Morphological characterization of Saudi Arabian date palm cultivars based on vegetative and reproductive traits

Nabeel Al-Wusaibai1, Abdallah Ben Abdallah2, Mohamad Al-Husseini1, Hajji Al-Hajji1, Husein Al-Salman1, Khaled Kurshed1, And Abdallah Oihabi3
(1) Date Palm Research Centre (DPRC), P. O. Box 43,Al-Hassa-31982, KSA.
(2) FAO Project (UTFN/SAU/043/SAU), DPRC,
P. O. Box 43, Al-Hassa-31982, KSA.
(3) FAO Programme Coordination Unit, P O Box 558, Riyadh-11421, KSA.

n_alwusaibai@yahoo.com

ABSTRACT

The Kingdom of Saudi Arabia is among the top three date producing countries of the world, producing over a million tons of dates annually from an estimated 23 million date palms grown in over 172,000ha accounting for 17% of the global production. The Kingdom has a wide genetic pool of over 400 date palm cultivars.

We studied 11 representative cultivars from eastern, central and western region of the Kingdom. The major vegetative traits studied pertained to fronds, including the leaflets and thorns (spines) on the fronds. With regard to the reproductive traits the number of bunches, bunch stalk, strands, flowers and fruits (fructification) were studied.

Results revealed that the cultivars from the western region had an intensive vegetative growth, as reflected by the higher number of fronds in the cultivars, Ajwah, Anbara and Safawi. This parameter could serve as an indicator to distinguish between cultivars from the date growing regions of the Kingdom. With regards to the length of the fronds, cultivars from the central region viz. Nabutsaif, and Sulaj registered the maximum frond length. Further, the highest number of thorns on the fronds was recorded in the cultivarSafawi from the western region, while the cultivarKhunaizi from the eastern region had longest thorns. It is pertinent to mention that the cultivars from the central region were characterized by few thorns on the frond spaced closely and consequently had more area on the frond for leaflets which could be a genetic character to adapt to the environment. Observations on the reproductive traits revealed that the cultivars from the eastern region recorded the best results with regard to bunch number (Sheshi),length of bunch stalk

(Khalas),width of bunch stalk (Reziz) and number of strands per bunch (Khalas). Further, Anbara from the western region recorded the maximum average fruit length and width while the cultivars Khalas and Reziz recorded the maximum length and width of the seed, respectively. Further, the cultivars Sheshi and Ajwa recorded the maximum weight of fruit and seed, respectively. With regard to the form of fruits Khalas, Sheshi and Sokai were oval, Reziz, Ajwah and Nabutsaif were aspheric while fruits of Anbara and Sulaj were semi-cylinderical in form. Seeds of the cultivars studied had three distinct forms viz. semi-cylinderical in Khalas and Ajwah, fusiform in Sheshi, Anbara and Sulaj while it was oval in Reziz and Nabutsaif. These studies form the basis to categorize date palm varieties of the Kingdom into clusters based on the above traits.

Key Words: Date palm, cultivars, Saudi Arabia, morphological characterization

INTRODUCTION

Date palm Phoenix dactylifera L. is an important fruit crop of the arid regions of the world especially in the Middle East and North Africa where it has been cultivated since ancient times and is closely associated with the life and culture of the people in these regions. It is estimated that there are 100 million date palms of which 60 % exist in the Arab world. It is believed to have been cultivated as early as 4000 B.C. and has its origin in Mesopotamia (Wrigley, 1995).During the past three centuries, dates have also been introduced to new production areas in Australia, the Indian sub continent, Mexico, southern Africa, South America, and the United States. Dates are a main income source and staple food for local populations in many countries in which they are cultivated, and have played significant roles in the economy, society, and environment of those countries (Chao and Krueger, 2007). Date palm has wide genetic diversity due to a high degree of out breeding (Popenoe, 1992). Zaid and De Wet, 2002 reported the occurrence of3,000 cultivars around the world.

