

Research Article



Response of Male Pollinizers in Fruit Set, Yield and Quality of Date Palm (*Phoenix dactylifera* L.). Cv. Dhakki

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Abstract | Date palm (*Phoenix dactylifera* L.) is a major fruit crop of Pakistan, after citrus and mangos. Artificial pollination is a one of most important cultural practice for improving yield of Date palm due to dioecious nature of palm tree. Pollen sources play important role in fruit setting. The growers pollinate the date by using low potency pollen source and get low yield. Present studies were conducted with the aim to explore best pollen sources for maximum fruit set and yield. In this respect, an experiment was conducted during 2012 and 2013 to evaluate the male spath characteristics and to observe the effect of pollen sources on fruit set, yield and physico-chemical characteristics of Dhakki date palm. Data were recorded for spath length, width, number of strands/spath, number of flower per strands, number of spath per tree, weight of pollen grain/spath, weight of pollen grain/tree, pollen viability, fruit set, yield and physico-chemical characteristics. The results indicated that males were significantly differed from one another in all these characters during both years of study. Maximum spath length (107.21, 107.81cm), weight of pollen grain (150.07, 147.57g)/ tree and number of spath/tree (18.52, 19.24) were recorded in M6, whereas, maximum spath width (15.29, 16.58cm) was observed in M5. The highest number of strand/spath (245.21, 240.53), number of flower/ strand (84.29, 86.80) and weight of pollen grain (12.13, 11.18g) /spath were observed in M3. Maximum pollen viability (93.78, 93.34%) was noticed in M2. As far as the effects of pollen sources are concerned, the maximum fruit set (90.17, 92.43%), fruit length (4.28, 4.27 cm), fruit width (2.28, 2.30 cm) fruit weight (22.33, 22.79g), fruit yield (109.48, 104.83 kg/tree), moisture % (68.17, 68.20) were recorded when pollinated with M2. Highest TSS % (35.81, 36.28) reducing sugars % (5.15, 5.11), non reducing sugars % (13.82, 13.44) and total sugars % (18.97, 18.55) were recorded in M6 during both years of investigation. These results suggest that for maximum fruit set, yield and quality, the Dhakki date should be pollinated with pollens of M2 and M6.

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Introduction

Date Palm (*Phoenix dactylifera* L.) is an extensively cultivated tree of the World (Ragab, 1975). It occupies a pivotal position in the economic development of many countries including Pakistan.

In addition, it also provides raw materials for many industries. Date is rich in sugar and a good source of energy (Baloch et al., 2006; Al-Abdulhai et al., 2011). The 100 gm of edible portion of date contains 1.42 calories comprises of 70% carbohydrates, 2.5% protein, 0.4% fats, 2.1% mineral, 15-30% moisture

content and 3.9% fiber, Vitamin A, B-Complex and Vitamin E and K (Sarfraz et al., 2012). Pakistan is the 2nd major date exporting country after Tunisia. Major importers of Pakistani dates are Bangladesh, India, Italy, Germany, Canada, Japan, UAE, Denmark, South Africa, Australia, Saudi Arabia, USA and UK (Amin et al., 2007). In Pakistan area under cultivation during 2012 and 2013 was 931 and 896 hectares with a total production of 557.3 and 524.6 tonnes (Anonymous, 2012-13). In Dera Ismail Khan many exotic and local date varieties are commercially grown. Amongst them local cultivar "Dhakki" is famous for its high yield and extra large size (Iqbal et al., 2009) which has grown throughout the Pakistan. Dhakki cultivar is producing low yield due to poor fruit setting by using pollen source of unknown potency. Artificial pollination is carried out due to its diocious nature. (Hussain et al., 1979). For successful pollination, high potent pollen sources play an important role (Iqbal et al., 2012; Dejrouni et al., 2015). In earlier studies various researchers, investigated the floral characteristics of male palms and their pollen effects on fruit set and yield. *i.e.* Al-Ghandi et al. (2002) and Iqbal et al. (2008; 2009) reported that males were differed in floral characteristics. Qureshi et al. (2009) and Ismail (2014) reported that germination percentage of pollen varies from one male to another. Awad and Al-Qureshi (2012) studied that pollens have direct effect on the receptivity of female flower. Bacha et al. (2002) and Abbas et al. (2012) determined that female flower receptivity was also different due to verital aspect and genetic characteristics of female palm. The Pollens have direct effect on the maternal tissues of fruit which is known as metaxenia (Janick, 1979). The metaxenic effects on fruit were also reported by various researchers (Al-Ghamdi et al., 1988; Shaheen et al., 1989; El-Makhtoun, 1990; Al-Khalifa 2006; Frag et al., 2012; Hafez et al., 2014). It is an established fact that some males are high potent as compared to others which contribute to increase in fruit set and yield (Iqbal et al., 2004). Ibrahim and Shahid (1994) tested the effect of six males on cv Hillawi and Khudrawi and reported that males significantly affected the fruit setting and yield. El-Salhey et al. (1997) studied the pollen viability of different males and their effect on fruit set and yield and concluded that males varied in respect of pollen viability, fruit set and yield. Rahemi (1998) documented the effect of different pollen sources on the fruit set and fruit characteristics. Abdul Hamid (2000), Halail and El-Kholey (2000), Osman and Soliman (2002), Marzouek et

