

Research Article



Quantitative and Qualitative Characteristics of Date Palm Cv. Gulistan in Response to Pollination Times

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Abstract | Pollination time is one of the most important factors, which affect pollination efficiency and fruit set. Fruit set, yield and physico-chemical characteristics of date palm cv. Gulistan were assessed under agro climatic condition of D. I. Khan, Khyber Pakhtunkhwa, Pakistan during 2012 and 2013. Treatments consisted of five varied pollination timings i.e., at spathe opening day, 3, 6, 9, and 12 days after spathe opening. Fresh male strand placement technique was used in this study. Strands were cut from a freshly opened male spathe and 2 – 3 strands were placed between the strands of the female inflorescence. Data were collected for fruit set (%), fruit drop (%), fruit yield (kg palm⁻¹) and wide range of physico-chemical quality parameters. Results revealed that pollination times affected all the parameters significantly. Maximum fruit set of 98.12, 93.14% and fruit yield of 79.43 and 78.80 kg palm⁻¹ were recorded in 2012 and 2013, respectively, from pollination at spathe opening day. Mean values for these parameters decreased when pollination was carried out after spathe opening. Late pollination after 12 days of spathe opening reduced fruit set and yield but improved the overall fruit physico-chemical quality characteristics with maximum fruit length (4.15, 4.22 cm), fruit weight (14.23, 14.44 g), pulp weight (13.45, 13.33 g), reducing sugars (21.25, 21.18%) and total sugars (29.36, 28.85 %). This study proved that pollination at spath opening day was more effective for optimum fruit set and economic yield. However, delayed pollination improved the fruit quality characters but at the expense of decreased fruit set and yield and increased percent fruit drop.

Received | November 21, 2016; **Accepted** | November 26, 2017; **Published** | January 01, 2017

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Citation | Iqbal, M., K. Usman, M. Munir and M.S. Khan. 2017. Quantitative and qualitative characteristics of date palm cv. gulistan in response to pollination times. *Sarhad Journal of Agriculture*, 34(1): 40-46.

DOI | <http://dx.doi.org/10.17582/journal.sja/2018/34.1.40.46>

Keywords | *Phoenix dactylefera* L., Pollination, Quality, Yield, Gulistan

Introduction

Date palm (*Phoenix dactylefera*) yield is severely affected by natural way of pollination. Thus artificial pollination is necessary for profitable yield due to its dioecious nature. Male and female flowers emerge from axillary buds of separate palms covering in spathe (sheath). Timing of all the spathe emer-

gence is not the same (Hussain et al., 1984; Bechar et al., 1999). Artificial pollination is affected by so many factors (Attalla et al., 1998). Pollination time is one of the most important factors affecting date palm production (Daud and Ahmed, 2008). Successful pollination is associated with the time when stigma is receptive and pollen could fertilize the egg within ovule. Various studies have highlighted the response

of fruit set, fruit yield and quality of date palm cultivars to pollination time. Dowson (1982) recorded highest fruit set in Khalas date when pollinated after 4 days of spathe opening. Research findings revealed that suitable pollination time is 2-4 days after spathe opening (Zaid, 1999). Hussain et al. (1984) reported that highest fruit set and yield was produced when pollination of Khalas date was carried out at 2-4 days after spathe opening. Iqbal et al. (2004b) observed that pollination should be performed 1- 4 days after spathe opening for obtaining higher fruit set and yield. Shafqat et al. (2005) obtained maximum fruit set and yield in date palm cultivars Hillawi, Khudrawi, Shamran and Zarin when pollinated 2 days after spathe opening. Al-Obeed and Soliman (2011) pollinated Barhey date palm on spathe opening day and one, two, three and four weeks after spathe opening. They revealed that pollination delayed by three weeks after spathe opening significantly reduced fruit set, fruit retention and bunch weight but improved fruit physico-chemical characteristics. Marshee (2011) observed the best pollination time in Barhee and Zahedi date palm as 1-2 days before spathe opening. Zirari (2012) pollinated Najda date palm at the interval of 1,7,10 and 15 days after spathe opening and observed that pollination after 7 and 10 days of spathe opening significantly increased fruit set and yield. Ahmad et al. (2013) found that earlier pollination on spathe opening day increased fruit set in Rothana date palm, however fruit quality was inferior. Pollination 4-6 days after spathe opening resulted in lower fruit set and bunch weight, however it improved fruit quality. Iqbal et al. (2013) while studying pollination effects at different day hours on second day after spathe opening in Dhakki date palm during 2008 and 2009 concluded that pollination at different day hours significantly affected fruit set and other quality parameters. They reported that Pollination at 12 pm was found to be more effective for having highest fruit set, yield and size of fruit. Rahanma and Rahkhodaeij (2014) pollinated Madhjoool date palm 1-3 days before spathe opening and 1-3 days after spathe opening. They achieved increased fruit set with pollination 1-3 days before spathe opening but fruit weight and size were not optimal.

