EFFECTS OF INDIGENOUS AND FOREIGN POLLINIZERS ON THE YIELD AND FRUIT CHARACTERISTICS OF DATE PALM CULTIVAR KHALAS

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ABSTRACT

This research was carried out at Research and Training Station, Date Palm Research Center of Excellence, King Faisal University, Al-Ahsa, Saudi Arabia during 2017 and 2018 to investigate the effects of indigenous and foreign pollinizers on the yield and physicochemical fruit characteristics of date palm cv. Khalas. Pollen grains of different date palm male pollinizers were collected from different geological locations of Saudi Arabia and Egypt. Fifteen twelve-year-old date palm trees were selected for the experiment, for which five spathes for each palm were selected per replication. The experiment was laid out as a Randomized Complete Block Design with three replicates for each treatment. The findings of the present study showed significant differences among pollinizer sources. Female date palms pollinated with indigenous male pollen grains (Al-Ahsa, Saudi Arabia) exhibited superior results regarding fruit set percentage, parthenocarpic fruit percentage, tamar fruit percentage, fruit drop percentage, total number of fruit nodes per bunch, bunch weight, pulp weight, pulp ratio, seed ratio and pulp:seed ratio, fruit fresh weight, fruit dry weight, fruit length, fruit width, fruit volume, seed weight, seed length, seed width, fruit moisture content and total soluble solids. It is can be concluded that although the response to pollination and fertilization of date palm is species dependent, however, the indigenous cultivar Khalas was more responsive to the local male types than the foreign males for better fruit set, higher yield and best fruit quality traits.

Key word: Date palm, *Phoenix dactylifera* L., pollination, male source, pollen grain.

تأثير الملقحات المحلية والخارجية فى المحصول وجودة ثمار نخيل التمر صنف خلاص

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المستخلص

أجري البحث في مركز التميز البحثي في النخيل والتمور– جامعة الملك فيصل– بالمملكة العربية السعودية خلال موسمي 2017 و 2018 لدراسة تأثيرات الملقحات الداخلية (المحلية) والخارجية على المحصول وخصائص الثمار الطبيعية والكيميائية لصنف التمر خلاص. جمعت حبوب اللقاح لمختلف مصادر الفحول من مختلف المناطق الجغرافية في المملكة العربية السعودية وجمهورية مصر العربية. لإتمام هذه الدراسة تم اختيار 15 نخلة بعمر 12 سنة، وتم اختيار 5 عذوق على نخلة لكل مكررة. نفذت التجربة في تصميم القطاعات الكاملة المعشاة بثلاث مكررات لكل معاملة. بينت نتائج الدراسة الحالية وجود فروقات معنوية بين مصادر الملقحات. أشجار نخيل التمر المؤنثة والملقحة بفحال من واحة الأحساء بالمملكة العربية السعودية مع نتائج متفوقة في النسب المئوية لعقد الثمار، الثمار البكرية، ثمار التمر، تساقط الثمار، والعدد الكلي للندب على العذق، وزن العذق، وزن لحم الثمرة، نسبة اللحم، نسبة البذرة، معدل اللحم إلى البذرة، الوزن الطازج والجاف للثمرة، طول وعرض وحجم الثمرة، وزن وطول وعرض البذرة ومحتوى الرطوبة للثمرة بالإضافة إلى المواد الصلبة الذائبة الكلية. خلصت النتائج إلى أنه على الرغم من أن استجابة التلقيح والإخصاب في نخيل التمر تعتمد على أنواع الفحال، إلا أن تلقيح صنف خلاص كان أكثر استجابة لأنواع الذكور المحلية عن الذكور الخارجية للحصول على أفضل عقد ثمار ومحصول وخصائص جودة الثمرة.

الكلمات المفتاحية: التلقيح، مصدر الفحال، حبوب اللقاح، شكل الثمرة، حجم الثمرة.

