Effect of Different Pollen Sources on Yield and Fruit Quality of Barhi Date Palm Cultivar under Sudan Conditions

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Abstract

This research was conducted to study the effect of different pollen grain sources on yield, maturity and fruit quality of "Barhi" date palm cultivar. Pollen grains were collected from six locations, Al-khoglab Male1, Soba Male2, Al-Halfaya Male3, Bahary Male4, Al-Grief Male5, Shambat Male6, for hand pollination of Barhi cv. female trees during successive seasons (2019-2021). Fruits were harvested at full maturity stage (full coloring) to determine physical and chemical characteristics as bunch weight, total yield, fruit weight, length, and diameter, seed weight, length and diameter, Total Soluble Solids (TSS%), maturity % and fruit flesh weight %. Results indicated that the highest Pollen germination % and length fruit were recorded in Shambat Male 6.The highest fruit set %, bunch weight, total yield, fruit length /diameter (L/D) ratio with Al-khoglab Male 1and Shambat Male 6.There is no significant differences with six pollen sources was attained fruit diameter, Seed Weight and seed length / diameter (L/D) ratio. It is better to use, Al-khoglab Male1 or Shambat Male 6. Pollen grains of Khartoum region -Sudan to pollinate date palm of Barhi to obtain the best fruit quality.

Keywords: Barhi date palm (*Phoenix dactylifera* L.), pollen grain sources, fruits set, fruit quality, physical and chemical characters

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Introduction

Date palm (*Phoenix dactylifera* L.) is a common fruit tree around Arabian countries, Middle East, North African countries and in hot arid regions of the world (Chao and Krueger, 2007) as the Arab Muslim world are the main production areas, 11 countries in these regions carry out 94% of world production; the 1st place was occupied by Egypt followed successively by Iran and Saudi Arabia, Abd Elkader (2016). Barhi" cultivar is the most important soft cultivar grown in Egypt and consumed at the full mature stage of development Khalal stage (Iqbal *et al*., 2004). The color of fruit changes during maturation from green in the kimri stage to yellow in the khalal stage and to brown in the rutab and tamr stages (Al-Redhaiman, 2004) .Date palm is one of the most important fruit crops grown in Sudan. It needs a lot of efforts on researching how to increase its' yield quantitatively and qualitatively. Therefore, it is essential to study the factors influencing productivity and enhancing its' quality attributes. One of the most important factors is pollination of female palms by the compatible male at a suitable period with the best pollen type which can improve fruit quality. Also at Khartoum state the date industry has not been able to attain any commercial status simply for the reason that its ripening is during July and August. This synchronizes with autumn rains which are responsible for causing rot and fermentation of the Rutab fruit on the palm due to high humidity and high temperatures during this period. In addition, little information is available

on date palm males which would lead to the usage of low quality males (low pollen viability) in pollinating high valuable female trees which would affect fruit setting and thereby the yield and its' attributes. Effect Pollen grains of on seed characters is known *Xenia* (Nixon, 1955); and effect pollen grain from different male types on fruit set, yield and fruit characteristics is known as *Metazina* (Iqbal and Munir, 2012). The efficiency of pollination and fruit set depends on several factors such as male flowering time, pollinizer source, the viability and amount of pollen grains, pollination time, and the receptivity of female flowers (Munir *et al*., 2014).Also many researches proved that the fruit set percentage differ between cultivars and that pollen grains effect directly the female flowers (Awad and Al-Qrashi, 2012; Iqbal, 2012 and Omar *et al*., 2014). The most imperative yield of date development is a consequence of high fruit set percentage. The achievement of this rate relies upon a blend of a few variables, i.e. the quality of the pollen source, the pollination efficiency process, the compatibility of males and females as well as environmental conditions (Iqbal and Munir, 2012). However, different investigators have demonstrated the possibility of using pollens from different palm species with a great success. Fattahi *et al*. (2014) assured that pollination of fruitful trees is a vital step for having a good product. In addition pollen grains effected directly the quality and the quantity of the fruits (Soliman and Osman, 2001; Farag, 2012 and Hafez *et al*., 2014). The present investigation aimed to study the effect of different pollen sources of pollen on the yield, quality attributes, and maturity of "Barhi" date palm cultivar.