Date palm is the important fruit crop of Pakistan having 89.6 hectares area under cultivation with 524.6 tonnes production (Anonymous, 2013). In Pakistan, local cultivar "Gulistan" originating from Panyala (Dera Ismail Khan, Pakistan) is ranked at 2nd position

after Dhakki due to its larger size and is superior in terms of its nutritive value than all other cultivars of Pakistan. Its fruit is also consumed at Doka (*Khalal*) stage due to high sugar content at dry state having exportable quality (Iqbal et al., 2011). Growers of this area lack knowledge about the optimum time of most indigenous date palm cultivars. The general practice is to apply pollen several times after spathe opening which is a laborious and expensive job. Limited data is available regarding the proper pollination technique in date palm varieties available in the area particularly Gulistan. Thus present study was conducted to determine the suitable pollination time and its effect on date palm (cv. Gulistan) fruit set, yield and quality under the agro-climatic condition of D.I. Khan.

Materials and Methods

An experiment was conducted for two consecutive years during 2012-2013 at Research Farm, Gomal University, Dera Ismail Khan. Fifteen female date palms (cv. Gulistan) being 20 years old were selected. Equally mature male spathes from selected healthy male palms were cut and brought to the laboratory. Male strands were separated by removing the protective sheath. After separation, male strands were kept in an air tight glass bottle and then kept in house hold refrigerator at 4°C. Pollination was carried out by inserting 3-4 male strands into the female spathe at spathe opening day and 3, 6, 9 and 12 days after spathe opening thereby constituting five treatments. The experimental design was randomized complete block with three replicates. At the time of spathe opening bagging was done with waxy paper to avoid contamination and after pollination re-bagging was practiced. All the standard cultural practices were adopted accordingly. The data was gathered on the following parameters:

Fruit Set: Percent fruit set was calculated after four weeks of pollination according to El-Makhtoun (1981). Fruit set calculation was carried out by the following equation.

$$\text{Percent fruit set (\%)} = \frac{\text{No. of retained fruits on the strand} \times 100}{\text{No. of retained fruits} + \text{No. of flowers scars on the same strand}}$$

Fruit dropping (%): Fruit drop percentage was calculated by the following formula.

Table 1: *Effect of different pollination times on fruit set, fruit length and fruit weight of date palm cv. Gulistan.*

Treatments (pollination time)	Fruit set (%)		Fruit length(cm)		Fruit weight(g)	
	2012	2013	2012	2013	2012	2013
At spathe opening	98.12a	93.14a	4.01e	3.60d	12.81b	13.10b
3 days after spathe opening	80.91b	82.20b	4.03d	4.02c	12.01b	13.35b
6 days after spathe opening	65.08c	63.32c	4.08c	4.08b	12.99b	13.41b
9 days after spathe opening	27.13d	31.45d	4.10b	4.10b	14.06a	13.62b
12 days after spathe opening	15.48e	12.48e	4.15a	4.22a	14.23a	14.44a
LSD	5.27	3.41	0.01	0.05	0.65	0.69