The Kingdom of Saudi Arabia is among the top three date producing countries of the world, producing over a million tones of dates annually from an estimated 23 million date palms grown in over 172,000ha accounting for 17% of the global production. Over 400 date palm cultivars have been reported from Saudi Arabia (FAOstat 2010; Anonymous, 2006). As in all date palm growing countries of the world in Saudi Arabia too, date palm cultivars are region specific characterized by unique vegetative and reproductive traits. These traits play an important role in characterization of a particular cultivar in respect to its adaptation to a particular agro-ecosystem besides impacting the yield and commercial norms of dates. Studies on characterization of date palm cultivars are rare (Baker *et al*., 1999).

This study pertains to the morphological characterization of major Saudi Arabian date palm cultivars from the eastern, westeran and central regions of the Kingdom based on vegetative and reproductive traits.

MATERIALS AND METHODS

Studies were carried out during 2013 to characterize major Saudi Arabian date palm cultivars from the eastern (4), western (3) and central (4) date palm growing regions of the Kingdom based on the vegetative and reproductive traits. The cultivars studied are presented in table 1.

Studies on the vegetative traits were carried out with respect to the fronds where in observations on several characters viz.number of fronds / palm, length of fronds (m), number of leaflets / frond, length of frond mid-rib with leaflets (m), number of thorns (spines) /frond, length of thorn / frond (m), length of frond mid-rib with thorns (m) and length of frond mid-rib between last leaflet and first thorn (m) were recorded. As regards the reproductive traits fruit bunch characters viz. number of bunches / palm, bunch stalk length (m), bunch stalk width (m) and number of strands / bunch were studied. Further, observations on the physical traits (length, width and forms) of fruits and seeds were also recorded in Khalas, Sheshi, Reziz, Ajwah, Anbara, Sulaj, Nabutsaif and Sugai.

With regard to the frond and bunch characters three replications (palms) per cultivar was maintained. Individual observations were recorded on one frond or bunch in each of the three replicate palms. As regards the fruit characters observations were recorded in three palms per cultivar wherein 15 fruits per palm were maintained. Data on the above characters was compiled and subjected to statistical analysis (ANOVA, p=0.05). Results of the study are presented and discussed below.

RESULTS AND DISCUSSION

Results presented below indicate significant variation among cultivars for all the traits studied.

Among the several vegetative traits studied results presented

in table 2 reveal that the date palm cultivars from the western region of the Kingdom had the highest average number of fronds / palm (65.77) with the cultivars Ajwah (66.30) and Anbara (66.00) having the maximum and statistically similar number of mean number of fronds. The least number of fronds/ palm (39.33) were seen from the cultivars in the central region of the Kingdom with the cultivar Sukari recording the lowest mean number of fronds (32.00). Further table 2 reveals that length of the fronds and leaflets / frond were inversely related to the number of fronds/ palm with cultivars from the east recording a least values for mean frond length of 3.70 m and leaflets/ frond of 162.25 as compared to cultivars from the central region which registered the highest frond length of 4.70 m and leaflets/ frond of 205.43. A similar trend was observed with respect to length of frond mid-rib with leaflets, where cultivars from the central region recorded the highest mean value (3.72m), with cultivars from the east registering the lowest mean value for this character (2.57m). It can be inferred that the lower number of fronds per palm for cultivars from the central region of the Kingdom was compensated by higher frond length and leaflets / frond there by sustaining photosynthetic levels in relation to date palm cultivars from the west of the Kingdom where the cultivars recorded higher number of fronds / palm. Though, cultivar wise significantly different values were recorded for number of leaflets on the right and left of the frond, this character was cultivar specific with the same number of leaflets being recorded for each cultivar on the right and left of the frond mid-rib.Microsatellites analysis of 26 Tunisian date palm cultivars using stable vegetative features showed high polymorphism among the cultivars studied (Hamza*et al*.,2011a).In date palm yield levels are known to be correlated the number of fronds. Nixon, 1957 reported that an average of 7.5 leaves/bunch ratio in the Deglet Noor cultivar was needed to obtainhigh yields of fruit of good quality and also to assure the production of an adequatenumber of bunches the following year. Bacha and Shaheen, 1986 concluded that increasingleaf/bunch ratio up to 9: 1 resulted in increasing yield and improving fruit quality in both Nabutsaif and Reziz cultivars.

