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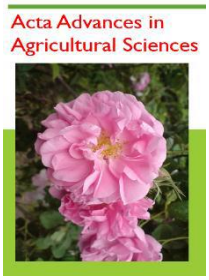

Research Article

Effect of pollen source and area distribution on yield and fruit quality of 'Khalas' date palm (*Phoenix dactylifera*, L.) under Saudi Arabia conditions

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ABSTRACT

Khalas' date palm trees are known in the production of the main date varieties grown in Saudi Arabia. The influence of pollens (introduced from these two locations) on yield and fruit quality of "Khalas" dates was estimated in the experiment conducted from 2012 to 2013. Twelve 'Khalas' female trees were grown and selected in two locations (L_1; the Agricultural Experimental and Research Station-Deyrab, Faculty of Food and Agricultural Sciences, King Saud University, Riyadh and L_2; a private orchard, Al-Ahsaa district -West Riyadh). Results indicated that pollen source significantly affected the fruit set percentage as maximum fruit set (57.57%) was observed from trees pollinated with M_1 (Rayidh male). Bunch weight, fruit weight, flesh weight and fruit volume were significantly improved with pollens from M_1 palm trees compared to the other male tree (M_2). Bunches pollenated from M_1 recorded the highest values in most physical characters. There were non-significant effects between the two locations of female tree in fruit set, yield component and fruit quality. Interaction effect ($M_1 \times L_2$) recorded the highest fruit set; bunch weight and most physical and chemical characters in both seasons. Moreover, bunches were pollinated by M_1 either in L_1 or L_2 earlier ripening 22 - 24 days than other bunches pollinated with M_2. This study recommends that the best pollen source (Male tree) should be selected from different locations in order to get the most desired fruit quality characteristics in Khalas date palm.

Introduction

Saudi Arabia is one of the leading date producing countries that harbors about 450 cultivars (Bashah 1996). Most of these cultivars are known only to some specific localities and their distribution is confined to these areas (Zaid and Wet 1999a). Date palm is a dioecious plant with separate male and female trees in which pollination is normally done by wind. However, to ensure and improve fruit setting, pollination should be done artificially in which mature male inflorescences are cut off before spathe splits and strands are placed in the

female flower cluster allowing pollens to be transferred onto female flowers (Asif et al., 1983; Shabana et al., 1985). Pollen of date palm has an effect on the resulting seed shape and size (Xenia) and on the size, development, quality and ripening time of date palm fruits (Metaxenia) (Nixon, 1954). Pollen source affects fruit quality and ripening time (Monselise 1988; Nasser and AL-Khalifa 2006). A metaxenic effect on reducing time to fruit ripening was pronounced in areas of arid climate since high temperature is the dominant factor enhancing fruit growth and development (Shaheen et al., 1989). However, fruit growth and development may be threatened by frost, rain or even the relatively short period of warm temperature during the season of fruit growth and development (Farag, 2005).

This research aimed to study the effect of two sources of pollen on fruit quality and maturity of "Khalas" date palm cultivar grown in two locations under Saudi Arabia conditions.

Materials and Methods

Plant materials and pollination treatments

The present study was conducted during two successive growing seasons of 2011/2012 and 2012/2013. To determine the influence of pollen source on fruit set, yield and quality, two males were chosen (M_1 from Riyadh district and M_2 from Al-Ahsaa district, West Riyadh, KSA) on Khalas cultivar. Six 'Khalas' female trees were grown and selected in each location (L_1: the Agricultural Experimental and Research Station-Deyrab, Faculty of Food and Agricultural Sciences, King Saud University, Riyadh; L_2: a private orchard, Al-Ahsaa district -West Riyadh) for the experiment. The trees are grown in sandy soil at 10 m apart. All palms were at similar age (15 - 16 years old), uniform in growth and subjected to the same management and cultural practices. Ten spathes were randomly chosen per female. Five spathes were pollinated (8 strands/spathe) by M_1 and the other five pollinated by M_2 in each female in both locations. All spathes were bagged after pollination with a big craft paper bag. Hand pollination was carried out by placing desired male pollen strands within female spath from each pollen source.

