Research Article

ISAH Indian Journal of Arid Horticulture
Year 2025, Volume-7, Issue-2 (July-December)

Investigating the influence of pollen sources on fruit traits of date palm (*Phoenix dactylifera*) cv. Barhee in hot arid condition

R.K. Meena*, M.K Choudhary, Chet Ram, D. Singh, Jitendra Gurjar and Jagadish Rane

ICAR-Central Institute for Arid Horticulture, Bikaner, Rajasthan

ARTICLE INFO

Received: 01 April 2025
Accepted: 24 November 2025

Keywords: Date palm, Pollen sources, Pollination, Yield.

doi:10.48165/ijah.2025.7.2.5

ABSTRACT

Date palm is a dioecious species thus the commercial cultivation of date palm depends on the efficient pollination process to achieve higher fruit set and quality. This research experiment was conducted at ICAR-Central Institute for Arid Horticulture, Bikaner during 2021 and 2022 to investigate the effects of different male date palm (M1, M2, M3 and Ghanami) on various fruit traits, yield and total soluble solids of date palm variety Barhee. Among the four pollen sources, M1 resulted in the highest number of berries per strand, lowest fruit drop percentage, maximum fruit bunch weight, fruit length, fruit width and yield. The TSS percentage was higher when pollens from M1 were used compared to others. The study suggests that the selection of pollen source plays a crucial role in determining the yield and quality of date palm variety Barhee. These findings can be useful for the cultivation and breeding of date palm trees, especially for improving fruit yield and quality.

Introduction

Date palm (*Phoenix dactylifera* L.) is a perpetual, diploid, monocotyledonous plant that exhibits dioecious characteristics (Zhao *et al*., 2012). It possesses a total of 36 chromosomes, organized into 18 pairs (2n = 36). It is unisexual species with male and female inflorescences are located on distinct individual trees (Robinson *et al*., 2012). The palm tree bears its inflorescences, commonly referred to as racemes, within the leaf axils near the trunk. These racemes are enclosed by a rigid casing known as a spathe, which unfolds upon the maturation of the inflorescence (Zaid and Arias-Jimenez, 2002). Male spathes emerge and open from December to March, releasing pollen, while female spathes open from January to late March (often around 7:00 AM). There is lack of synchronization in anthesis, which resulted in non-availability of pollen grain for pollination if the not stored (Iqbal *et al*., 2004).

Pollen grains from male flowers, which are transferred to female palms, the process is known as pollination (Bekheet and Hanafy, 2011). Date palm pollination occurs both naturally—through insects and wind—and artificially, using methods such as placing pollen strands, dusting pollen, or suspending pollen. Date palm being dioecious in nature, the mechanical or hand pollination is essential for proper fruit set, as natural pollination through wind or insects is negligible (Saroj *et al*., 2021). Artificial pollination using compatible pollen sources significantly enhances fruit set, ripening and quality in commercial date palm cultivation (Omar and El-Abd, 2014). The phenomenon of metaxenia, where pollen directly influences the physical and chemical properties of

Corresponding author's Email: rkmeena8119@yahoo.com (Dr. Ramkesh Meena)

fruits, affects fruit ripening time, color, size, weight and seed characteristics (Al-Khalifah, 2006). Similarly, different male parent sources have been shown to directly affect date fruit quality. However, achieving high economic yields depends on a greater percentage of successful fruit setting, which is influenced by the effectiveness of pollination, pollen quality, pollination efficiency, timing, male-female compatibility and environmental factors such as temperature, irrigation, soil conditions and fertilization (Iqbal *et al*., 2012; Sharma *et al*., 2021).

Numerous studies have been conducted to evaluate the impact of various pollen sources on fruit characteristics and yield in order to determine the most suitable pollenizers for achieving optimal crop production and to assess the compatibility between different cultivars (Al-Khalifah, 2006; Al-Muhtaseb and Ghnaim, 2006; Shafique *et al*., 2011; Iqbal *et al*., 2012; Rezazadeh *et al*., 2013; Hafez *et al*., 2014 and Salomon-Torres *et al*., 2017). Considering the critical role of pollen in date palm cultivation, this study aims to assess how different pollen sources influence key fruit traits of cv. Barhee under hot arid conditions. The study seeks to determine the extent to which pollen from various male genotypes influences fruit set, fruit size, fruit quality parameters, and overall productivity. By understanding these pollen–parent effects, the research aims to identify the most suitable pollen sources capable of enhancing yield, improving fruit characteristics, and optimizing date palm production in arid environments.