al. (2002), Al-Obeed and Abdul Rehman (2002) and El-Kosary and Soliman (2003) found that different male pollens have significant effect on fruit weight, size and pulp as well as fruit yield. Shafique et al. (2011) reported that pollens have direct effect on the physical and chemical properties of fruit. In addition, the role of pollen sources in improvement of quality, quantity and yield of date palm has been investigated by Damankeshan and Panahi (2013) and Omar et al. (2014).

Date growers of this area use pollen from males of unknown potency grown in wild grooves, consequently they get low yield. Realizing the importance of male, a study was designed to evaluate the floral characteristics, quantity and potency of their pollen grains in fruit setting, yield and quality. Earlier a little research work has been reported in this area on the effect of pollen sources on fruit set, yield and fruit physical characteristics and needs extensive work. Furthermore, no research work has been conducted on maturity time and chemical characteristics of Dhakki dates when fertilized by various pollen sources. The present study was, therefore, carried out with an attempt to improve the fruit set, yield and physico-chemical characteristics of date palm cv "Dhakki" through selecting best male source for fertilizing this promising cultivar.

Materials and Method

An experiment was conducted at Agriculture Extension Farm, Rakh Manghan Mandhra Kalan Dera Ismail Khan, Khyber Pakhtun Khwa, Pakistan during 2012 and 2013. Seven males were raised from seeds, symbolized as M1, M2, M3, M4, M5, M6 and M7 of irrespective age were selected from Dhakki area for recording of spath characteristics from the wild groves of date palm. The experiment was laid out in Randomized Complete Block Design having seven treatments and three replications. In this regard, twenty one Dhakki trees possessing 20 years of age with vigorous growth were selected for the present investigation. Row to row and plant to plant distance were maintained as 10 meters. These plants were propagated through conventional method by suckers. Male spathes were cut as protective sheath crack appeared at the top and then were brought to Laboratory. The protective sheath was removed for the separation of male strands. After separating the male strands, these strands were stored in refrigerator

Table 1: *Spath characteristics and pollen viability % of male palms used in pollination during 2012 and 2013 seasons*

