastewater, etc.), and the study of genetic diversity of date palm. The sharing and transfer of technology and experience among the GCC countries are an integral part of the project. The following activities are in progress or planned in Qatar.

Crop Management Fruit thinning to improve air circulation within the fruit bunch has proved very effective, but on-farm testing is still under progress. Studies on irrigation scheduling also are under way.

Postharvest Handling and Processing Techniques Locally made glass chambers, ventilated and equipped with shelves, have proved effective for drying dates in shorter periods (5 days only vs. 12 days under plastic tunnels or 14–18 days for direct sun drying). The equipment also helps in reducing skin separation and keeps the date fruits much cleaner.

Saline and Treated Wastewater Effects on Date Fruit Quality and Heavy Metal Concentration When Managed with Soil Conditioners This experiment has been approved under Activity 9 (Effect of irrigation with treated water on fruit quality and heavy minerals content) of the ICARDA (2010) project. The objectives are to investigate the effect of saline water and wastewater on date quality under Qatari conditions and to study the concentration of heavy metals, if any, in soil, plant leaves, and date fruits. This is a two-factor experiment of strip-plot design with three replicates, comprising of two soil conditioners: Zeolite at 2 % by volume and Compost at 10 kg/plant/year. Plants will be irrigated with two types of water: groundwater available at the farm and treated wastewater. Fruit mass in each season will be recorded, and soil, leaf, and fruit analyses will be completed.

10.7.3.2 Future Research Projects

A few projects proposed to fill the gaps and deficiencies of locally evolved technology for growing of date palm and increasing production in the country to make it self-sufficient are under consideration. The Government of Qatar should consider this on a prioritized basis to establish a date palm research and development body for preparation, collaboration, and implementation of such projects.

Research Project to Evaluate High Yielding and Stress Resistant Cultivars High-yielding good quality date palm cultivars capable of withstanding different stresses such as biotic (pests and diseases) and abiotic (drought, salinity, high temperature) are the demand of the day. In addition to conventional breeding, modern techniques of biotechnology and genetic engineering should be used to create new cultivars. Breeding material may be brought in from countries possessing cultivars of high potential.

Research Project for Water Conservation and Minimal Irrigation Requirements The circumstances of water availability are not encouraging, and the situation is expected to deteriorate further in view of future climatic changes deemed to occur rapidly. Therefore, water utilization per kilogram of dates has to be minimized for effective and efficient use of the limited precious water resources. For this purpose, water losses through leaching and evaporation have to be minimized, and water utilization has to be justified. Appropriate water requirements are to be determined. This project will encompass research and development activities. Research activities will stimulate design of engineering and agronomic techniques like field leveling, mulching (plastic or harvested and grinded date palm leaves), application of soil conditioners, improvement of soil physical properties (infiltration rate and water-holding capacity) through cultivation practices, and application of organic matter (manures, compost, and raw organic material from crop residues, poultry, and other agricultural allied industries). Research has to be systematic and develop a few but significantly contributing techniques. The development activities will consist of transforming traditional irrigation system (mainly flood irrigation) into bubbler or drip irrigation.

Research Project to Combat Soil and Water Salinity Effects Soil and water salinity are very significant problems hampering date palm growth and yield, and the impact is expected to be exacerbated further with predicted climatic changes. The very limited quantity of good quality irrigation water will consequently require greater utilization of saline groundwater, which will definitely result in salt accumulation in the rhizosphere and secondary salinity buildup. Conducting research on techniques like leaching fractions for various combinations of cultivars, soil textures, climatic conditions, irrigation water of variable salt content, and different soil salinity levels will be another component of the research. The impact of organic matter applications to improve physical properties of soil and for providing relatively better environment conditions to plants even in saline soils and mulching to reduce evaporation and salt accumulation and resultant adverse effects on growth and yield of date palm could be other investigating components.

Research Project for Generation of Improved Agronomic Practices Agronomic practices are key considerations for date palm growth and play a critical role in yield performance. Most of these are traditional, general, and less quantitative in nature. For example, details are not available to recommend specific quantities of fertilizer and manure for a specific cultivar grown in a particular type of soil. Specific stage and time of application and types of fertilizer are also unclear. Similarly, the ideal harvest time for each cultivar is not specified. Therefore, establishing specific recommendations for various agronomic operations is very important for achieving maximum yields. Fertilizer formulations for each important cultivar under a specific set of soil and climatic conditions, investigating effects of growth hormones and conducting research on climatic change, e.g., change in temperature, humidity, evaporation, etc., are important priorities.

Research Project on Integrated Pest Management (IPM) Date palm fruit loss and deterioration of quality caused by insects have become highly significant in the last two decades. Various types of insects such as borers, bugs, beetles, moths, weevils, scale insects, beetles, and mites attack the plant. Dubas bug and red palm weevil have become very important in recent years and are out of control at certain locations. The most common practice against insects is to use chemical pesticides. However, objections are increasingly being raised against such practices. Environmental considerations and concerns about the residual effects of insecticides are emerging rapidly. Therefore, it is logical that an IPM approach be adopted. Collaborative regional efforts to control common insects may be required. Putting strict quarantine measure in force to block entry of new insects and implementing awareness programs among date palm growers will strengthen the efforts.