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INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is a cross-pollinating fruit tree, due to its dioecious nature (31). Recently, Torres *et al*. (39) identified four candidate genes in male date palms that give them male attributes. The two genes related to male flower development and its function were found only in male palms whereas a third gene suppressed the development of the female flower organ in males, which makes cross-pollination imperative. However, the competency and receptivity of female flower to embrace male pollen varies across a single spathe, therefore, a 60-80% pollination is considered satisfactory for good fruit set (15, 29). The efficiency of pollination and fruit set depends on several factors such as male flowering time, source, viability and amount of pollen grains, pollination time, and the receptivity of female flowers. Best pollination results can be observed within 2-4 days of pollination if these factors are ideal (41). For commercial date palm cultivation, artificial pollination is required using compatible pollen source, which has been reported to affect fruit set, ripening and quality (25). The direct effect of pollen on fruit physical and chemical characteristics is known as metaxenia, which affects time of fruit ripening and colour (7), fruit size (4), weight of fruit and seed (11). Similarly, Gasim (12) reported that the direct effect of male parent on date fruit qualities varies with the male parent source. The emergence and opening of date palm male spathes start from December to March while female inflorescence opening starts from January to end of March, depending on the cultivar (15). However, the protandrous cultivars faces shortage of pollen grains at the time of stigma receptivity (5). Moreover, the viability of pollen grains varies from one cultivar to another (23). Date palm is pollinated by natural (insect and wind) and artificial (pollen strands placement, pollen dusting, pollen suspension) means. Natural pollination is not preferred in commercial cultivation which can affect fruit setting and consequently the yield is decreased up to 50-70% in certain cultivars (20, 22). he response of female flowers to male pollen grains varies with the cultivar, which significantly marks the fruit yield and quality. Shafique *et al*. (35) reported that the physicochemical characteristics of the Dhakki fruit (fruit drop, fruit weight, flesh weight, seed weight, total soluble solids, titratable acidity, sugars, ascorbic acid and total phenols) were affected by different male pollen sources. A varied effect of different pollinizers taken from different geological locations (Aswan, New Valley and Balteem) on fruit characteristics was also observed in date palm cv. Hayany (26). Higher fruit set and yield was recorded in cv. Barhee when it was pollinated with male cv. Zahidi, however, the fruit physical traits were improved when the same cultivar was pollinated with male cv. Jarvis No. 1 (21). Some studies stated that date palm cultivars are more responsive to their respective male cultivars rather than the other cultivars of same species. However, Salomon-Torres *et al*. (33) reported that date palm cv. Medjool was more responsive to male cv. Khadrawy regarding physicochemical fruit traits, whereas the yield was higher when the same female cultivar was pollinated with male cv. Zahidi. On the other hand, the total yield of cv. Medjool was decreased 28.72% when it was pollinated with the same male cultivars. The male and female flowering time is negatively affected by climate change. Due to that phenomenon, the female spathes emerged earlier than the male ones or during the fruit development time, in May onwards. The late emerging female spathes are often removed because of the non-availability of male pollen at that particular time. Therefore, the date palm growers in Al-Ahsa region rely on the foreign stored pollen grains, which are brought from nearby countries. Keeping in view the importance of date palm pollination, a study was designed to determine the effects of male pollen sources from varied geographical locations on the yield and physicochemical attributes of date palm cv. Khalas under the arid agro-climatic condition of Al-Ahsa.

MATERIALS AND METHODS

The aim of present study was to determine the effects of different indigenous and foreign pollinizer sources on the yield and physicochemical fruit characteristics of date palm cv. Khalas. The research experiment was conducted at the Research and Training