Year 2012								
Treatments Identity Num-bers	Spath length (cm)	Spath width (cm)	No. of spath per tree	Number of strand per spath	Number of flower per strand	Weight of pollen grain /spath (g)	Weight of pollen grain /tree (g)	Pollen via-bility(%)
M1	94.47b	10.34d	11.10cd	235.13b	71.13b	11.45b	134.54ab	80.23b
M2	49.44g	13.14c	9.15d	103.13f	63.11d	12.13a	117.96bc	93.78a
M3	84.15c	15.18a	11.54d	245.21a	84.29a	5.80g	53.10d	43.50f
M4	60.13f	14.27b	14.15bc	167.16e	50.16f	7.13f	101.00c	62.34d
M5	77.21d	15.29a	15.46b	190.21c	47.45g	7.22e	107.08c	58.17e
M6	107.21a	11.00d	18.52a	168.84e	62.41e	8.10d	150.07a	70.11c
M7	71.37e	9.13e	10.20d	181.19d	67.20c	9.25c	94.48c	35.08g
LSD	2.41	0.66	3.02	1.94	0.53	0.07	0.07	1.05
Year 2013								
M1	98.52b	9.69d	11.61d	226.79b	69.18b	10.23b	137.21ab	85.19b
M2	48.51f	14.17b	8.15 f	106.37g	63.13c	6.00d	119.82bc	93.34a
M3	82.40c	15.18ab	11.37 d	240.53a	86.80b	11.18a	52.85e	45.14e
M4	58.60e	14.56b	13.81c	168.25e	47.83d	7.38c	104.30cd	62.82d
M5	77.54d	16.58a	15.13 b	185.33c	46.77d	7.29c	108.30cd	58.88d
M6	107.18a	12.00c	19.24 a	163.52f	65.20c	8.24c	147.57a	72.82c
M7	70.17e	9.82dc	10.45e	183.46d	67.88b	9.75b	93.20d	39.28f
LSD	3.88	1.65	0.40	0.47	7.07	1.10	25.13	4.03

Means followed by different letter(s) are significantly different at 5% level of probability using LSD test.

at 4°C. Eight spathes from each female tree were pollinated manually by inserting 3-4 fresh male strand onto female spath after 2 days of spath opening at 12 p.m. After pollination, bagging of each spath was done with waxy paper to avoid contamination. Bags were removed three weeks after pollination. All the standard cultural practices were applied accordingly.

Data on the following parameters were recorded
Male spath characteristics were recorded using the method described by [Iqbal et al. \(2004\)](#).

Pollen viability (%): Before pollination, pollen viability percentage was determined as procedure adopted by [Moreira and Gurgel \(1941\)](#).

Fruit set (%): After four weeks of pollination, fruit set was calculated according to [El Makhtun \(1990\)](#).

Days to fruit set: The number of days to fruit set were recorded when two carpals of tricarpeal ovary were abscised in each spath and then mean days were calculated.

Fruit weight (g): Twenty fruits of each tree were weighed by electric balance and average weight of fruit was computed.

Fruit size (cm): The length and width of twenty (20) fruits from each tree was measured with the help of

measuring scale and mean size of fruit was calculated.
Fruit drop (%): Percent fruit drop was calculated using following formula:

$$\frac{\text{Number of fruit drops}}{\text{Total number of fruits set}} \times 100$$

Days to maturity: The number of days to maturity were counted from fruit setting to when 50 % fruits colour was turned into yellow in each tree and then mean days were calculated.

Fruit yield (tree/kg): All the fruit bunches from each treatment were weighed and finally mean yield per tree (kg) was determined.

Moisture (%): Moisture content in fruit was determined by direct heating method as recommended by [AOAC \(1984\)](#).

Total soluble solids (Brix): Total soluble solids was determined by hand refractometer as per [AOAC \(1995\)](#).

Reducing sugars, non-reducing sugars and total sugars: Reducing, non reducing and total sugars were determined by Lane and Annon method as described as [AOAC \(1995\)](#).

Statistical Analysis: The collected data were analyzed statistically using Computer software MSTATC.

The method of Analysis of Variance (ANOVA) was applied and means were separated using Least Significant Difference (LSD) test in accordance to procedure prescribed in [Steel and Torrie \(1980\)](#).