Means within each column with the same letter are not significantly different at $P \leq 0.05$.

$$\text{Drop (\%)} = \frac{\text{Number of fruit dropped}}{\text{Total number of fruit set}} \times 100$$

Physico-chemical analysis: At time of harvest (*Khalal stage*), twenty fruits from each tree per replicate were selected randomly for physico-chemical measurements. Fruit weight was measured with electronic balance; diameter and length were measured with the help of a Vernier caliper. After peeling, pulp and seed weights were recorded as described by [Ismail et al. \(2006\)](#). Moisture content (MC) was determined according to [AOAC \(2005\)](#) by using oven drying method. Reducing, non-reducing and total sugars were determined by Lane and Eynon as given in [AOAC \(2003\)](#).

Fruit yield tree⁻¹: All the fruit bunches of each treatment were weighed at maturity and average yield tree⁻¹ was determined.

Statistical analysis

Data were statistically analyzed by using analysis of variance (ANOVA) technique with the help of statistical programme STATISTIX 8. Least Significant Difference was used to know differences between means at 5% level of probability ([Steel et al., 1997](#)).

Results and Discussion

Fruit set

The highest fruit set during 2012 (98.12%) and 2013 (93.14 %) was recorded with pollination at spathe opening day ([Table 1](#)). It was followed by pollination at 3 and 6 days after spathe opening. The lowest fruit set in 2012 (15.40%) and 2013 (12.41%) was observed in late pollination at 12 days after spathe opening. The highest fruit set with early pollination was probably due to peak time of stigma receptivity for pollen germination and pollen tube development to stimu-

late fertilization in ovary and with the passage of time stigma receptivity decreased as also reported by [Ream and Furr \(1969\)](#) and [Nasir et al. \(1997\)](#). These results are similar with those of [Iqbal et al. \(2004b\)](#), who recorded highest fruit set in Dhakki date palm when pollination was carried out at earlier time. Similarly, [Al-Obeed and Soliman \(2011\)](#) reported highest fruit set in cultivar Sayer at spathe opening day.

Fruit length

Time of pollination affected fruit length significantly during 2012 and 2013 as shown in [Table 1](#). Maximum fruit length (4.15, 4.22 cm) was produced with pollination performed after 12 days of spathe opening. Pollination at spathe opening day produced shortest fruit (4.01, 3.06 cm) during both years of study. The decrease in fruit length due to early pollination might be due to highest fruit set having increased competition for assimilate that eventually resulted in reduced fruit size/length. [Abdel-Galil et al. \(2007\)](#) also reported that delaying pollination significantly improved fruit length.

Fruit weight

Fruit weight was also affected significantly by pollination times in both years of study ([Table 1](#)). Maximum fruit weight (14.23, 14.48 g) was recorded when pollination was carried out after 12 days of spathe opening. On the other hand, minimum fruit weight (12.81, 13.10 g) was recorded with pollination performed at spathe opening day. These results might be due to decreased fruit set and increased fruit length obtained on account of delayed pollination. This in turn has a positive impact on fruit size due to increased food supply to demand ratio by the growing fruit as a whole ([Elham et al., 2006](#)).

Pulp weight

Pollination times had significant effect on pulp weight

Table 2: Effect of different pollination times on pulp weight, seed weight and fruit drop of date palm cv. Gulistan.

Treatments (pollination time)	Pulp weight (g)		Seed weight (g)		Fruit drop (%)	
	2012	2013	2012	2013	2012	2013
At spathe opening	11.81b	12.09b	1.00c	1.01c	16.48b	15.82b
3 days after spathe opening	11.86b	12.32b	1.02bc	1.03bc	16.55b	16.57b
6 days after spathe opening	11.97b	12.37b	1.03bc	1.04b	16.56b	16.68b
9 days after spathe opening	12.42ab	12.59b	1.06ab	1.12a	16.59b	16.67b
12 days after spathe opening	13.45a	13.33a	1.10a	1.10a	19.17a	18.60a
LSD	1.15	0.63	0.05	0.02	1.25	1.77

Means within each column with the same letter are not significantly different at $P \leq 0.05$.

