

Effect of pollen source on yield parameters and yield of date palm (*Phoenix dactylifera* L) cultivars

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ABSTRACT

The investigations were conducted at experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana during 2015 to study the effect of pollen source on date palm (*Phoenix dactylifera* L). Four date palm cultivars (Hillawi, Zahidi, Khadrawi and Shamran) and two pollinizers (*P dactylifera* and *P sylvestris*) were selected for present investigations. The results indicated that fruit setting percentage and days of Doka stage were significantly affected by male pollinizer. Maximum fruit set (81.98%) was recorded in cv Khadrawi, maximum fruit length (4.69 cm) and bunch weight (35.87 kg) in cv Hillawi and highest fruit breadth (2.63 cm) and weight of seed (1.64 g) in cv Zahidi using *P sylvestris* as pollen source. The pollinizer *P dactylifera* with cv Khadrawi resulted in maximum fruit weight (14.17 g) and fruit pulp (12.44 g) while with Shamran it gave highest pulp-stone ratio (10.56). Fruit maturity was one week earlier in all the cultivars when *P sylvestris* was used as pollen source.

Keywords: Date palm; cultivars; pollinizers; yield characteristics; yield

INTRODUCTION

The genus *Phoenix* is composed of 14 species distributed in old world (Anon 2013). Saudi Arabia, Egypt, Iran and Iraq are the leading date producing and exporting countries. The area under systematic cultivation of date palm is very less in India but there was considerable increase in date palm plantation in Gujarat in 2004-2005. The total area increased from 8973 to 16000 ha during last decade. It has high adaptability and potential in arid and semi-arid zones of Haryana, Punjab, Rajasthan and Gujarat (Abbas 2014).

All species of *Phoenix* are dioecious with male individuals bearing staminate and female individuals bearing pistillate flowers. It has been observed that some date cultivars had better yield when pollinated with selected males rather than with others (Djerbi 1995). To make pollination effective it is better if 2 to 3 strands of male flowers are inserted between strands of female spathe. To overcome this problem artificial pollination is considered to be the most important factor affecting fruit set and yield (Hussain et al 1979). Failure

of effective pollination leads to the formation of triple parthenocarpic fruits of no economic value (Zaid and De Wet 1999). Although fertilization and fruit set are the two major results of pollination there is still another interesting but uncommon effect called Metaxenia, the direct influence of pollen on the maternal tissues of the fruit (Janick 1979). Pollen source has been reported to affect fruit set, ripening and quality (AI-Obeed and Abdul-Rahman 2002).

Most of the male palms available are of seedling origin with great variations in their pollen quality. These pollen grains can bring about lot of variations in the productivity, size, quality and maturity of date fruits in combination with different female cultivars. These effects on tissue of purely maternal origin rather than on parts resulting from syngamy have been described as Metaxenia (Swingle 1928). No work has been reported on effect of pollinizers on fruit growth and development of date palm under Hisar conditions. For improving early maturity and better fruit yield in date palm cultivars the present study was conducted on the effect of pollinizers on fruit set, physical parameters and fruit maturity.

MATERIAL and METHODS

The present studies were carried out in experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana during the year 2015. The plants of selected female cultivars (Hillawi, Zahidi, Khadrawi and Shamran) were tagged for pollination. Two male pollinizers *Phoenix dactylifera* and *P. sylvestris* were used as pollen

parents. The experiment was laid out on more than 30 year old plants in randomized block design with three replications and data were collected on yield characteristics and yield. For fruit set (%) five female strands per bunch were randomly selected from each treatment and fruit set was calculated as per the method given below (El-Makhtoun 1981). The parameters like fruit length, fruit breadth, fruit weight, fruit pulp, seed weight and pulp-stone ratio were

$$\text{Fruit set (\%)} = \frac{\text{Number of fruits retained on strand}}{\text{Number of fruits retained} + \text{Number of flower scars on the same strand}} \times 100$$

calculated by selecting ten fruits randomly from each replication of date cultivars. For bunch weight three bunches from each treatment were harvested and the fruits were picked and weighed. The mean weight of fruits per bunch was calculated and for fruit maturity five bunches per treatment were selected and the date of Doka stage was noted down when there was colour change from green to yellow of fifty per cent or more fruits per bunch.

Statistical analysis of data collected during the study was done by applying the technique of analysis of variance (Rai and Grover 2006). All the statistical analysis was carried out by using OPSTAT statistical software.

RESULTS and DISCUSSION

The data on yield parameters and yield are given in Table 1.