Results and Discussion

Male spath characters

Results indicated ([Table 1](#)) that maximum spath length was observed in M6 (103.21, 107.18 cm) during 2012 and 2013, respectively. The highest spath width was recorded in M5 (15.29, 16.58 cm). The maximum number of 18.52, 19.25 spath/tree were noted in M6. From the perusal of [Table 1](#), the highest number of strand/spath and number of flower/ strand were observed in M3 (245.21, 240.53) and (84.29, 86.80), respectively. Maximum weight of pollen grain/ tree was recorded in M6 (150.07 and 147.57g). Maximum (12.13 and 11.18 g) weight of pollen grain/spath was found in M1 and pollen viability was noticed in M2 (93.78, 93.34 %). From the results, it was indicated that significant differences were observed among males regarding spath characteristics and pollen viability percentage. These results are in agreement with the findings of [Marzouk et al. \(2002\)](#); [Iqbal et al. \(2004; 2009\)](#), [Hafiz et al. \(2014\)](#) and [Djerouni et al. \(2015\)](#). It is evident from the results that male having maximum number of spath, number of strand/ spath and number of flower/ strand produced maximum pollen quantity and can be used to pollinate maximum number of female tree. Also males having high percentage of pollen viability caused maximum fruit setting. Hence, M2 is recommended for pollination of Dhakki date.

Fruit set (%): The data regarding fruit set percentage is given in [Table 2](#). The results show that pollen sources had significant effect on the fruit set percentage in both years (2012 and 2013). The highest fruit set (90.17, 92.43%) was recorded when female trees were pollinated with M2. It was followed by M1 and M6 (79.67, 78.79%) and (69.40, 67.16%) respectively. The lowest fruit set (38.80, 40.41%) were recorded with pollination of M7. Difference in fruit setting behavior of male may be due to genetic character. These results are in line with the findings of [El- Salhey et al. \(1997\)](#) who reported variation in fruit setting of males. Similar results were reported by [Iqbal et al. \(2004; 2011\)](#).

Days to fruit set: Data indicated that minimum days to fruit set (14.32, 15.67) were observed when pollinated with M5 in 2012 and 2013 respectively ([Table](#) March 2017 | Volume 33 | Issue 1 | Page 111

2). The maximum days to fruit set (18.80, 19.17) were noted when trees pollinated with M1, followed by M6 (18.29, 18.49) and M3 (17.83, 18.00), in both years 2012 and 2013 respectively. The variation in days to fruit set may be attributed to genetic characters of pollen sources. These results are in agreement with the findings of [Iqbal et al. \(2011\)](#) and [Djerouni et al. \(2015\)](#) who reported that pollen sources had a significant effect on days to fruit set in date palm.

Fruit length (cm): Various pollinizers significantly affected the fruit length ([Table 2](#)). The lengthiest fruits (4.28, 4.27cm) were produced when pollinated with M2, whereas M4 produced shortest fruit (4.13, 4.14 cm) 2012 and 2013, respectively in both years of study. These results are contrary to the findings of [Muh-tasib and Ghnaim \(2006\)](#) who reported that pollen sources had no significant effect on fruit length, [Iqbal et al. \(2008\)](#) and [Omar et al. \(2014\)](#) also reported that pollen sources significantly affected fruit length.

Fruit width (cm): Data showed significant effect of pollinizers on fruit diameter in 2013. However, results were non-significant during 2012. Maximum fruit diameter (2.28, 2.30 cm) was produced when pollinated with M2. Minimum fruit diameter (2.21, 2.22cm) was recorded by pollinating the cultivar with pollens of M5. However, there were non significant differences among the pollinizers M1 and M3. The results of 2013 are partially agreed with the findings of [Hamid \(2000\)](#) and [Marzouk et al. \(2002\)](#) who reported that pollen sources have significant effect on fruit width.

Fruit weight (g): The data pertaining to fruit weight of Dhakki was significantly affected by different male pollinizers during both study years ([Table 2](#)). Maximum fruit weight (22.33, 22.79 g) was recorded when pollination was done with M2 in 2012 and 2013, respectively. It was followed by M6 and (21.87, 21.67g) and M1 (21.40, 21.35g), respectively in 2012 and 2013. The M7 produced the minimum fruit weight (17.14 and 17.21g) during both years of study respectively. Maximum fruit weight in M2 was associated with maximum size and moisture content in fruits. These results are in line with the findings of [Omer et al. \(2014\)](#) who reported that pollen sources had significant effect on fruit weight. Similar results were also reported by [Simozrag et al. \(2016\)](#).