Research Project on Control Measures Against Date Palm Diseases Diseases are no less harmful to the date palm than insects. Diseases may retard growth, cause withering or mortality of plant or deteriorate fruit quality and thus ultimately decrease yield and the income of growers. Therefore, it is very important to conduct very relevant research to minimize such losses through controlling diseases if they cannot be eradicated totally.

Research Project to Implement Modern Harvesting Techniques and Reduce Postharvest Losses Although proper harvesting of fruit of date palm is very important to minimize losses and deterioration of quality, very little improvement has occurred in traditional techniques. It is highly desirable that fruit harvesting be modernized by adopting new technologies and mechanization such has occurred with other crops. Finding the appropriate harvesting time of each cultivar, single or multiple harvests and date fruit types (soft, semidry or dry) are called for, while keeping in mind prevailing seasonal conditions as well as future climatic changes.

Research Project on Packing, Long-Term Preservation, Value-Added Products and By-products Date production is minimally profitable to growers because of post-harvest losses, few value-added products, and little utilization of residual plant materials such as leaves and empty fruit bunches, which typically are burned. These factors must be considered seriously to add value to date palm growing along with efforts to enhance fruit production. Favorable income can be realized for farmers if new value-added products derived from by-products of date fruits and residual material are introduced. Development of new techniques to store dates for longer periods, the introduction of new products by combining dates with other food items, dry fruit and related foods, along with, using crop residues and stem wood and petioles to make useful and attractive articles for home use, as well as composting and mulching of waste material to enhance crop production are worthy subjects for future research and development.

10.7.3.3 Training Project for Development of Human Resources

Date production by traditional means is centuries old in Arabian countries. However, there is a dilemma because local manpower and human resources are neither well informed nor appropriately or sufficiently trained to carry out modern production, preservation and processing of the crop. Therefore, proper training is of high importance to assure a progressive future, self- reliance, and self-dependence. Qatar has to take a note of this important requirement.

10.7.3.4 Development of New Land Areas for Date Palm Cultivation

Project for Development of Land and Water Resources for Date Growing Land and water resource surveys are a basic requirement to point the agriculture sector of a country in the proper scientific direction. Feasibility studies of land classification and suitability provide critical information to manage these resources effectively while highlighting significant problems to be overcome for growing date palms. Identified problems can best be solved on a prioritized basis.

Development Project to Replace Old Orchards/Cultivars with New Large Modern Orchards by the Government and Private Sectors One of the major reasons for low date fruit yields is the presence of old cultivars having very little potential, as well as low resistance to any kind of stress. Nonproductive male plants (more than needed for pollination) are widespread in the orchards. Therefore, it is urgent that not only old cultivars should be replaced but also the government and private owners/companies should establish some new mega date palm orchards using modern technologies. The following sequential steps are recommended:

(a) Carry out surveys to select orchards at different sites that need replacement.
(b) Continue land classification surveys to select new sites and areas more appropriately suitable for growing date palms.
(c) Prepare a plan for stepwise removal/replacement of old cultivars as well as establishment of new larger orchards in the public sector.
(d) Purchase of land by the government declared suitable for growing of date palm.
(e) Establish mega date palm farms owned by the private sector and maintained through modern techniques.

10.7.3.5 Probabilities of Increasing Date Palm Plantations in Qatar

Presently, date palm is grown on 2,366 ha of land in Qatar, but there is very high potential to increase this area if prevailing problems are resolved. Considering the land evaluation data presented in Table 10.11, it is clear that only Mapping Unit 9 and 12 have problems of slope that are difficult to address. However, all the other mapping units have problems like cleaning (coarse surface fragments), salinity, water availability, and low soil fertility (Anonymous 2004). Thus, about 171,595 ha (Mapping Units 7, 10, 11, 14, 15, and 17) can be brought under date palm by providing irrigation water and application of suitable fertilizers. Hence, there is the theoretical potential to increase date palm area by some 70 times over the present area (see Fig. 10.5).