Materials and methods

This study was conducted at Hag Bashier orchard at El-Seleat North Project on eighteen 12 year old uniforms 'Barhi' date palm trees divided into three replicates during the 2013 season. Several pollen sources of local date palm trees males were evaluated with respect to their viability (according to germination test), the best sources were selected and named according to their location in the project area and to ease the handling of such males: "Male 6" from Horticulture research station at Shambat, "Male 5" from Hag Bashier orchard and "Male 2" from El –Nefeady orchard. In addition, three commercial males were used in this study: "Male 3", and "Male 1" males from Talab orchard and "Male 4" from Khartoum University.

1. Pollen germination (%)

At the beginning of the season, pollen germination test was done for all pollen sources on a nutrient media which consisted of 20% sucrose and 1% agar according to the method followed by Kwan (1969) and Asif *et al*. (1983). Pollen germination (%) was recorded after 24 hours using a light microscope 100x and for those which had germination tube longer than pollen diameter.

2. Pollen operation

Male spathes were cut as soon as cracked. Pollination was done by dusting of pollens on spathe opening day on females Barehi cultivar. Pollens were diluted by mixing them with flour in a ratio of 1 pollen: 2 flour to ensure maximum pollen use, after pollination, bagging was done in accordance with the size of spathes of each female to avoid contamination. These bags were removed after two weeks of pollination.

3. Measurements and determination of fruit characteristics

3.1. Fruit set percentage: Eight female strands per spathes were selected for recording of number of flowers and fruit setting after four weeks by using the following formula:

Fruit set % = Number of fruits setting on the strand/ Total number of flowers per the same strand × 100

At the harvest day, of Barhi date palm trees were harvest at maturity stage in the end of the khalal stage (at full color stage).

3.2. Bunch Weight (kg) and total yield: Eight bunches from each source pollen was weighed independently using a weighing balance to calculate the total yield at harvest, which was expressed in kilograms (kg).

At harvest day, 20 fruits with 3 replicates from each female tree were taken to determine fruit **Characteristics as follow:**

4. Fruit characteristics:

4.1.Fruit weight (g): fruits of each pollen source tree were weighed by electric balance and average weight of fruit was computed in grams.

4.2.Fruit Length, Diameter (cm) and L/D ratio: Fruit length was measured from the end of the fruit to the top of the shoulder which was expressed in (cm). While, fruit diameter was measured at the broadest point of the fruit shoulder and stated in (cm).

4.3.Seed weight (g); length and diameter (cm) and L/D ratio: After separation of pulp and weight seed in (g), the seed length and diameter measured in (mm).

4.4.Total Soluble Solids (TSS %): It was measured by hand refractometer

4.5.Maturity (%): It was calculated as weight of fruits that reached Rutab stage to the total fruit weight at harvesting date

4.6.Fruit flesh weight (%):

Flesh weight (%) = {Flesh weight (g)/ Fruit weight (g)} × 100

5. Statistical analysis:

All data parameters studied were analyzed as a Completely Randomized Design in factorial arrangement with three replications. All data were subjected to statistical analysis as described by Snedecor and Cochran, (1989). The differences between means were differentiated using test according to (Duncan, 1955).

Results

6. Effect of different pollen sources on Pollen germination (%)

The results indicate that pollen germination % significantly affect by various male pollinizers are revealed in (Table 1) the highest Pollen germination % was recorded in M6 (Shambat station) as gave (89.3%) followed by M5 (Hag Bashier orchard) as gave(8304) followed by M1 (Talab orchard 1) as gave (76.6) followed by M2 (El –Nefeady orchard) as gave (73.8) and then M3 (Talab orchard 3) as gave (70.8), finally M4(Khartoum University) as gave (60.7) in descending order.