Fruit drop (%): Data recorded for fruit drop percent -

Table 2: Effect of pollen sources on fruit set, days to fruit set, fruit size, weight, fruit drop, days to maturity and yield of Dbakki date during 2012 and 2013

Year 2012								
Males Identity Numbers	Fruit set (%)	Days to fruit setting	Fruit length (cm)	Fruit width (cm)	Fruit weight(g)	Fruit drop (%)	Days to maturity	Yield (kg/tree)
M1	79.67b	18.80a	4.27ab	2.25	21.40b	40.48a	148.14e	80.80b
M2	90.17a	17.79a	4.28a	2.28	22.33a	32.22c	149.13e	109.48a
M3	46.16f	17.83a	4.15ab	2.25	18.19e	37.81ab	152.38d	63.16cd
M4	57.46d	17.78a	4.13b	2.25	20.51c	36.80b	155.14c	59.10cd
M5	53.39e	14.32b	4.25ab	2.21	19.15d	33.49c	161.48a	63.14cd
M6	69.40c	18.29a	4.24ab	2.25	21.87b	32.81c	157.79b	65.82c
M7	38.80g	15.47b	4.16ab	2.24	17.14f	33.45c	154.16c	54.82d
LSD	2.17	1.84	0.14	NS	0.45	2.45	1.27	10.37
Year 2013								
M1	78.79b	19.17a	4.23ab	2.24b	21.35b	40.14a	148.12e	83.15b
M2	92.43a	117.24bc	4.27a	2.30a	22.79a	30.45c	149.13e	104.83a
M3	46.49e	18.00b	4.16ab	2.21b	17.77e	38.13a	154.09d	57.36d
M4	56.11d	16.58cd	4.14b	2.26ab	20.16c	39.16a	156.86c	69.97d
M5	55.40d	15.67d	4.22b	2.22b	19.16d	34.15b	163.81a	58.80d
M6	67.16c	18.49ab	4.26ab	2.26ab	21.67b	34.18b	159.32b	70.17c
M7	40.41f	16.19bd	4.25ab	2.25ab	17.21e	33.14b	155.13d	52.13d
LSD	2.68	0.58	0.13	0.06	2.20	3.09	1.60	9.48

Means followed by different letter(s) are significantly different at 5% level of probability using LSD test.

age revealed that minimum fruit drop (32.22, 30.45%) was recorded when pollinated with M2, whereas maximum fruit drop (40.48, 40.14%) was recorded with M1 during 2012 and 2013 respectively (Table 2). The results show that different pollinizers play vital role in fruit drop. These results are in conformity with the findings of Iqbal et al. (2011) and Shafique et al. (2011) who reported that fruit drop can be reduced by pollinizers.

Days to maturity: Minimum days to maturity (148.14, 148.12) were recorded by M1 which caused early maturity by 13.34, 15.04 days during 2012 and 2013, respectively (Table 2). M5 took maximum days to maturity (161.48, 163.81) in both years 2012 and 2013, respectively. Variation in days to maturity may be due to genetic make up of pollen sources. These results are in conformity with the findings of Al-Khalifa (2006) and Iqbal et al. (2011) who reported that pollen sources had significant effect on fruit ripening time. Abdel Malik (2012) reported similar findings.

Yield (kg/tree): Different pollen sources had exhibited significant effect on fruit yield during 2012 and 2013 (Table 2). M2 produced the highest fruit yield of 109.48, 104.83 kg /tree during 2012 and 2013, re-

spectively. The lowest fruit yield of 52.82 and 52.13 kg/tree was noted when pollinated with M7 in both years. Results indicated that M2 produced highest yield which is due to maximum fruit setting, fruit weight, size, less fruit drop and higher moisture percentage. These findings are in accordance with the findings of Iqbal et al. (2008), Abdel Malik (2012) and Omer et al. (2014) who reported that fruit yield was significantly affected by various pollens sources, however contradict to the findings of Muhtasib and Ghnaim (2006), Shafique et al. (2011) and Iqbal et al. (2011) who reported non significant effect of pollen sources on fruit yield.

Moisture content (%): The highest moisture content of (68.17, 68.20 %) was found with pollination of M2 and lowest moisture content (60.34, 60.42%) was observed with M5 during 2012 and 2013 (Table 3). Results revealed that fruit weight is associated with moisture content which was highest in M2. These results are supported by the findings of Omer et al. (2014) who reported that pollen sources had significant effect on fruit moisture.