Fruit set: The fruit set percentage recorded at Doka (Khalal) stage showed that pollen from *P. sylvestris* gave higher fruit set (68.58%) as compared to *P. dactylifera* (64.11%). However the maximum fruit set (71.17%) was recorded in cv Hillawi which was statistically at par with Khadrawi and the lowest (60.09%) was recorded in Shamran. The differences in fruit set among the four cultivars might be due to differences either in pollen viability or compatibility barriers. The present results are in agreement with the findings of Rahemi (1998), Bacha et al (2000) and Aly (2001). The interaction between the cultivars and pollinizers also showed significant difference. Maximum fruit set (81.98%) was observed when cv Khadrawi was pollinated with *P. sylvestris* pollens and the minimum (58.11%) was found in cv Shamran when

pollens from *P. dactylifera* were used. It is supported by the findings of Ghalib et al (1988), El-Amer et al (1993) and Ibrahim and Shahid (1994) who reported that different pollen sources caused variations in fruit set in various cultivars.

Fruit length: The average fruit length was significantly affected due to pollen parent, cultivars and the interactions between the treatments. The longest fruits were recorded in cv Hillawi (4.54 cm) followed by Shamran (4.03 cm) whereas shortest fruits (3.61 cm) were observed in cv Zahidi. The pollen parent *P. dactylifera* (4.02 cm) recorded significantly higher value of fruit length as compared to pollen source *P. sylvestris* (3.93 cm). Statistically longest fruits (4.69 and 4.39 cm) were observed in cv Hillawi pollinated with pollens of *P. sylvestris* and *P. dactylifera* respectively while the pollens of *P. dactylifera* recorded the smallest fruits (3.51 cm) in cv Zahidi. The increase in fruit length could be due to improving cell size or cell number by nutrient elements and may be attributed to the improving of fruit growth and uptake of nutrients that accelerated metabolic process. This finding is in close agreement with the finding of Harhash and Abdel-Nasser (2010) who also reported that fruit length was significantly affected due to various male pollinizers.

Fruit breadth: The cv Zahidi produced the fruits having maximum breadth of 2.37 cm which was statistically at par with cv Khadrawi (2.35 cm). The cultivars Hillawi and Shamran recorded the fruit breadth of 2.06 cm and 2.12 cm respectively which significantly differed with each other. Fruit breadth (2.25 cm) was obtained maximum when pollinized with pollens of *P. sylvestris*. The increase in fruit breadth could be due to improving cell size or cell number by nutrient elements and may be attributed to the

Table 1. Effect of pollinizers on yield parameters of date palm cultivars

Pollinizer	Cultivar				Mean	Cultivar				Mean
	Hillawi	Zahidi	Khadrawi	Shamran		Hillawi	Zahidi	Khadrawi	Shamran	
Fruit set (%)						Fruit length (cm)				
<i>P dactylifera</i>	73.74	64.29	60.31	58.11	64.11	4.39	3.51	3.90	4.30	4.02
<i>P sylvestris</i>	68.60	61.65	81.98	62.07	68.58	4.69	3.71	3.57	3.76	3.93
Mean	71.17	62.97	71.15	60.09		4.54	3.61	3.74	4.03	
Fruit breadth (cm)						Fruit weight (g)				
<i>P dactylifera</i>	2.01	2.11	2.43	2.26	2.20	8.13	8.36	14.17	12.87	10.88
<i>P sylvestris</i>	2.11	2.63	2.27	1.99	2.25	10.74	12.65	9.53	8.04	10.24
Mean	2.06	2.37	2.35	2.12		9.44	10.50	11.85	10.46	
Fruit pulp (g)						Seed weight				
<i>P dactylifera</i>	7.01	6.07	12.44	11.84	9.34	1.17	1.05	1.48	1.12	1.21
<i>P sylvestris</i>	9.52	11.19	8.07	6.71	8.87	1.32	1.64	1.28	1.27	1.38
Mean	8.27	8.63	10.25	9.27		1.24	1.35	1.38	1.20	
Pulp-stone ratio						Bunch weight (kg)				
<i>P dactylifera</i>	5.99	6.00	8.39	10.56	7.73	29.42	10.99	24.39	31.43	24.06
<i>P sylvestris</i>	7.26	6.80	6.24	5.23	6.38	35.87	16.46	21.43	27.29	25.26
Mean	6.62	6.40	7.31	7.90		32.64	13.73	22.91	29.36	