Material and Methods

The endeavour of current study was to conclude the effects of four pollinizer sources (M1, M2, M3 and Ghanami) on the yield and physicochemical fruit characteristics of one date palm cultivar viz., Barhee at the ICAR-Central Institute for Arid Horticulture, Bikaner during 2021 and 2022 (Latitude 28o06'N and Longitude 73o20'E). Fifteen-year-old plants of cv. Barhee planted at a spacing of 8 m × 8 m were used as female parents. The experiment was conducted using a Randomized Block Design (RBD) with five replications. Five spathes of similar size from each palm, which had emerged and opened on the same date, were selected for data collection in each replication.

Male inflorescences were harvested immediately after the spathes opened naturally. They were carefully transported to a designated drying area, where the spathes were removed. Each inflorescence was individually suspended in a well-ventilated space for one week. Pollen was collected daily by gently shaking the inflorescences over a clean newspaper surface. The collected pollen was then stored at 4°C in airtight containers until use for pollination.

Each female plant was pollinated only once, using pollen from a single male parent. Female spathes were monitored for natural cracking and then manually opened. Pollination was performed between the second and fourth days after spathe opening to optimize receptivity. Manual pollination was achieved by dipping a small piece of sterile cotton into the stored pollen and gently inserting it into each female flower, ensuring direct contact with the stigma for effective pollen transfer. After pollination, the spathes were immediately covered with breathable brown paper bags to prevent contamination from wind- or insect-mediated natural pollination. The bags were removed once fruit set was confirmed (typically 10–14 days after pollination).

Among the different morphological traits, the number of berries per strand was determined by counting the total number of berries from five individual strands from each replication. Subsequently, the average number of berries per strand was calculated. Similarly, the percentage of fruit drop was determined by counting the number of scars per strand at three-week intervals for each tree and the average fruit drop percentage was calculated. The weight of the entire fruit bunch was measured after harvest using an electric weighing machine and expressed in kilograms (kg). To determine the total yield at harvest, each spathe was individually weighed using a weighing balance and expressed in kilograms (kg). Additionally, for each replication, 10 fruits were randomly selected from each strand and weighed to calculate the average fruit weight, which was expressed in grams (g). The pulp thickness of 10 representative fruits per replication was measured using a Vernier caliper and the average pulp thickness was calculated in millimetres (mm). Moreover, the seeds of the same selected fruits were weighed using an electronic balance and the average seed weight was calculated in grams (g). The length and width of the selected fruit seeds were measured using a vernier calliper and the average seed length and width were calculated in millimeters (mm). Finally, to measure the TSS, a digital refractometer (RX 5000, Atago, Japan) was used and the TSS was expressed in degree Brix (°Brix).

The collected data were subjected to statistical analysis using the method of analysis of variance (ANOVA) for a randomized block design (RBD), as described by Gomez and Gomez (1984).

Results and Discussion

Table 1 shows that the 'Barhee' cultivar, when pollinated with M1, exhibited significantly ($P \leq 0.05$) higher values for the number of strands per bunch (64.60), number of berries per strand (18.40) and bunch weight (4.74 kg). In contrast, pollination with M3 resulted in the lowest values for these traits, with strands per bunch (44.40), berries per strand (13.20) and bunch weight (2.70 kg). However, bunch per plant, stalk length, bunch length and strand length showed non-significant differences. According to Table 2, all pollen sources significantly affected fruit characteristics. Pollination with M1 the highest fruit weight (8.65 g), fruit length (27.46 mm) and fruit width (20.51 mm). Conversely, the lowest fruit weight (6.71 g) and fruit width (16.72 mm) were observed with M3, while the shortest fruit length (24.99 mm) was recorded with M2. Stone weight, stone length and stone width showed non-significant differences.

This phenomenon can be attributed to the metaxenia effect, where the growth of the ovarian tissues is influenced by the hormones released by the growing endosperm and embryo tissues, which are dependent on the pollen source. These hormones diffuse into the ovarian tissue and have a distinct impact on the growth of the fruit. These findings are consistent with Rezazadeh *et al*. (2013), who reported that different pollen sources had significant effects on marketable yield, with the best male pollens increasing the yield up to 41%. Similarly, (Iqbal *et al*., 2012) reported significant effects of different male pollen sources on different pomological traits and the economical yield index.