Measurements of fruit set and yield at harvest

Fruit set (%) Fruit set was calculated every two weeks (during May and June months) using the following equation:

Fruit set (%) =No. of retained fruits on the strand/No. of retained fruits + No. of flowers scars on the same strand×100 (El-Makhton, 1981)

To determine the total yield at harvest, each spathe was weighed separately using weighing balance and was expressed in kilogram (kg).

Determination of physical quality characteristics:

At the end of the Bisir stage (maturity stage), bunch weight was recorded and 50 fruits per bunch were randomly collected and immediately transported to the Fruit Laboratory of the College of Food and Agricultural Sciences for quality measurements. Fruit and seed weight (g), size (cm^3), height and diameter (cm) were recorded. The moisture percentage was determined in fruit flesh. The percentage of soluble solids content (SSC) was determined in fruit juice using BRX-242 digital refractometer. Titratable acidity was determined in juice by titrating with 0.1 N sodium hydroxide in the presence of phenolphthalein as an indicator and results were expressed as a percentage of maleic acid (Shaaban et al., 2006). Reducing, non–reducing and total sugars were determined according to A.O.A.C.1995.

Experimental design and statistical analysis:

The experiments were set in split-plot design with five replicates per treatment according to Little and Hills 1972 and analyzed using SPSS statistics software version 17.0 (SAS/STAT, 1988). Means were compared using Duncan's new multiple-range test at $P \leq 0{\cdot}05$.

Results

Effect of pollen sources on physical and chemical characteristics of date palm "Khalas":

Results presented in Table 1, indicated that pollen source from male1 (Riyadh) recorded

the highest significant values in fruit set, bunch weight and testing physical characters. There were non-significant differences between males in fruit set and bunch weight during 2012 season only. Male1 (from Riyadh) recorded the highest significant differences in fruit weight, fruit volume, seed weight, and fruit length and fruit diameter.

On the other hand results of most chemical characters were affected by pollen sources, while there were non- significant differences between pollen sources in SSC during 2012 and 2013, reducing and total sugars in 2013 only. There were significant differences between males in acidity and fruit moisture during 2012 and 2013, also in reducing and total sugars in 2012 only

Effect of female tree locations on physical and chemical characteristics of date palm "Khalas"

Data illustrated in Table 2, showed that there were non-significant between locations (Riyadh and Al-Ahsaa) in fruit weight, seed weight and fruit diameter during 2012 and 2013, also during 2013 in fruit set, bunch weight, fruit volume and during 2012 fruit length only. There were significant differences during 2012 in fruit set, bunch weight fruit volume and during 2013 in fruit length.

Moreover, there were non-significant differences in some chemical characters such as reducing and fruit moisture during 2012 and 2013, also during 2013 and 2012 in SSC and total sugars percentages, respectively. There were significant differences between locations in acidity during 2012 and 2013 and during 2012 and 2013 in SSC and total sugars percentages, respectively.

Interaction effect of pollen source (male trees) and locations (M x L) on physical and chemical characteristics of date palm "Khalas"

Pollen sources and female tree locations significantly influenced physical and chemical characteristics (Table 3)

Fruit set (%): there were significant differences between $M_1 \times L_1$ and other interactions ($M_1 \times L_2$, $M_2 \times L_1$ and $M_2 \times L_2$) during 2013 and recorded the highest (61.71%) significant value .There were nonsignifcant differences between $M_1 \times L_1$ and $M_2 \times L_2$; between $M_1 \times L_2$ and $M_2 \times L_1$during first season,

Bunch weight (kg): There were significant differences between pollen and locations interactions during 2012 and 2013 seasons except between $M_1 \times L_2$ and $M_2 \times L_2$ in second season, table 5. The highest significant differences were 15.56 kg recorded by $M_1 \times L_2$ during 2012 season.