Table 10.11 Land suitability of Qatari soils for growing date palm

Mapping units	Suitability class	Area (ha)	Area (%)
1	N1c	16,279	1.4
2	N1c	281,860	24.5
3	N1c	242,151	21.1
4	N1c	213,759	18.6
5	N1c	9,989	0.9
6	N1c	21,722	1.9
7	S3m	34,596	3.0
8	N1c	9,849	0.8
9	S3t x c	11,161	0.1
10	N1n	26,355	2.3
11	N1n	61,415	5.3
12	N2t	14,432	1.2
13	N1c	32,429	2.8
14	N1n	3,055	0.3
15	N1m n	24,249	2.1
16	N1c	7,152	0.6
17	N1n	21,924	1.9
18	N1c	22,402	2.0
19	N1c	17,177	1.5

Source: Anonymous (2004)
S3 marginally suitable, *N1* presently not suitable, *C* clearing limitation (surface coarse fragments), *t* due to land grading limitation (topography), *x* due to salinity limitation (leaching water requirement), *m* due to moisture availability limitation (water availability), *n* due to nutrition limitation (NPK application)

10.8 Processing and Novel Products

No processing, packing or novel products production industry has yet been established in Qatar. Most dates are marketed fresh without any formal packaging. However, imported packing materials of all types are available in the market.

10.9 Conclusions and Recommendations

The area under date palm and production (in 2010, 2,469 ha; 21,491 mt of dates) indicates that Qatar is relatively small date producer. Yield has been increasing steadily since 1980. Good potential exists to expand the area and production of dates if existing soil and water resources are used efficiently. Date palm feasibility studies indicate that 171,595 ha potentially can be brought under this important fruit in the country. However, major constraints of low yields, scarcity of good quality water, soil and water salinity, low-yielding cultivars, poor

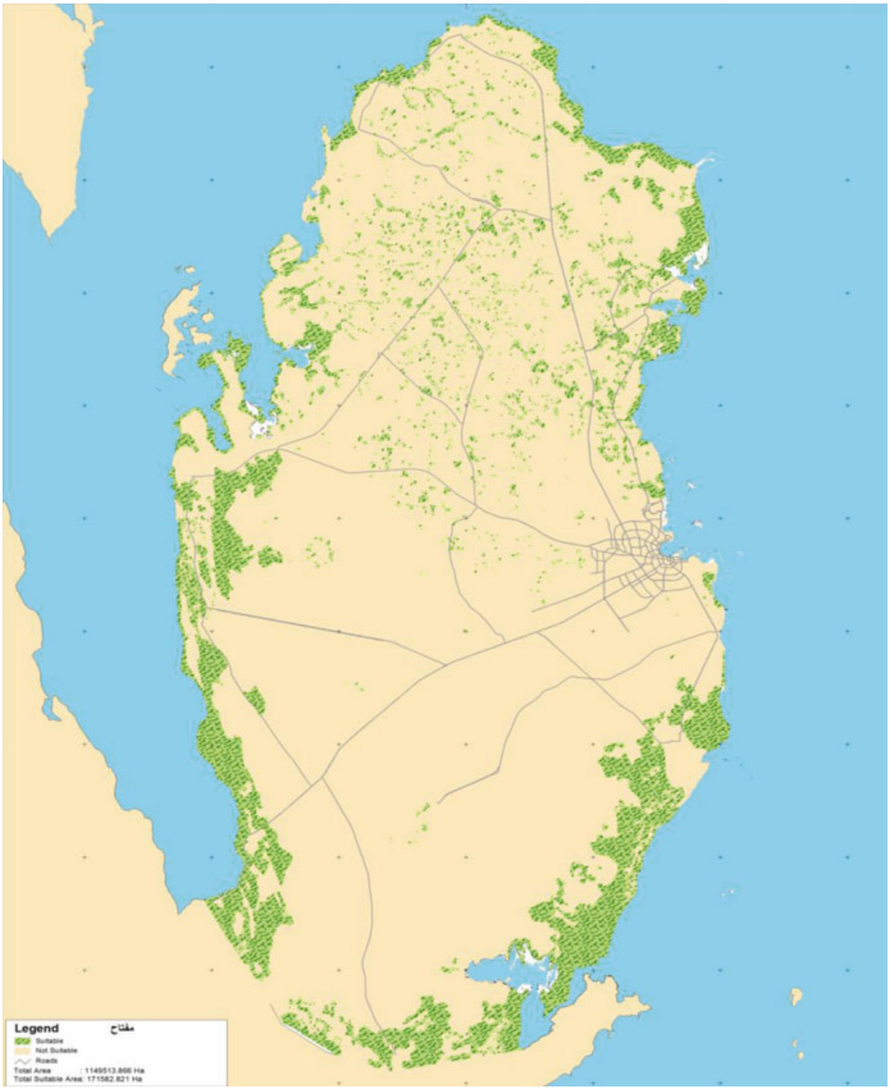

Fig. 10.5 Potential suitable areas for date palm cultivation (shaded in *green*) (*Source*: Department of Agriculture and Water Resources)

agronomic practices due to limited know-how of the growers, insects and diseases, and lack of research support all need to be addressed on a prioritized basis. Tissue culture is to be strengthened to meet needs of the country and stop the importation of plantlets. Research and development facilities for date palm must be established. A considerable amount of research and development work is required to promote date palm cultivation and achieve higher yields. For this purpose, many research and development projects have to be planned and implemented. New areas have to be brought under cultivation. A date palm-based industry has to be created to reduce the need for imported date products and by-products.

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