Table 3: Effect of different pollination times on fruit yield, moisture content and reducing sugars of date palm cv. Gulistan.

Treatments (pollination time)	Fruit yield (kg palm ⁻¹)		Fruit moisture (%)		Reducing sugars (%)	
	2012	2013	2012	2013	2012	2013
At spathe opening	79.43a	78.80a	64.36c	64.36c	20.10c	20.12b
3 days after spathe opening	74.11b	75.16b	65.16b	65.16b	20.12c	20.13b
6 days after spathe opening	55.10c	59.15c	65.79ab	65.79ab	20.14b	20.14b
9 days after spathe opening	21.78d	18.83d	66.13a	66.14a	20.14b	20.16b
12 days after spathe opening	15.15e	15.48e	66.15a	66.16a	21.25a	20.88a
LSD	1.16	2.57	0.72	0.73	0.01	0.45

Means within each column with the same letter are not significantly different at $P \leq 0.05$.

during both the study years (Table 2). Maximum pulp weight (13.45, 13.33 g) was produced with delayed pollination (till 12 days of spathe opening). Minimum pulp weight of 11.81 and 12.09 g was recorded in palms receiving pollination at spathe opening day in both years. These results matched with that of Marzouk et al. (2002).

Seed weight (g)

Results indicated that seed weight increased with delayed pollination (Table 2). Maximum seed weight (1.10 g) was recorded with pollination after 12 days of spathe opening during both the study years. Pollination at spathe opening day produced lightest (1.00, 1.01 g) seed weight. Analogous results were communicated by Daud and Ahmed (2008), who reported that delaying pollination significantly produced maximum seed weight. Delayed pollination lead to natural thinning, which perhaps increased cell division, cell enlargement and the biosynthesis of carbohydrates and proteins (Samih, 2006).

Fruit drop

Results indicated significant effect of days to pollination on the fruit drop percentage during both years of study (Table 2). Minimum fruit drop (16.48,

15.82%) was observed when pollination was performed at spathe opening day. Maximum fruit drop (19.17, 18.60%) was recorded when pollination was carried out at 12 days after spathe opening. These results indicated that earlier pollination retained more fruit due to highest fruit set. In late pollination there was less number of fruit set and more fruit dropping %age. Late pollination resulted in more fruit drop probably due to poor pollen viability. These results are in conformity to the findings of other researchers (Iqbal et al., 2004a; Saeed, 2005). They noticed maximum fruit drop when pollination was delayed after spathe opening day.

Yield tree⁻¹

Different pollination times exhibited significant effect on yield production during 2012 and 2013 (Table 3). Maximum fruit yield per palm (86.82, 87.51 kg palm⁻¹) was recorded from pollination at spathe opening day. It was gradually decreased with delaying pollination. The lowest yield of 15.15 and 15.48 kg per palm was obtained from late pollination (12 days after spathe opening). The results indicate that yield is strongly associated with maximum fruit set and less fruit drop. As mentioned earlier, maximum fruit set percentage and minimum fruit drop was no-

ticed from earlier pollination (at spathe opening day). These results matched well with the findings of [Iqbal et al. \(2004b\)](#), who obtained maximum fruit bunch weight in Dhakki date palm from earlier pollination. Similarly, [Shafqat et al. \(2005\)](#) obtained highest yield from Hillawi, Khudrawi, Shamran and Zarin date palm cultivars from pollination at spathe opening day.