Station, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia during 2017 and 2018 (Latitude 25° 16' 7.068" N and Longitude 49° 42' 27.522" E). Pollen grains of different date palm male pollinizers were collected from different geological locations of Saudi Arabia and Egypt (Table 1) and were stored at 4ºC. Fifteen date palm trees were selected for the experiment, in which five spathes on each palm were selected per replication. Pollen grains were dusted at 11am with a very soft brush at the time of spathe opening of twelve years old, uniform female date palm cv. Khalas. The dusting technique was repeated after three days to enhance uniform fruit setting in all bunches. All female pollinated spathes were bagged with the brown waxy paper to avoid any contamination, which were removed after fruit setting (2 weeks after pollination). However, around mid-summer, each fruit bunch was covered with polyethylene mesh netting bag for the protection from birds and insects. The experiment was laid out on Randomized Complete Block Design with three replicates in each treatment. The agro-climatic data was downloaded from the on-farm wireless weather station, Model WS3083 (Aercus Instruments, West Yorkshire, UK), installed around 25 meters away from the experimental orchard (Table 2). The weather data was also cross-checked with the local weather station. All the standard cultural practices were carried out uniformly. The data were recorded on the following variables: number of strands per bunch, length of strands, fruit set percentage, parthenocarpic fruit percentage, biser fruit percentage, tamar fruit percentage, fruit drop percentage, total number of fruit nodes per bunch, bunch weight, pulp weight, pulp ratio, seed ratio and pulp:seed ratio, fruit fresh weight, fruit dry weight, fruit length, fruit width, fruit volume, seed weight, seed length, seed width, fruit moisture content, total soluble solids, total sugar, reduced sugars and non-reduced sugars (1). The collected data was statistically analyzed using Statistical Analysis Software, Release 9.4 (SAS Institute, North Carolina, USA) and the Duncan Multiple Range Test was applied to determine the least significance difference between the means.

Table 1. Different indigenous and foreign male pollinizers and their GPS coordinates

Pollinizers	Location	GPS Coordinates
Indigenous (Saudi Arabia)		
Pollinizer-1	**Al-Hofuf, Al-Ahsa**	**25° 16' 3.0648'' N 49° 42' 30.3192'' E**
Pollinizer-2	**Al-Hofuf, Al-Ahsa**	**25° 16' 25.9932'' N 49° 42' 23.4144'' E**
Foreign (Egypt)		
Pollinizer-3	**Al-Badrashen, Al-Giza**	**30° 1' 19.3836'' N 31° 12' 52.8804'' E**
Pollinizer-4	**Green Valley, Al-Kharga**	**25° 27' 16.3476'' N 30° 33' 12.1608'' E**
Pollinizer-5	**Al-Rashid, Al-Bahira**	**29° 52' 0.6168'' N 31° 15' 9.5868'' E**

Table 2. Agro-climatic information of the research venue during experimental years 2017-18

Growing Season	2017-18 Temperature (°C)			Relative humidity (%)		Wind speed (km/h)		Precipitation (mm)	
	Max	Min	Ave						
	2017-18	2017-18	2017-18	2017	2018	2017	2018	2017	2018
March	**28-34**	**16-17**	**22-25**	**18 > 70**	**6 > 51**	**2 > 45**	**3 > 41**	**0.00**	**0.00**
April	**38-35**	**21-21**	**29-28**	**6 > 43**	**9 > 55**	**4 > 50**	**4 > 56**	**0.00**	**2.15**
May	**43-40**	**26-24**	**35-32**	**5 > 31**	**5 > 38**	**3 > 54**	**3 > 45**	**0.00**	**0.84**
June	**45-45**	**28-30**	**36-38**	**4 > 21**	**4 > 23**	**5 > 56**	**6 > 58**	**0.00**	**0.00**
July	**48-46**	**30-31**	**39-39**	**4 > 31**	**4 > 25**	**2 > 39**	**5 > 62**	**0.00**	**0.00**
August	**46-46**	**30-29**	**38-38**	**6 > 51**	**4 > 29**	**1 > 33**	**5 > 53**	**0.00**	**0.00**
September	**44-44**	**26-27**	**35-35**	**6 > 61**	**6 > 61**	**1 > 41**	**1 > 33**	**0.00**	**0.00**

Maximum, minimum and average temperature in each cell represent year 2017 and 2018 values. Relative humidity and wind speed in each year represent the minimum to maximum average values

RESULTS AND DISCUSSION

Table 3 indicated a statistically significant ($P \leq 0.05$) effect of different pollinizers on the fruit set percentage, parthenocarpic fruits percentage, tamar fruits percentage, fruit drop percentage, total No. of fruit nodes per bunch, bunch weight, pulp weight, pulp ratio, seed ratio and pulp:seed ratio of date palm cv. Khalas. However, there was a non-significant effect of different pollinizers on the No. of strands per bunch, length of strands and biser fruits percentage. Maximum No. of strands per bunch were counted when female palm was pollinated with Pillinizer-3 and Pollinizer-4