However, the statistical analysis showed non-significant effects for stone weight, stone length and stone width. Kumawat *et al*. (2022) also reported a non-significant difference in seed weight when pollen from various sources was used. Similarly, in the current experiment, comparable results were obtained. This may be attributed to the fact that the pollen sources employed in their study differed from those used in the present investigation. Consequently, the interactive effect of pollen from different cultivars may vary depending on the cultivars used as receivers. The data in Table 3 showed that the different pollen sources shows non-significant effects on per cent fruit drop and pulp thickness. The 'Barhee' exhibited the maximum (41.68°B) TSS when pollinated with M1, followed by M2 (41.40°B) and Ghanami (40.70°B) pollen source. Contrary to our research Salomon-Torres *et al*. (2017) found no significant variation in TSS in response to different pollen sources. The quality of the pollen, its germination rate and the growth of pollen tubes may also contribute to the differences in TSS content.

The variability in yield can be attributed to variations in the quality of the pollen source, its viability and the compatibility between male and female plants. The highest total yield (57.47 kg) was obtained in Barhee pollinated with the M1 (Table 3). The lowest total yield (48.33 kg) was obtained when pollinated with the M3 pollen. The quality of the pollen, its germination rate and the growth of pollen tubes may also contribute to the differences in yield.

Table 1. Effect of different pollen sources on bunch characteristic of variety Barhee

Barhee	Bunch/ plant	Stalk length (cm)	Bunch length (cm)	No. of strands/ bunch	Strand length (cm)	No. of berry/ strands	Bunch weight (kg)
M1	10.68	78.14	31.20	64.60	48.80	18.40	4.74
M2	10.30	74.14	29.00	60.20	48.00	15.60	3.40
M3	10.24	71.06	28.40	44.40	43.20	13.20	2.70
Ghanami	10.40	75.94	31.00	63.20	47.40	17.00	3.52
CD at 5%	NS	NS	NS	6.62	NS	2.24	0.98
SEm±	0.17	2.20	1.11	2.13	2.13	0.72	0.32
CV (%)	3.67	6.56	8.26	8.18	10.61	10.01	19.63

NS: Non-significant

Table 2. Effect of different pollen sources on fruiting characteristic of variety Barhee

Barhee	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Stone weight (g)	Stone length (mm)	Stone width (mm)
M1	8.65	27.46	20.51	0.84	16.17	8.80
M2	7.54	24.99	17.16	0.66	16.12	7.43
M3	6.71	27.27	16.72	0.78	15.71	7.76
Ghanami	7.46	26.39	18.02	0.76	15.94	7.19
CD at 5%	0.60	1.51	1.54	NS	NS	NS
SEm±	0.19	0.48	0.50	0.06	0.53	0.44
CV (%)	5.71	4.08	6.11	16.63	7.39	12.70

NS: Non-significant

Table 3. Effect of different pollen sources on fruiting characteristic of variety Barhee

Barhee	Per cent fruit drop	TSS (°Brix)	Pulp thickness (mm)	Yield per plant (kg)
M1	35.10	41.68	6.14	57.47
M2	53.00	41.40	5.41	53.61
M3	53.70	36.28	5.24	48.33
Ghanami	39.36	40.70	5.51	55.09
CD at 5%	NS	1.21	NS	2.06
SEm±	7.27	0.39	0.26	0.66
CV (%)	35.91	2.18	10.22	2.76

NS: Non-significant

Conclusion

Based on the results it can be concluded that the choice of pollen source has a significant effect on the yield and quality of date fruit produced by Barhee cultivar. These results suggest that date palm growers should prioritize using pollen from reliable sources for pollinating their trees. The present study concluded that the pollen grains obtained from M1 exhibit superior results regarding fruit growth and quality characteristics. This can help to maximize yield and produce higher quality fruit, ultimately leading to increased profits for the growers. Overall, this study provides valuable information for date palm growers and researchers seeking to improve the productivity and quality of date palm. Further research could investigate the potential benefits of using pollen from promising male date palm genotypes to enhance both yield and fruit quality.