Fruit moisture content (%)

Moisture is one of the essential components of fruit which affects basically its quality. Results indicated that fruit moisture content was significant in both years of study ([Table 3](#)). Moisture content was maximum (66.15, 66.16%) with late pollination i.e. 12 days after spathe opening. Contrary to this, earlier pollination resulted in fruits with lower moisture content (64.36%, 64.36%). Highest moisture content is closely associated with maximum fruit size and weight which was observed in late pollination. [Ahmad et al. \(2013\)](#) communicated similar findings who reported significantly higher moisture content with late pollination.

Reducing sugars

Reducing sugar is a mixture of glucose and fructose and released from the hydrolysis of sucrose. Our results indicated that reducing sugars increased with delay in pollination during both the study years ([Table 3](#)). Maximum reducing sugars (21.25, 21.18%) were recorded with pollination delayed till 12 days after spathe opening, while lower values (20.10, 20.11%) were noted with pollination at spathe opening day. This might be due to less number of fruits on bunch, which had increased cells division, cell enlargements and higher biosynthesis of carbohydrates regarding sugar content. These results are in conformity with that of [Ahmad et al. \(2013\)](#), who stated that late pollination significantly improved reducing sugars content. Similar results were reported by [Al-Wasfy \(2005\)](#) who documented that delaying pollination by 6-9 days from the time of female spathe cracking caused much improvement in fruit chemical constituents.

Non-reducing sugars

Results indicated that contents of non-reducing sugars increased with delay in pollination ([Table 4](#)). The percentage of non-reducing sugars was higher with late pollination (12 days after spathe opening) during 2012 and 2013. The Data further indicated that early pollination at spathe opening resulted in low-

er percentage of 8.11 and 8.13% non-reducing sugars during 2012 and 2013, respectively. These results corroborate the work of [Abdallah et al. \(2002\)](#), who reported that percentage of non-reducing sugar increased significantly when pollination was delayed after spathe opening.

Table 4: *Effect of different pollination times on non-reducing sugars and total sugars of date palm cv. Gulistan.*

Treatments (pollination time)	Non-reducing sugars (%)		Total sugars (%)	
	2012	2013	2012	2013
At spathe opening	8.11c	8.11d	28.21d	28.23b
3 days after spathe opening	8.12c	8.12cd	28.24cd	28.25b
6 days after spathe opening	8.14b	8.14bc	28.29bc	28.28b
9 days after spathe opening	8.16ab	8.16ab	28.30b	28.32b
12 days after spathe opening	8.17a	8.17a	29.39a	29.04a
LSD	0.01	0.02	0.05	0.44

Means within each column with the same letter are not significantly different at $P \leq 0.05$.

Total sugars

Results indicated significant variation in percentage of total sugar on account of time of pollination ([Table 4](#)). Maximum mean value for total sugars (29.39, 29.04%) was noticed with delayed pollination i.e., 12 days after spathe opening. Total sugars contents were minimum (28.20, 28.23%) with pollination performed at spathe opening day. Highest total sugars in late pollination may be due to greater fruit size, lesser fruit set and higher dropping percentage. Moreover, high proportion of reducing sugars in the total sugars might be one of the reasons of overall increased total sugars trend in late pollinated spathes. Sugar content is an important attribute in quality assessment of date palm fruit. Analogous results were reported by [Abdalla and Sayed-Ahmad \(1993\)](#), [Kirk and Sawyer \(1997\)](#) and [Moustafa \(1998\)](#), who found that total sugars content in fruit is significantly affected by pollination time.

Conclusions

In the light of results obtained it is concluded that pollination at spathe opening day is the most effective production technique for getting optimum fruit set as well as profitable yield. However, delayed pollination

can improve the physico-chemical characteristics of the date palm fruit at the expense of decreased fruit set, yield and increased percent fruit drop.

Authors' Contribution

Muhammad Iqbal is the principal author who conducted this research. Khalid Usman is the corresponding author and did revision of the paper till final shape for publication. Muhammad Munir did lab analysis and Muhammad Sohail Khan assisted in preparation of the draft of this paper.

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