(52.40), followed by Pollinizer-1 (50), whereas minimum No. of strands were counted in Pollinizer-2 (46.60) and Pollinizer-5 (49). Similar non-significant trend was observed regarding length of strands i.e. Pollinizer-4 (48 cm), Pollinizer-3 (46 cm), Pollinizer-5 (45.20 cm), Pollinizer-1 (44.40 cm) and Pollinizer-2 (43.0 cm). Apparently, the selection of uniform spathes led to a non-significant data regarding No. of strands per bunch and length of strands. As the pollen grains from different male pollinizers were applied after the emergence of female flowers, therefore, these attributes should not be affected. Hence, the data presented here only indicated the uniformity in the sample population. Maximum fruit set percentage was recorded when indigenous pollinizers were applied i.e. Pollinizer-1 (77.90%) and Pollinizer-2 (74.91%), however, minimum fruit set percentage was obtained when female flowers were pollinated with foreign pollinizers i.e. Pollinizer-3 and Pollinizer-4 (62.91%) and Pollinizer-5 (57.24%). Fruit set percentage is a reliable indicator that ratify the pollen compatibility phenomenon (6), as in most cases it is often species dependent (32). Present results suggested that the indigenous male pollinizers (Saudi Arabia) significantly fertilized female Khalas cultivar, however, pollen grains collected from different geological regions (Egypt) could be partially incompatible with the female Khalas cultivar as there was 19-25% less fruit set percentage was observed. More or less similar results were reported in two different studies when the recipient female was cv. Medjool, which was treated with difference male sources. The highest fruit set percentage was obtained as 74.05% and 49.50%, respectively in both studies (13, 28). Data regarding parthenocarpic (unfertilized or Shees) fruit percentage showed that the female bunches pollinated with indigenous pollen grains sources produced minimum parthenocarpic fruits i.e. Pollinizer-1 (6.47%) and Pollinizer-2 (7.15%) whereas bunches pollinated with foreign pollen sources produced significantly higher number of parthenocarpic fruits i.e. Pollinizer-5 (13.50%), Pollinizer-4 (12.57%) and Pollinizer-3 (12.22%). The development of parthenocarpic fruits could be due to many reasons such as male or female incompatibility (40), environmental factors (27), hormonal deregulation (19) and delay or rapid growth of ovary due to the changes in regulation of gibberellin (38). Similarly, low temperatures (8-20°C) believed to enhance formation of parthenocarpic fruits and reduced normal fruit development (10). Although, the biser (unripe) fruit percentage was non-significant statistically, however, highest percentage was noted when the female Khalas cultivar was pollinated with indigenous pollen sources such as Pollinizer-1 (10.19%) and Pollinizer-2 (9.83%). Minimum percentage of biser fruits were counted in foreign male pollen sources, Pollinizer-3 (7.71%), Pollinizer-4 (7.86%) and Pollinizer-5 (8.09%). It is therefore, assumed that the production of unripe biser fruits was due to the biochemical changes and not due to the pollinizers. As dates are categorized as climacteric fruits and the ripening processes are associated with a concurrent increase in the internal ethylene concentration and higher rate of respiration (2, 8) and are used as benchmarks in establishing the ripening of fruit. However, a few reports described the absence or reduced peak in respiration when fruits are ripened on the tree, despite a distinct rise in ethylene concentration (9, 34). Salomon-Torres *et al*. (33) reported a non-significant effect of different male pollinizers on immature fruits trait of cv. Medjool. Present study also reported a non-significant effect of various pollinizers on biser (unripe) fruits, which was usually influenced by low external temperature, low respiration rate, and inappropriate relative humidity during fruit development phases. Tamar (ripe) fruit percentage was significantly ($P \leq 0.05$) affected by different pollinizers whereas maximum tamar fruit percentage was observed when the female was pollinated by Pollinizer-1 (67.71%) followed by Pollinizer-2 (65.08%). Tamar fruit percentage was minimum when Khalas cultivar was pollinated by foreign pollens that is Pollinizer-5 (49.15%) followed by Pollinizer-4 (55.05%) and Pollinizer-3 (55.20%). Similar results were reported by Rezazadeha *et al*. (30) when they pollinated female inflorescence with ten local and two international date palm pollinizers. They observed highest ripened fruit number than the