7. Effect of different pollen sources on fruit set (%) and fruit characteristics:

7.1.Fruit set:

Results presented in (Table 2) clarify the highest significant fruit set percentages attributed to pollination recorder with Males M1 (Talab orchard 1) or M6 (Shambat station) (72.5 and 70.3%, respectively) with insignificant differences. Whereas the minimum fruit set was of Male 5 (55.9%).

7.2.Bunch weight (Kg) and Yield (kg/palm):

Table 2, results indicated that there is no significant differences among all pollen sources were observed on yield however, trees pollinated with “Males M1 (Talab orchard 1) or M 6 Shambat station) gave the highest yield (134.7 and 132.3 kg, respectively) while those pollinated with (Male 5) gave the least yield (109.0 kg). A similar trend was observed with respect to average bunch weight.

7.3.Fruit weight (g):

Data in table (3) related that “Barhi” trees pollinated with Male 1 (11.6 g), or Males 6 (11.5 g) with insignificant differences followed by M5 (Hag Bashier orchard), M4 (Khartoum University) males showed the highest significant average fruit weight (11.3 and 10.5 g, respectively) but with insignificant differences from those attained from pollination with Males M2 (El –Nefeady orchard), M3 (Talab orchard 3).

7.4.Fruit Length, diameter (cm) and L/D ratio:

Data in (Table 3) related that no significant differences among pollen treatments were observed with respect to fruit length. The highest length fruit of Barhi obtained with M6 (Shambat station) as gave (29.6 mm). There is no significant difference with different pollen sources was attained fruit diameter. The highest significant fruit length /diameter (L/D) ratio with M1 (Talab orchard 1) and M6 (Shambat station).

7.5.Seed weight, length and diameter and L/D:

Data in (Table 4) related that no significant differences were observed with respect to Seed Weight of Barhi date palms pollinated with different pollen sources. The highest average. Seed length obtained from M6 (Shampat station) (17.0 mm) with respect to seed length / diameter (L/D) ratio they were insignificantly affected by all the used pollens.

7.6.Total soluble solids (TSS %):

Data in (Table 5) related that no significant differences were observed among treatments with respect to fruit total soluble solids (TSS %), however, trees pollinated with M2 (El –Nefeady orchard) gave the highest fruit TSS % (41.8 %).

7.7.Maturity (%):

Data in (Table 5) related that maturity % as calculated as weight of fruits that reached Rutab stage to the total fruit weight at harvesting date. Maturity (%) of pollen sources at harvest date differed significantly from all males, which were statistically identical to each. the significantly minimum Maturity % obtained from M5 (Hag Bashier orchard) as gave (7.9%) followed by M6 (Shambat station) as gave (10.4%).

7.8.Fruit flesh weight (%):

Data in (Table 5), showed that M2 (El –Nefeady orchard) male palm possessed significantly greatest Fruit flesh weight % (96.6%) followed by M5 (Hag Bashier orchard) and M3 (Talab orchard 3) as gave (91.8 and 91.6) respectively.

Table (1): Effect of different pollen sources on pollen germination % of Barhi date palm

Male No.	Site	Pollen germination (%)
Male 1	Al-khoglab	76.6 c
Male 2	Soba male	73.8.cd
Male 3	Al-Halfaya	70.6 d
Male 4	Bahary	60.7d
Male 5	Al-Grief	83.4b
Male 6	Shambat	89.3a

The same letters in each column are not significantly differently at 5% probability

Table (2): Effect of different pollen sources on fruit set % bunch weight and total yield, of Barhi date palm

Male No.	Fruit set %	Average bunch weight/Kg	Total yield /kg/tree
Male 1	72.5a	26.9a	134.7a
Male 2	60.0a	25.6 a	128.0a
Male 3	59.1b	22.3 a	111.7a
Male 4	60.0b	24.5 a	122.7a
Male 5	55.9c	21.8 a	109.9a
Male 6	70.3a	26.5 a	132.2a