Results pertaining to characteristics of thorns (spines) on date palm fronds in major Saudi Arabian cultivars (Table 3) show significant differences among the cultivars studied with Safawi from the west of the Kingdom recording the highest number of thorns / frond (39.00). In general cultivars from the east recorded least mean number of thorns / frond (22.33) as compared to cultivars from the central region of the Kingdom which recorded the highest mean value (26.60). This character was inversely related to length of the thorns on the frond with cultivars from the east recording higher mean values (0.18m) as compared to date palm cultivars from the central region of the Kingdom (0.10m).Variation in this trait (spines) could be a physiological adaptation to different environmental conditions prevailing in the three regions of the Kingdom.

With regard to the fruit bunch characteristics (Table 4), significant differences were recorded for the traits studied with the highest mean number of bunches / palm being recordedin date palm cultivars from the east (12.59) followed by cultivars from the west (11.33) and the central region of the Kingdom (9.23), respectively. The cultivar Sheshi from the east registered the highest number of fruit bunches/ palm (16.33). As regards the number of strands / bunch the cultivars from the east registered the highest mean values (76.75), while the cultivars from the west of the Kingdom registered the lowest mean value (49.33). For this trait, the cultivar Khalas recorded the highest value of 94.30 strands/ bunch.The cultivars, Khalas and Reziz from the east also recorded maximum length and width of bunch stalk, respectively. Yield levels in date palm are known to be influenced by vegetative traits especially the leaf/ bunch ratio (Nixon, 1957; Bacha and Shaheen, 1986). Our findings with respect to the cultivars Reziz and Khalas are in agreement with these reports.

Further from figure 1 it is evident that the cultivar Anbara from the western region recorded the maximum average fruit length and width while the cultivars Khalas and Reziz recorded the maximum length and width of the seed, respectively. Further, the cultivars Sheshi and Ajwa recorded the maximum weight of fruit and seed, respectively (Figure 2). Reports from Saudi Arabia indicate that analysis of the morphological data of fruits revealed a high level of diversity in length-width ratio, colour, shape of the fruit, fruit-base and in the percentage of area covered by the fruit cap. Correlation of morphologic characters with genomic similarity using RAPD markers showed that the fruit shape is one of the characteristics most influenced by genetic variation (Al-Khalifa *et al*.,2012). Studies carried out on the quality norms of premier date palm cultivars from the eastern region of Saudi Arabia (Al-Abdoulhadi, 2011), showed that Khalas recorded the maximum fruit

length in all the three categories of large, medium and small sized fruits . With regard to the breath of fruits, the cultivar Sheshi registered the highest values. Further, Sheshi recorded the highest fruit weight values, which in turn influenced the number of fruits per unit weight, with Sheshi recording the least number of fruits per 500g .Sakret al.,2010 from Egypt reported fruit length to significantly differ among the fruits of eight date palm cultivars studied with the cultivar Kuboshy registering the maximum fruit length, while the cultivar Samany registered the maximum fruit width.

With regard to the form of fruits Khalas, Sheshi and Sokai were oval, Reziz, Ajwah and Nabutsaif were aspheric while fruits of Anbara and Sulaj were semi-cylinderical in form. Seeds of the cultivars studied had three distinct forms viz. semi-cylinderical in Khalas and Ajwah, fusiform in Sheshi, Anbara and Sulaj while it was oval in Reziz and Nabutsaif (Table 5).Our results are in agreement with reports by Al-Khalifa *et al* 2012 for fruit shape of the cultivars Khalas and Sukari. Studies carried out in Tunisia on date palm cultivars to study the morphological and genetic diversity showed significant differences among subpopulations for all traits measured with morphological variation being correlated to fruit maturity period (Hamza *et al*., 2011b).