Acknowledgements

Authors sincerely acknowledge the ICAR, New Delhi and ICAR-CIAH, Bikaner for providing the facility for carrying out the research.

Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

References

Al-Khalifah, N.S. 2006. Metaxenia: influence of pollen on the maternal tissue of fruits of two cultivars of date palm (*Phoenix dactylifera* L.). *Bangladesh Journal of Botany*, 35(2): 151-161.

Al-Muhtaseb, J.A. and Ghnaim, H.D. 2006. Effect of pollen source on yield, quality and maturity of "Barhi" date palm. *Journal of Agricultural Sciences*, 2: 9-14.

Bekheet, S.A. and Hanafy, M.S. 2011. Towards sex determination of date palm. In: Date palm biotechnology. Dordrecht: Springer Netherlands. pp. 551-566.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley and Sons, New York, p. 680.

Iqbal, M., Ghafoor, A. and Rahman, S. 2004. Effect of pollination times on fruit characteristics and yield of date palm cv. *Dhakki. International Journal of Agriculture and Biology*, 6(1):96-99. https://doi.org/10.17582/journal.sja/2024/40.4.1128.1134

Iqbal, M., Niamatullah, M. and Munir, M. 2012. Effect of various *Dactylifera* males pollinizer on pomological traits and economical yield index of CV's Shakri, Zahidi and Dhakki date palm (*Phoenix dactylifera* L.). *The Journal of Animal and Plant Sciences*, 22(2):376-383

Kumawat, P., Rathore, R.S., Singh, R.P. and Kumar, S. 2022. Study the effect of different pollination techniques on date palm production. *Sugar Tech*, 24(6):1887-1893.

Omar, A.E.K. and El-Abd, A. E. 2014. Enhancing date palm (*Phoenix dactylifera* L.) productivity, ripening and fruit quality using selected male palms. *Acta Advances in Agricultural Sciences*, 2(6):11-19.

Rezazadeh, R., Hassanzadeh, H., Hosseini, Y., Karami, Y. and Williams, R.R. 2013. Influence of pollen source on fruit production of date palm (*Phoenix dactylifera* L.) cv. Barhi in humid coastal regions of southern Iran. *Scientia Horticulturae*, 160: 182–188. https://doi.org/10.1016/j.scienta.2013.05.038

Robinson, M.L., Brown, B. and Williams, C.F. 2012. The date palm in southern Nevada. *University of Nevada Cooperative Extension*, 23:1-26.

Salomon-Torres, R., Ortiz-Uribe, N., Villa-Angulo, R., Villa-Angulo, C., Norzagaray-Plasencia, S. and Garcia-Verdugo, C.R.I.S.T.I.A.N. 2017. Effect of pollenizers on production and fruit characteristics of date palm (*Phoenix dactylifera* L.) cultivar Medjool in Mexico. *Turkish Journal of Agriculture and Forestry*, 41(5):338-347. https://doi.org/10.3906/tar-1704-14

Saroj, P.L., Kumar, K., Kumawat, K.L., Sarolia, D.K. and Meena, R.K. 2021. Significance of pollinizers in arid fruit culture: A review. *Progressive Horticulture*, 53(2):123-141. https://doi.org/10.5958/2249-5258.2021.00022.1

Shafique, M., Khan, A.S., Malik, A.U., Shahid, M., Rajwana, I.A., Saleem, B.A., Amin, M. and Ahmad, I. 2011. Influence of pollen source and pollination frequency on fruit drop, yield and quality of date palm (*Phoenix dactylifera* L.) cv. Dhakki. *Pakistan Journal of Botany*, 43:831-839.

Sharma, K.M., Baidiyavadra, D.A. and Chaudhary, H. 2021. Artificial pollination in date palm: a review. *Indian Journal of Arid Horticulture*, 3(1&2):1-7. https://doi.org/10.48165/ijah.2021.3.1.1

Zaid, A. and Arias-Jimenez, E.J. 2002. Date Palm Cultivation; Food and Agricultural Organization: Rome, Italy.

Zhao, Y., Williams, R., Prakash, C. S. and He, G. 2012. Identification and characterization of gene-based SSR markers in date palm (*Phoenix dactylifera* L.). *BMC Plant Biology*, 12:1-8. https://doi.org/10.1186/1471-2229-12-237