CD_{0.05}

	Pollinizers	Cultivars	Pollinizers x cultivars
Fruit set	1.15	1.63	2.30
Fruit length	0.03	0.05	0.07
Fruit breadth	0.02	0.03	0.04
Fruit weight	0.48	0.68	0.96
Fruit pulp	0.30	0.42	0.59
Seed weight	0.08	0.12	0.17
Bunch weight	0.51	0.72	1.02

improvement of fruit growth and uptake of nutrients that accelerated metabolic process. Similar results were postulated by Harhash and Abdel-Nasser (2010) and El-Sabagh (2012). The cumulative effect of cultivars and pollen sources on average fruit breadth was found significant in all cultivars. The fruits of cultivar Zahidi developed from fertilization of *P. sylvestris* pollens contained the maximum fruit breadth of 2.63 cm. The least fruit breadth of 1.99 cm was found in cultivar Shamran when pollinated with same pollen source. The cv Khadrawi obtained maximum fruit breadth (2.43 cm) when pollinated with *P. dactylifera*. Similar results were found by Abdel Hamid (2000) and Marzouk et al

(2002) who reported that pollen sources significantly affected fruit breadth.

Fruit weight: The fruit weight differed significantly with the pollen sources. The only cvs Khadrawi and Hillawi were significantly different from the other cultivars. The significant maximum fruit weight (10.88 g) was recorded in fruits produced by pollination of *P. dactylifera* while the *P. sylvestris*-fertilized fruits had a lower fruit weight (10.24 g). The fruits of cv Khadrawi were heaviest (11.85 g) amongst the fruits of all the four cultivars followed by cv Zahidi (10.50 g). The cultivars Hillawi and Shamran gave average

fruit weight of 9.44 and 10.46 g respectively. The interaction between cultivars and pollen sources was also found significant. The maximum fruit weight was reported in cv Khadrawi with pollens of *P dactylifera* (14.17 g) whereas lowest (8.04 g) was recorded in cultivar Shamran fertilized with *P sylvestris* pollens. The cultivars Hillawi and Zahidi gave maximum fruit weight with *P sylvestris* whereas pollens used from *P dactylifera* produced maximum fruit weight in Khadrawi and Shamran. This might be due to the released hormones by growing endosperm and embryo tissues that diffused into the ovary tissue and induced fruit growth. These results collaborate with the finding of El-Makhtoun and Abdel-Kader (1993) and El-Makhtoun et al (1995).

Fruit pulp: The maximum pulp weight (9.34 g) was recorded in fruits developed from fertilization of *P dactylifera* while the flowers pollinated with *P sylvestris* pollens gave fruit pulp weight of 8.87 g. The highest pulp weight of fruits (10.25 g) was observed in cv Khadrawi which significantly differed from Hillawi, Zahidi and Shamran having weight 8.27, 8.63 and 9.27 g respectively. The cultivars Hillawi and Zahidi were statistically at par with each other. The interactive effect of pollen sources and cultivars was also found significant. The maximum pulp weight (12.44 g) was recorded in cv Khadrawi fertilized with pollens of *P dactylifera*. It was followed by cvs Shamran and Zahidi which produced fruit pulp of 11.84 and 11.19 g when pollinated with *P dactylifera* and *P sylvestris* respectively. The minimum pulp weight (6.07 g) was observed in cv Zahidi fertilized with *P dactylifera* pollens. This might also be due to the released hormones by growing endosperm and embryo tissues that diffused into the ovary tissue and induced fruit growth. The similar results were obtained by Al-Hamoudi et al (2006), Al-Ghamdi et al (1988) and Ghnaim and Al-Muhtaseb (2006) who reported that pollen sources significantly affected pulp weight.

Weight of seed: The average seed weight was significantly affected by the pollen sources, cultivars and their interactions. The significantly higher seed weight of 1.38 g was obtained from fruits which were pollinated with *P sylvestris* pollens while the fruits fertilized with *P dactylifera* recorded 1.21 g seed weight. Amongst the four cultivars maximum seed weight (1.38 g) was observed in cultivar Khadrawi which showed significant difference with the cultivars Hillawi and Shamran having seed weight of 1.24 and 1.20 g respectively but it was statistically at par with

the cultivar Zahidi (1.35 g). The maximum seed weight was recorded in cv Zahidi (1.64 g) fertilized with *P sylvestris* pollens followed by cv Khadrawi (1.48 g) when pollinated with *P dactylifera* pollens. The minimum seed weight (1.12 g) was observed in cv Shamran when pollinated with *P dactylifera* pollen source. Reason behind this might be xenic effect. These results are partly confirmed by those of Krueger (2001) and Moustafa (2001).