It can be concluded that there exists wide variability among the date palm cultivars studied and further molecular analysis will help to determine the relationship among these cultivars forming the basis to categorize date palm varieties in Saudi Arabia into clusters based on the above traits.

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Tables

Table 1. Major date palm cultivars from the eastern, western and central date palm growing regions of Saudi Arabia selected for the study

Sr. No.	Date palm cultivars of Saudi Arabia studied		
	Eastern region	Western region	Central region
1	Khalas	Ajwah	Sulaj
2	Sheshi	Anbara	Sukari
3	Reziz	Safawi	Nabutsaif
4	Kheneizi		Sugai

Table 2. Characteristics of date palm fronds in major Saudi Arabian cultivars

Sr. No.	Cultivar	Mean values					
		Number of fronds / palm	Length of fronds (m)	Number of leaflets / frond	Number of leaflets on right of frond mid-rib	Number of leaflets on left of frond mid-rib	Length of frond mid-rib with leaflets (m)
I. Cultivars from the Eastern Region							
1	Khalas	55.00ab	3.87b	175.70c	88.70c	88.70c	2.77c
2	Sheshi	46.70bc	3.43c	145.00d	73.00d	73.00d	2.69c
3	Reziz	56.70ab	3.45c	152.30d	76.00d	76.00d	2.20d
4	Kheneizi	45.30bc	3.98b	176.00c	87.70c	87.70c	2.61cd
II. Cultivars from the Western Region							
5	Ajwah	66.30a	4.05b	199.00b	99.00b	99.00b	3.16b
6	Anbara	66.00a	3.51c	169.30c	87.00c	87.00c	2.64c
7	Safawi	65.00a	4.79a	170.30c	83.30cd	83.30cd	3.40b
III. Cultivars from the Central Region							
8	Sulaj	53.30ab	4.97a	224.00a	113.70a	113.70a	4.08a
9	Sukari	32.00d	4.28b	197.70b	98.30b	98.30b	3.25b
10	Nabutsaif	32.70d	5.13a	186.70bc	92.70c	92.70c	3.97a
11	Sugai	-	4.43b	193.30b	96.70b	96.70b	3.58ab
Regional mean values							
	East	50.93	3.70	162.25	81.35	81.35	2.57
	West	65.77	4.12	179.53	89.77	89.77	3.07
	Centre	39.33	4.70	205.43	100.35	100.35	3.72

Figures with same letters within the column are not significantly different (p=0.05)

Table 3. Characteristics of thorns (spines) on date palm fronds in major Saudi Arabian cultivars

Sr .No.	Cultivar	Mean values			
		Number of thorns /frond	Length of thorn / frond (m)	Length of frond mid-rib with thorns (m)	Length of frond mid-rib between last leaflet and first thorn (m)
I. Cultivars from the Eastern Region					
1	Khalas	27.33c	0.16b	0.87b	0.24c
2	Sheshi	20.33d	0.12bc	0.77b	0.29b
3	Reziz	21.00d	0.13b	0.87b	0.21c
4	Kheneizi	25.67c	0.24a	0.90b	0.23c
II. Cultivars from the Western Region					
5	Ajwah	19.00d	0.12bc	0.75b	0.38a
6	Anbara	18.67d	0.09c	0.72bc	0.40a
7	Safawi	39.00a	0.12bc	0.36b	0.34b
III. Cultivars from the Central Region					
8	Sulaj	25.00c	0.08c	0.84a	0.22c
9	Sukari	31.67b	0.08c	0.84b	0.31b
10	Nabutsaif	26.33c	0.14b	0.92b	0.39a
11	Sugai	23.33c	0.09c	0.73bc	0.35ab
Regional mean values					
	East	22.33	0.18	0.85	0.24
	West	25.56	0.11	0.61	0.37
	Centre	26.60	0.10	0.83	0.32