Fruit weight (g): There no significant differences between interactions during 2012 and 2013 seasons, except between $M_1 \times L_1$ and $M_1 \times L_2$ and between $M_2 \times L_1$ and $M_2 \times L_2$ in first season,

Fruit volume (cm^3): The interactions between pollen from Riyadh and Riyadh location ($M_1 \times L_1$) rerecorded the highest (13.50 cm^3) significant fruit volume as compared with other interactions in both seasons. There were non-significant differences among interactions, table 5.

Table 1. *Effect of pollen source on fruit set (%), physical and chemical. Characteristics of Khalas date palm trees during 2012 and 2013 seasons.*

Physical and chemical characteristics	Seasons	Pollen sources		LSD
		Male1 (M_1)	Male2 (M_2)	
Fruit set (%)	2012	57.57a[X]	55.56b	*0.98*
	2013	57.82a	47.66b	*6.29*
Bunch weight (kg)	2012	10.72a	10.94a	*2.99*
	2013	11.50a	9.06b	*1.76*
Fruit weight (g)	2012	14.94a	10.94b	*0.93*
	2013	11.48a	9.86b	*1.15*
Fruit volume (cm^3)	2012	11.64a	10.08b	*1.33*
	2013	10.78a	9.19b	*0.95*
Seed weight (g)	2012	1.17a	1.07b	*0.059*
	2013	1.14a	1.08b	*0.032*
Fruit length (cm)	2012	3.96a	3.51b	*0.12*
	2013	3.64a	3.42b	*0.15*
Fruit diameter (cm)	2012	2.52a	2.28b	*0.077*
	2013	2.37a	2.28b	*0.062*
SSC (%)	2012	54.00a	55.46 a	*2.35*
	2013	63.93a	65.00a	*1.34*
Acidity (%)	2012	0.40b	0.48a	*0.040*
	2013	0.541a	0.48b	*0.052*
Reducing sugars (%)	2012	36.48 b	38.02a	*1.52*
	2013	34.50a	35.44a	*1.90*
Total sugars (%)	2012	44.66b	46.80a	*1.99*
	2013	48.63a	47.72a	*2.64*
Fruit moisture (%)	2012	18.55a	17.08b	*1.19*
	2013	16.71b	18.17a	*0.66*

[X]*Means not sharing the same letter within each row differ significantly at P≤0.05.*

Seed weight (g): There were non-significant differences among pollen sources and locations during 2012 and 2013 seasons.

Fruit length (cm): Results of fruit length of pollen sources and locations interactions were no significant in fruit season, while there were significant differences between ($M_1 \times L_2$) and other interactions during 2013 season. $M_1 \times L_1$ recorded the highest (3.75cm) significant fruit length in both seasons,

Fruit diameter (cm): During 2012 season, there were significant differences between ($M_1 \times L_1$) and ($M_2 \times L_1$) ***;*** ($M_1 \times L_2$) and ($M_2 \times L_2$) only, on the other hand during 2013, $M_1 \times L_2$ recorded the highest (2.41cm) significant fruit diameter as compared with other interactions,

SSC (%): There were no significant between ($M_1 \times L_1$) and ($M_2 \times L_2$); ($M_1 \times L_2$) and ($M_2 \times L_1$), while there were significant between ($M_1 \times L_1$) and ($M_1 \times L_2$); ($M_2 \times L_1$) and ($M_2 \times L_2$) during 2012 and 2013 seasons.

Acidity (%): There were significant differences between ($M_2 \times L_1$) and the other interactions during 2012 season, while between ($M_1 \times L_1$) and the other interactions during 2013 season. The highest (0.6%) significant content of acidity was obtained by ($M_1 \times L_1$) during second season,

Reducing sugars (%): There were significant differences between ($M_1 \times L_2$) and the other treatments and recorded the lowest (34.67%) significant reducing sugars in 2012, while there were significant differences between ($M_1 \times L_1$) and ($M_2 \times L_2$); ($M_1 \times L_2$) and ($M_2 \times L_1$) during 2013 season