culled ones when a local pollinizer was used as a source of pollination. Abbas and Ibrahim (3) found that the time of the ethylene emission and climacteric peak during fruit ripening was significantly influenced by pollen parents, which led to maximize ripe edible fruits of date palm cv. Hillawi. Minimum fruit drop percentage was recorded in Pollinizer-1 (15.63%) followed by Pollinizer-2 (17.94%) whereas maximum fruit drop was counted in Pollinizer-5 (29.26%), Pollinizer-3 (24.87%) and Pollinizer-4 (24.52%). Similar results were reported by Iqbal *et al*. (17) who observed significant effect of different male pollen source on fruit drop in cvs. Zahidi (5.30%), Shakri (5.60%) and Dhakki (39%). In other studies, Iqbal *et al*. (16) and Shafique *et al*. (35) suggested that the large fruit size and shorter internodes space could be the factors playing role in the higher percentage of fruit drop in date palm cultivars. Total number of fruit nodes per bunch were counted when cv. Khalas was pollinated with Pollinizer-1 (704.60), which was statistically different to Pollinizer-2 (630.60) and Pollinizer-4 (628.40). Minimum number of fruit nodes per bunch were recorded in Pollinizer-5 (540.40) followed by Pollinizer-3 (560.20). Similar trend was observed regarding bunch weight trait where highest bunch weight was obtained when female palm was pollinated with indigenous pollen grains such as Pollinizer-1 (6.65 kg) and Pollinizer-2 (5.58 kg). Palms pollinated with foreign pollens produced significantly lower bunch weight such as Pollinizer-5 (2.64 kg), Pollinizer-3 (2.98 kg) and Pollinizer-4 (3.20 kg). Our results are in line with Rezazadeha *et al*. (30) who reported that different pollen source had significant effects on marketable yield, which was increased up to 41% when pollinated with the best male pollens. Shahid *et al*. (36) reported up to a 50% yield difference when date palm cv. Dhakki was pollinated with different males. Iqbal *et al*. (16) also reported significant variation in yield of Dhakki and Zahidi when pollinated with different male sources. Data regarding pulp weight showed that maximum pulp weight was recorded in fruits which were pollinated by indigenous Pollinizer-1 (11.17 g) followed by Pollinizer-2 (10.84 g), however, minimum pulp weight was noted in Pollinizer-5 (7.20 g) followed by Pollinizer-3 (7.39 g) and Pollinizer-4 (8.15 g). Similar trend was observed regarding pulp ratio attribute i.e. Pollinizer-1 (92.07) and Pollinizer-2 (91.00) whereas the minimum pulp ratio was noticed in Pollinizer-5 (85.17) followed by Pollinizer-3 (85.63) and Pollinizer-4 (88.18). Data regarding seed ratio was contrary to the pulp ratio wherein minimum seed ratio was recorded when pollens from Pollinizer-1 (7.93) were applied, followed by Pollinizer-2 (9.00), however, seed ratio was maximum in Pollinizer-5 (14.83) followed by Pollinizer-3 (14.37). Pulp seed ratio trend was like pulp ratio trend and maximum pulp seed ratio was observed when pollens were applied over female bunch from Pollinizer-1 (11.96) followed by Pollinizer-2 (10.14), while minimum pulp seed ratio was noticed in Pollinizer-5 (5.85) followed by Pollinizer-3 (6.22). The lowest seed ratio can be visualized to be the reason for higher pulp weight, pulp ratio and pulp seed ratio, which were influenced by different pollinizers. Iqbal *et al*. (17) reported similar results when date palm cvs. Zahidi, Shakri and Dhakki were pollinated with different males and recorded 53% more pulp weight in cv. Dhakki compared to the others. Salomon-Torres *et al*. (33) reported that highest pulp weight was recorded when cv. Medjool was pollinated with male cv. Khadrawy rather than pollination with the same cultivar's pollens. Rezazadeha *et al*. (30) stated that pulp weight significantly varied among pollinizers, ranging from 11.8 g to 14.5 g.