Figures with same letters within the column are not significantly different (p=0.05)

Table 4. Characteristics of date palm bunches in major Saudi Arabian cultivars

Sr. No.	Cultivar	Mean Values			
		Number of bunches / palm	Bunch stalk length (m)	Bunch stalk width (m)	Number of strands / bunch
	Cultivars from the Eastern Region				
1	Khalas	12.33b	1.67b	0.04b	94.3a
2	Sheshi	16.33a	0.98bc	0.05b	79.3b
3	Reziz	11.00b	1.06b	0.14a	63.7b
4	Kheneizi	10.67bc	1.24ab	0.04b	69.7b
Cultivars from the Western Region					
5	Ajwah	9.00c	0.81c	0.04b	65.0b
6	Anbara	12.00b	0.79c	0.04b	37.3a
7	Safawi	13.00b	1.05b	0.05b	45.7c

Sr. No.	Cultivar	Mean Values			
		Number of bunches / palm	Bunch stalk length (m)	Bunch stalk width (m)	Number of strands / bunch
Cultivars from the Central Region					
8	Sulaj	12.33b	1.24ab	0.04b	74.7b
9	Sukari	6.67d	0.88c	0.04b	54.7c
10	Nabutsaif	8.67c	1.48a	0.04b	74.7b
	Sugai	-	-	-	-
Regional mean values					
	East	12.59	1.11	0.07	76.75
	West	11.33	0.88	0.06	49.33
	Centre	9.23	1.20	0.04	68.03

Figures with same letters within the column are not significantly different (p=0.05

Table 5. Forms of date fruits and seeds in major Saudi Arabian cultivars

Sr. No.	Cultivar	Fruit form	Seed form
1	Khalas	Oval	Semi-cylindrical
2	Sheshi	Oval	Fusiform
3	Reziz	Aspheric	Oval
4	Ajwah	Aspheric	Semi-cylindrical
5	Anbara	Semi-cylindrical	Fusiform
6	Sulaj	Semi-cylindrical	Fusiform
7	Nabutsaif	Aspheric	Oval
8	Sugai	Oval	Fusiform