Total soluble solids (Brix): Data recorded for total soluble solids percentage showed that the maximum

Table 3: *Effect of pollen sources on fruit chemical characteristics of Dhakki date during 2012 and 2013*

Year 2012					
Treatments	Moisture%	TSS %	Reducing sugars %	Non reducing sugars %	Total sugars %
M1	66.10b	34.41ab	12.96bc	4.97a	17.93bc
M2	68.17a	34.10ab	12.31d	4.48a	16.79b-d
M3	62.20e	34.18ab	13.29b	4.21c	17.50bc
M4	62.22e	34.12ab	12.51cd	4.49bc	17.00cd
M5	60.34f	34.00ab	12.87bc	5.00a	17.87b
M6	65.19c	35.81a	13.82a	5.15a	18.97a
M7	64.16d	32.45b	12.16d	4.33c	16.49d
LSD	0.11	2.28	0.50	0.40	0.92
Year 2013					
M1	66.40b	34.41ab	13.00a-c	4.92a	17.92b
M2	68.20a	33.51b	12.31d	4.83a	17.14bc
M3	61.51d	34.18ab	13.26ab	4.19b	17.45bc
M4	61.10ed	34.12ab	12.55b-d	4.39b	16.94bc
M5	60.42e	34.00ab	12.76b-d	5.08a	17.84b
M6	64.19c	36.28a	13.44a	5.11a	18.55a
M7	64.46c	32.46b	12.17d	4.29b	16.46c
LSD	0.68	2.28	0.80	0.34	0.98

Means followed by different letter(s) are significantly different at 5% level of probability using LSD test.

TSS (35.81, 36.28%) were recorded with M6, followed by M1 (34.41, 34.41%) in 2012 and 2013, respectively (Table 3). Minimum TSS of 32.45, 32.46% were recorded when pollinated with M7 in both years, respectively. These results are in conformity with the findings of Shafique et al. (2011) who reported that different pollinizers have significant effect on fruit TSS.

Reducing sugars (%): Reducing sugar is a mixture of glucose and fructose and released from the hydrolysis of sucrose. It ranged from 12.16, 13.82%. Table 3 indicated that maximum reducing sugars of 13.82, 13.44% were recorded with M6 male pollinizer, while minimum of 12.16, 12.17% were recorded with M7 in 2012 and 2013, respectively. These results are in conformity with the findings of Ibrahim et al. (2014) who reported that different pollinizers have significant effect on reducing sugars.

Non reducing sugars (%): Maximum non reducing sugars (5.15, 5.11%) were recorded with M6 pollinizer while minimum (4.33, 4.29%) were achieved with M7 in 2012 and 2013, respectively (Table 3). These results are in conformity with the findings of Rahmadel et al. (2014) who reported that different pollinizers had not significantly affected non reducing sugars.

Total sugars (%): Sugars content is an important attribute for quality assessment. Sugars are most prevalent compounds in date. Data presented in (Table 3) indicated that male pollinizers had a significant effect on total sugars. Maximum total sugars (18.97, 18.55%) were recorded with M6 pollinizer, followed by M1 and M3 with 17.92, 17.93 and 16.79, 17.45%, respectively. Minimum total sugars (16.48, 16.47%) were recorded with M7 in 2012 and 2013, respectively. These findings are in accordance with the findings of Omer and Abdel (2014) who reported that total sugars were significantly affected with male pollinizers.

Conclusion

From the results, it is concluded that males differ greatly in floral characteristics like spath length, spath width, number of spath/tree, number of strand/spath, weight of pollen grain/ tree, weight of pollen grain/spath and pollen viability percentage. It is further indicated that males were variable in pollination response to fruit setting, yield and physico-chemical characteristics of fruits. Pollens of M2 pollinizer were found most effective for improvement of more than 50% fruit set and yield as compared to M7. Fruit quality was enhanced with pollination of M6 and can

be recommended for commercial production under the Agro-climatic conditions of Dera Ismail Khan.

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Author's Contribution

All the authors contributed equally.

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