The same letters in each column are not significantly differently at 5% probability

Table (3): Effect of different pollen sources on fruit weight, length, diameter and length/ diameter (L/D) of Barhi date palm

Male No.	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	L/D
Male 1	11.6 a	29.0a	27.8b	1.27a
Male 2	9.8ab	28.8a	24.7ab	1.20abc
Male 3	10.1ab	29.1a	24.4ab	1.17bc
Male 4	10.5a	29.7a	24.5ab	1.23ab
Male 5	11.3a	29.8a	25.6a	1.13c
Male 6	11.4 a	29.9a	23.7ab	1.27a

The same letters in each column are not significantly differently at 5% probability

Table (4): Effect of different pollen sources on seed weight, length, diameter and length/ diameter (L/D) of Barhi date palm

Male No.	Seed weight (g)	Seed length (mm)	Seed diameter (mm)	L/D
Male 1	0.9ab	16.0a	9.2ab	1.8a
Male 2	0.8b	16.1a	8.6 b	1.9a
Male 3	0.9ab	16.7a	9.1ab	1.8a
Male 4	1.0a	16.0a	9.1ab	1.9a
Male 5	1.0a	16.5a	9.3 a	1.8a
Male 6	0.9ab	17.0a	9.2 ab	1.8a

The same letters in each column are not significantly differently at 5% probability

Table (5): Effect of different pollen sources on maturity %, fruit flesh weight % and total soluble solids % of Barhi date palm

Male No.	Maturity (%)	Fruit flesh weight (%)	TSS (%)
Male 1	13.2abc	89.1b	36.3a
Male 2	20.1a	96.6a	41.8a
Male 3	17.5ab	91.6a	39.7a
Male 4	10.9bc	90.7ab	38.8a
Male 5	7.9c	91.8a	38.0a
Male 6	10.4bc	90.7ab	36.3a

The same letters in each column are not significantly differently at 5% probability

Discussion

Pollination is one of the important cultural that influences fruit set, yield and quality (Mangena and Mokwala, 2018). Many factors affect the pollination, one of them is pollen grain of different male types which affect fruit set, yield and fruit characteristics (Iqbal *et al*., 2012). Our results indicated that pollen grains were collected from six locations, M1 (Talab orchard 1), M2 (El –Nefeady orchard), M3 (Talab orchard 3), M4 (Khartoum University), M5 (Hag Bashier orchard) and M6 (Shambat station) differ in their response on fruit set and fruit quality of Barhi cv. female trees under the agro-climatic conditions of Khartoum city -Sudan country. The findings of this study revealed that different pollination sources have significant effects on various fruit yield s of Barhi date palm. Date palm trees pollinated with M1 or M6 as the highest Pollen germination % and length fruit were recorded in M6 (Shampat station) .The highest fruit set %, bunch weight, total yield, fruit length /diameter (L/D) ratio with M1 (Talab orchard 1) and M6 (Shambat station). The difference in set fruit of six pollen sources

may be attributed to pollen vitality as the highest Pollen germination (%) obtained from M6 (Shambat station), The data revealed that male pollen grains varied significantly due to pollen viability (Islam, 2017). Also, Iqbal *et al*. (2009) finding that variation in viability of pollen is due to genetic characters of the male the highest fruit set % obtained from M1(Talab orchard 1 or M6 (Shampat station).These results are in agreement with Kamis *et al*. (2010) & Iqbal *et al*. (2012) Ommima *et al*. (2015) who reported variation in fruit setting due to pollen source. Also, the results of this study revealed that male palms tested varied in their effect on fruit quality. variation in bunch weight total yield refers to the difference in pollen source, could be due to variation in pollen quality, germination percentage and pollen tube growth. Therefore, pollen source (male trees) has significant effect on fruit yield (Omar et al., 2014). In addition pollen grains effected directly the quality and the quantity of the fruits (Soliman and Osman, 2001; Farag, 2012; Hafez *et al*., 2014; Aubied and Hamzah 2019 and monir, 2020). Generally it could be safely concluded that Male (1) or M (6) were superior to pollen Barhi date palm as increased significantly the studied fruit quality (*Metaxenia*) especially fruit set, bunch weight total yield, physical characters in most cases as compared to the other Males