Figures

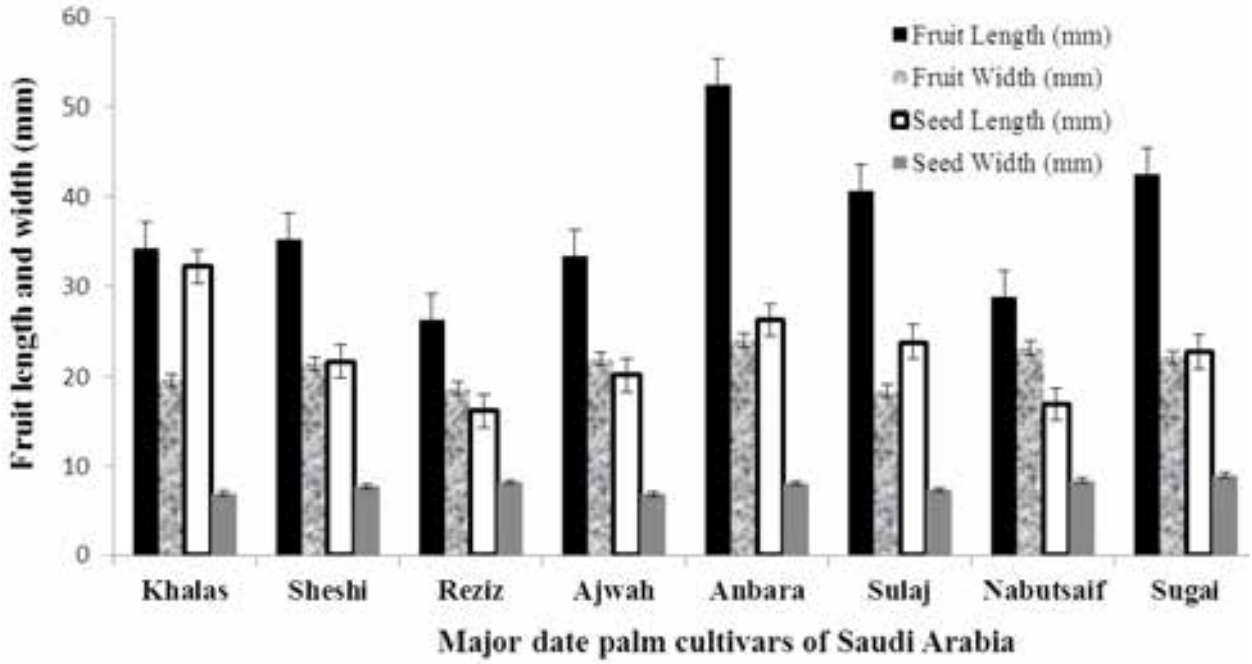

Figure 1. Physical traits (length and width) of date fruits and seeds in major Saudi Arabian date palm cultivars

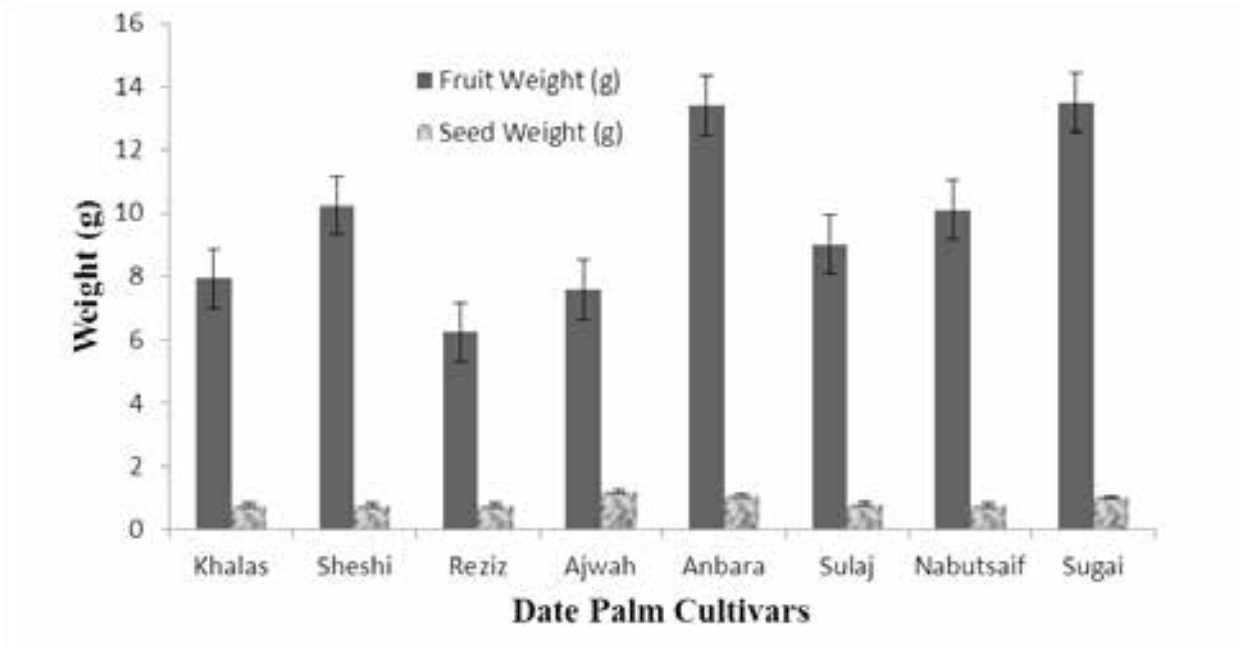

Figure 2. Weight of date fruits and seeds in major Saudi Arabian date palm cultivars