Pulp-stone ratio: Statistically higher pulp-stone ratio (7.73) was found in fruits pollinated with *P dactylifera* pollens while the flowers fertilized with pollens of *P sylvestris* gave 6.38 pulp-stone ratio. Amongst cultivars Shamran had highest pulp-stone ratio (7.90) followed by cv Khadrawi (7.31). The interactive effect of cultivars and pollen parents showed that the highest pulp-stone ratio (10.56) was recorded in cultivar Shamran when pollens of *P dactylifera* were used. The lowest pulp-stone ratio (5.23) was also found in same cv when pollinated with *P sylvestris* pollens. The increase in fruit pulp weight could be due to improving cell size or cell number by nutrient elements and/or may be attributed to the improving of fruit growth and uptake of nutrients that accelerated metabolic process. Similar results were found by Harhash and Abdel-Nasser (2010), Awad and Al-Qurashi (2012), El-Sabagh (2012) and Rezazadeh et al (2013).

Bunch weight: The average bunch weight was significantly affected by pollen parents as well as cultivars. The cv Hillawi recorded the maximum average bunch weight (32.64 kg) followed by cvs Shamran (29.36 kg) and Khadrawi (22.91 kg). The minimum bunch weight was observed in cv Zahidi (13.73 kg). The significantly higher average bunch weight was found in the plants which were pollinated by pollens of wild date palm (25.26 kg) as compared to *P dactylifera*-pollinated (24.06 kg) plants. The differences in bunch weight among the cultivars might be due to the differences in number of strands in all the cultivars which resulted in more or less number of fruits as well as different bunch weight. The interaction effect of pollen sources and cultivars also differed significantly. The highest average bunch weight was recorded in cv Hillawi (35.87 kg) when pollinated with pollens of *P sylvestris* followed by cv Shamran (31.43 kg) when pollinated with *P dactylifera* pollens. The lowest average bunch weight was found in cv Zahidi (10.99 kg) pollinated with pollens of *P dactylifera*. The reason behind this may be different genetic make up of pollens, pollen viability and male female

Table 2. Effect of pollinizers on fruit maturity of date palm cultivars

Pollinizer	Cultivar			
	Hillawi	Zahidi	Khadrawi	Shamran
<i>P. dactylifera</i>	2 nd week of July	3 rd week of July	4 th week of July	4 th week of July
<i>P. sylvestris</i>	1 st week of July	2 nd week of July	3 rd week of July	3 rd week of July

incompatibility. Positive effect of pollen sources has been reported in Hayyani (Ghnaim and Al-Muhtaseb 2006). The results are also in agreement with those of El-Kosary (2009).

Fruit maturity (date of Doka stage)

The data on date of Doka (Khalal) stage of maturity as affected by two male pollen sources are given in Table 2. The *P. sylvestris* pollens promoted early maturity of fruits in all cultivars as compared to the pollinizer *P. dactylifera*. All cultivars reached earlier to Doka (Khalal) stage when pollinated with *P. sylvestris*. The cultivar Hillawi was early ripening and reached Doka (Khalal) stage in 1st and 2nd week of July when pollinated with *P. sylvestris* and *P. dactylifera* respectively. The cv Zahidi was of mid-season and reached to Doka stage in 2nd and 3rd week of July when pollinated with *P. sylvestris* and *P. dactylifera* pollens. The other cultivars Khadrawi and Shamran were also of mid-season and reached to Doka (Khalal) stage in 3rd and 4th week of July. The pollens of *P. sylvestris* enhanced the fruit maturity by one week in the fruits of all cultivars as compared to fruits when pollinated with *P. dactylifera* pollens. The differences in time of fruit ripening might be due to the variable growth rates of pollen tubes (El-Ashry 2009, El-Hamady et al 2010). Effects of metaxenia on the time of ripening and harvesting have also been reported in other crops such as blueberry (Gupton and Spiers 1994), pistachio (Riazi et al 1995) and vine cacti (Mizrahi et al 2004).

CONCLUSION

From the present study it can be concluded that the pollinizer *P. sylvestris* showed metaxenic effect on fruit set, fruit breadth, weight of seed, bunch weight and date of Doka stage whereas fruit length, fruit weight, fruit pulp and pulp-stone ratio were improved when *P. dactylifera* was used as pollen parent. The cultivar Khadrawi was proved best as a female parent and showed maximum fruit weight, fruit pulp and weight of seed compared to the other cultivars.

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