Table 3. Effects of indigenous and foreign pollinizers of same species on the No. of strands per bunch, length of strands, fruit set percentage, parthenocarpic fruit percentage, biser fruit percentage, tamar fruit percentage, fruit drop percentage, total No. of fruit nodes per bunch, bunch weight, pulp weight, pulp ratio, seed ratio and pulp:seed ratio of date palm cv. Khalas during 2017-2018

Parameters	Pollinizer-1	Pollinizer-2	Pollinizer-3	Pollinizer-4	Pollinizer-5	LSD (5%)
No. of strands/bunch	50.00^{a} (±1.48)	48.60^{a} (±1.17)	52.40^{a} (±2.25)	52.40^{a} (±3.53)	49.00^{a} (±2.32)	6.82^{NS}
Strands length (cm)	44.40^{a} (±1.21)	43.80^{a} (±1.32)	46.00^{a} (±1.41)	48.00^{a} (±1.92)	45.20^{a} (±0.49)	4.36^{NS}
Fruit set (%)	77.90^{a} (±1.18)	74.91^{a} (±1.25)	62.91^{b} (±3.24)	62.91^{b} (±0.61)	57.24^{b} (±2.66)	9.15*
Parthenocarpic fruits (%)	6.47^{b} (±0.54)	7.15^{b} (±0.79)	12.22^{a} (±1.39)	12.57^{a} (±1.39)	13.50^{a} (±1.52)	6.75*
Biser fruits (%)	10.19^{a} (±0.87)	9.83^{a} (±0.78)	7.71^{a} (±1.80)	7.86^{a} (±0.94)	8.09^{a} (±1.26)	3.10^{NS}
Tamar fruits (%)	67.71^{a} (±1.15)	65.08^{a} (±1.67)	55.20^{b} (±3.40)	55.05^{b} (±0.64)	49.15^{b} (±3.55)	7.19*
Fruit drop (%)	15.63^{b} (±0.94)	17.94^{b} (±0.53)	24.87^{a} (±3.11)	24.52^{a} (±0.89)	29.26^{a} (±2.06)	5.96*
Fruit nodes/bunch	704.60^{a} (±30.03)	630.60^{b} (±22.39)	560.20^{cb} (±9.68)	628.40^{b} (±10.88)	540.40^{c} (±32.44)	71.96*
Bunch weight (kg)	6.65^{a} (±0.47)	5.58^{b} (±0.25)	2.98^{c} (±0.30)	3.20^{c} (±3.63)	2.64^{c} (±0.36)	0.98*
Pulp weight (g)	11.17^{a} (±0.61)	10.84^{a} (±0.21)	7.39^{b} (±0.54)	8.15^{b} (±0.58)	7.20^{b} (±0.37)	1.58*
Pulp ratio	92.07^{a} (±0.61)	91.00^{a} (±0.21)	85.63^{b} (±1.43)	88.18^{ab} (±0.86)	85.17^{b} (±0.93)	2.91*
Seed ratio	7.93^{b} (±0.61)	9.00^{b} (±0.21)	14.37^{a} (±1.43)	11.82^{ab} (±0.86)	14.83^{a} (±0.93)	2.91*
Pulp:seed ratio	11.96^{a} (±1.17)	10.14^{a} (±0.25)	6.22^{c} (±0.67)	7.65^{bc} (±0.64)	5.85^{c} (±0.42)	2.27*

Similar letter(s) in a row are non-significant statistically at 5% level of probability. Figures in parentheses represent the variability within replicates. * represents the significant statistical difference between the means of each treatment whereas NS indicates the non-significant statistical difference.