Total sugars (%): The same trend was noticed as reducing sugars, Table 6. $M_2 \times L_1$ was the lowest significant value in both seasons and recorded 43.05% during 2012 season,

Table 2. *Effect of location of female trees on fruit set (%), physical and chemical characteristics of Khalas date palm trees during 2012 and 2013 seasons.*

Physical and chemical characteristics	Seasons	Locations		LSD
		Riyadh (L_1)	Al-Ahsaa (L_2)	
Fruit set (%)	2012	62.32a[X]	50.81b	6.42
	2013	53.74a	51.74a	7.19
Bunch weight (kg)	2012	7.44b	14.22a	1.85
	2013	11.00a	9.56a	1.89
Fruit weight (g)	2012	12.60a	13.27a	1.66
	2013	11.12a	10.22a	1.24
Fruit volume (cm^3)	2012	11.61a	10.11b	1.34
	2013	9.69a	10.28a	1.09
Seed weight (g)	2012	1.11a	1.12a	0.069
	2013	1.12a	1.09a	0.038
Fruit length (cm)	2012	3.70a	3.78a	0.194
	2013	3.45b	3.62a	0.16
Fruit diameter (cm)	2012	2.36a	2.44a	0.11
	2013	2.30a	2.34a	0.069
SSC (%)	2012	53.07b	57.84a	2.33
	2013	64.40a	64.53a	1.39
Acidity (%)	2012	0.52a	0.42b	0.045
	2013	0.55a	0.47b	0.050
Reducing sugars (%)	2012	37.93a	38.10a	1.80
	2013	34.76a	35.18a	1.92
Total sugars (%)	2012	45.58a	48.03a	2.53
	2013	48.27a	48.07b	2.65
Fruit moisture (%)	2012	16.70 a	17.45 a	1.71
	2013	17.21a	17.67a	0.82

[X]*Means not sharing the same letter within each row differ significantly at P≤0.05.*

Fruit moisture (%): There were no significant differences among pollen and locations interaction during both seasons except between ($M_2 \times L_2$) and the other interactions during 2013 season. $M_2 \times L_1$ recorded the highest (18.72%) significant fruit moisture content in second season.

Discussion

Results showed that “Khalas” dates exhibit “metaxenia” effect, since fruit quality has affected by pollen source (Kahn et al. 1994; Chaudhary and Dessay 1995; Shafique et al. 2011). Impact of pollen source on time of fruit development has been reported for date palm (Nasser and AL-Khalifa 2006) and blueberries (Gupton and Spiers 1994). The effect of pollen source on the development of fruit tissue is called "metaxenia" effect. Similarly, pollen source can influence the size and the shape of the seed ("xenia" effect) (Reuveni et al. 1986). Results showed that pollen from Riyadh (M_1) was superior to pollen from Al-Ahsaa district (M_2) most testing parameters especially physical characters. There were non-signficant effects between locations in fruit set, yield component and fruit quality. Interaction ($M_1 \times L_2$) recorded the highest value in most characters such as fruit set, bunch weight and most physical and chemical characters in both seasons. Moreover, bunches were pollinated by M_1 either in L_1 or L_2 earlier ripening 22 - 24 days than other bunches. Less time of fruit development and ripening is an important result for growers, since early-ripe fruit is more valuable than late-ripe fruit (Lichtenzveig et al. 2000), reported that

differences in the time to fruit ripening might be due to variable growth rates of pollen tubes. Thus the source of pollen is an important variable to consider in order improving fruit quality and ripening time. The results are in line with the findings of Ghalib et al. (1987) who reported that different pollen sources have a significant effect on dropping fruits of 'Sayer' and 'Hallawy' dates. On the other hand, the variation in bunch weight refers to the difference in pollen source, viability, male and female compatibility (Al- Ghamdi et al. 1988). The difference in yield could be due to variation in pollen quality, germination percentage and pollen tube growth. Therefore, pollen source (male trees) has significant effect on the ultimate fruit yield (Bacha, and Shaheen 1988; Shafique et al. 2011).

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