Conclusion

It was concluded from the research findings that best fruit setting was observed with Males M1 (Talab orchard 1) or M 6 (Shambat station) the highest bunch weight and yield M1 (Talab orchard 1) or M 6 (Shambat station) and hence it may be recommended to the growers that all different pollen sources positively affected on fruit characteristics of Barhi date palm and we can choose any source proved to be the best choice to attain economical yield under the agro climatic conditions of Khartoum -Sudan Hence it may be recommended to the growers that all Different pollen sources positively affected on fruit characteristics of Barhi date palm and we can choose any source would be the best choice to attain economical yield under the agro climatic conditions of Khartoum -Sudan.

References

Abd El-kader Boufersaoui, (2016). The date in all its forms 2nd International Conference for date palm (ICDP 2016) in Qassim, Kingdom of Saudi Arabia, from 10-12 October.

Al-Redhaiman, K.N., (2004). Modified atmosphere improves storage ability, controls decay and maintains quality and antioxidant contents of Barhi date fruits. Food Agriculture and Environment. 2, 25 – 32.

Aubied, I.A. and Hamzah, H.A. (2019). Effect of Pollen Grains and Growth Regulator NAA on Some Fruit Characterization of Date Palm Phoenix Dactylifera Cultivar. Sultani QJAS Al-Qadisiyah Journal For Agriculture Sciences, 9:.1, 136-142.

Awad, M.A. and Al-Qrashi, A.D. (2012). Partial fruit set failure phenomenon in (Nabbut-Ali) and Sabbaka‟ date palm cultivars under hot arid climat as affected by pollinator type and pollination method. Sci. Hor., 135: 157-163.

Chao, C.T. and Krueger, R.R. (2007). The Date Palm (*Phoenix dactylifera* L.): Overview of Biology, Uses and Cultivation. HortScience 42:1077-1082.

Duncan, D. B. (1955). Multiple range and multiple F. test. Biometrics, 11: 1-42.

Farag, K.M., Elsabagh, A.S. and El-Ashry, H.A. (2012). Phytohormonal changes in fruits of "Zaghloul" date palm in relation to metaxenic influences of used pollinators. American-Eurasian J. Agric. & Environ. Sci., 12(7): 862-871.

Fattahia, R.; Mohammad Zedeha, M. and Abdollah Khadivi-Khub (2014). Influence of different pollen sources on nut and kernel characteristics of hazelnut. Sci. Hor., 173: 15-19.

Hafez, O.M.; Saleh, M.A.; Mostafa, E.A.M.; Naguib, M.M. and Ashour, N.E. (2014). Effect of pollen grain sources on yield and fruit quality of Samany date palm. International Jpurnal of Agricultural Research, 9 (3), 164-168.

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 & Plant Sciences, 22 (2), 376-383.

Iqbal, M.; Ghafoor, A. and Rahman, S. (2004). Effect of pollination times on fruits characteristics and yield of date palm cv. Dhakki.Int.J. Agric. Biol.6, 96-99

Islam, S.E. (2017). Evaluation of Date Palm Males Types as Pollinators for Zaghloul and Samany Date Palm cvs. Grown in Qalyubia Middle East J. Agric. Res., 6(4): 1049-1056.

Khamis, M.M.; Sherif, M.M.; El-Bana, A.A. and Ghazawy, H.S. (2010). Evaluation of some pollen grain sources on fruiting and fruit quality of Siwi and Zaghloul date palm Cvs. Egypt. J. Appl. Sci., 25(1): 25-39.

Mangena, P. and Mokwala, P.W. (2018). Introductory Chapter: Pollination. In: Pollination in Plants. P.W. Mokwala (ed.). IntechOpen Limited, London, United Kingdom. p. 1-6.

Munir, M.; Alhajhoj, M.R.; Sallam, A.A.M.; Ghazzawy, H.S.; Al-Bahigan, A.M. (2020). Fruit yield and quality response of date palm cultivar Khalas to female Inflorescence Receptivity varied by pollination days. Plant Arch., 20, 4007–4014.

Omar, A.K., Al-Obeed, R.S.; Soliman, S. and Saif, A.M.A. (2014). Effect of pollen source and area distribution on yield and fruit quality of „Khalas‟ date palm (*Phoenix dactylifera* L.) under Saudi Arabia conditions. Acta Advances in AgriculturalSciences, 2(3): 7-13

Omaima, M. Hafez, Malaka A. Saleh, Ashour, N.E.; Mostafa, E.A.M. and Naguib, M.M. (2015). Evaluation of some pollen grain sources on yield and fruit quality of Samany Date Palm cv. *(Phoenix dactylifera* L.). Middle East.J. Agric. Res., 4(1- 3): 27-30.

Soliman, S.S. and Osman. S.M. (2001). Yield and fruit quality of Bartamoda and Malkabi dates as affected by different pollen types under South El-Wady conditions. J. Agric. Sci. Mansoura Univ., 26 (6): 3819-3829.

Snedecor, G. W. and Cochran, W. G. (1989). Statistical Methods. Iowa State University Press, 8th Edition, USA, 491p.

تأثير مصادر حبوب اللقاح المختلفة على محصول وجودة ثمار النخيل البرحي تحت ظروف السودان

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الملخص العربي

تم إجراء هذا البحث لدراسة تأثير مصادر حبوب اللقاح المختلفة على المحصول والنضج وجودة الثمار لصنف نخيل البلح "برحي". جمعت حبوب اللقاح من ستة مواقع مختلفة، الخجلاب ذكر 1، سوبا مالي ذكر 2، الحلفاية ذكر 3، بحري ذكر 4، الغريف ذكر 5، شمبات ذكر 6، للتلقيح اليدوي للأشجار المؤنثة خلال لصنف البرحي المواسم المتتالية (2019-2021). تم حصاد الثمار في مرحلة النضج الكامل (التلوين الكامل) لتحديد الخصائص الفيزيائية والكيميائية مثل وزن السوباطات، والمحصول الكلي، ووزن الثمار، طول و قطر الثمرة، ووزن البذور، والطول والقطر ، وإجمالي المواد الصلبة الذائبة (TSS٪) ، والنضج ٪ و النسبة المئوية لزن لحم الثمار. أشارت النتائج إلى أن أعلى نسبة إنبات لحبوب اللقاح وطول الثمار سجلت في ذكور 6 منطقة شمبات، وأعلى نسبة لوزن وطول الثمرة، ووزن السوباطة، والمحصول الكلي، ونسبة طول/ قطر الثمرة (L / D) مع منطقة الخوجلاب (ذكر 1) وشمبات (ذكر 6). لا توجد فروق ذات دلالة إحصائية لقطر ووزن البذور ونسبة طول / قطر البذور (L / D) بالستة مناطق المختارة لمصادر حبوب اللقاح. ومن النتائج المتحصل عليها يفضل استخدام (ذكر1) منطقة الخُجلاب أو(ذكر 6) منطقة شمبات كمصادر لحبوب اللقاح بمنطقة الخرطوم - السودان لتلقيح نخيل البرحي للحصول على أفضل جودة للثمار.

الكلمات الدالة: نخيل البرحي، مصادر حبوب اللقاح، عقد الثمار، جودة الثمار، الخصائص الفيزيائية والكيميائية