Data in Table 4 showed that the effect of different pollinizer sources was statistically significant (P≤0.05) on the fruit fresh weight, fruit dry weight, fruit length, fruit width, fruit volume, seed weight, seed length, seed width, fruit moisture content and total soluble solids of date palm cv. Khalas. However, the effect of pollinizers was non-significant on total sugar, reduced sugars and non-reduced sugars. Maximum fruit fresh weight (12.13 g), fruit dry weight (9.70 g), fruit length (35.60 mm), fruit width (23.38 mm) and fruit volume (10.12 ml) was measured when the female bunch was pollinated with indigenous Pollinizer-1, followed by indigenous Pollinizer-2. Whereas bunch pollinated with foreign pollinizers were inferior regarding the above-mentioned fruit characters, for example, fruit fresh weight (8.44 g), fruit dry weight (6.67 g), fruit width (17.93 mm) and fruit

volume (8.90 ml) were minimum when pollens taken from Pollinizer-5. Seed related attributes were significantly increased when cv. Khalas was pollinated with foreign pollens such as Pollinizer-5, seed weight (1.24 g), seed length (26.05 mm), however, seed width (9.94 mm) was maximum in Pollinizer-4 treatment. On the other hand, similar parameters were minimum when female bunches were pollinated with indigenous pollinizers such as Pollinizer-1, seed weight (0.95 g), seed length (20.96 mm) and seed width (7.97 mm). Shahid *et al*. (36) obtained a significant difference regarding fruit length and weight in cv. Dhakki when female was pollinated with different pollen sources however, there was non-significant effect on fruit width in first year of study and significant effect in next year. Our results are in line with them, however, the difference in size and weight is due to the difference in cultivars. Iqbal *et al*. (17) reported similar results in cvs. Zahidi, Shakri and Dhakki regarding fruit weight, size and seed weight. Similarly, Salomon-Torres *et al*. (33) observed significant effects of different male pollens taken from cvs. Deglet Noor, Medjool, Khadrawy and Zahidi on cv. Madjool regarding fruit and seed weight, length and diameter. Pollen taken from cv. Khadrawy had highest positive influence on these parameters compared to other pollinizers. They reported that lowest fruit set influenced highest fruit weight, which is not observed in our study. The reason could be the selection of different male pollinizer from different geological locations. Islam (18) reported similar results in cvs. Zaghloul and Samany regarding fruit and seed weight, size and shape. Siyahsar *et al*. (37) reported significant effects of different pollinizers on fruit weight, size and volume in cv. Zahedi. Chemical analysis of the tamar fruits of date palm cv. Khalas revealed that apart from fruit moisture content and total soluble solids all three sugars were non-significant statistically. Maximum fruit moisture content was estimated when the inflorescence were pollinated with foreign pollen grains i.e. Pollinizer-4 (22.14%) whereas minimum fruit moisture content was recorded in Pollinizer-1 (18.31%) treatment. An opposite response was recorded regarding total soluble solids parameter where recording was 71.60 brix (Pollinizer-1) and 69.00 brix (Pollinizer-2) when indigenous pollen grains were applied. However, that parameter was significantly decreased (up to 15%) when foreign pollen grains were used. Despite the non-significant difference between pollinizers regarding total sugar (mono, di and oligosaccharides), reduced sugars (glucose and fructose) and non-reduced sugar (sucrose), female palms pollinated with indigenous pollinizers had slightly a higher percentage of these traits such as Pollinizer-1 (total sugar, 58.06%, reduced sugars, 55.41% and non-reduced sugars, 2.65%). These values were declined in fruits, which were pollinated by foreign pollinizers. Similar results were reported in date palm cv. Dhakki, Medjool, Zaghloul and Samany regarding fruit moisture content and total soluble solids as both parameter were significantly influenced by different pollinizers (18, 33, 36). Our results indicated a non-significant effect of any pollinizer on sugar content of date palm cv. Khalas, which are contradictory to Shahid *et al*. (36), Salomon-Torres *et al*. (33) and Islam (18). The significant difference might be due to the activities of the enzymes system initiated by the metaxenia phenomenon (14, 24). The insignificant difference in sugars could be due to the reason that sugar content is mostly influenced by the plant nutrients. However, the impact of different pollen sources on the fruit physiology and biochemical reactions involved in the synthesis of sugars is still not fully clear. The findings of present study concluded that the pollen grains obtained from indigenous sources (Al-Ahsa, Saudi Arabia) exhibit superior results regarding fruit growth and quality characteristics compared to foreign pollen sources (Egypt). The difference among traits could be due to the difference in geological locations and male cultivars. Further research is needed to study in detail the microscopic scanning of pollens potential and its relationship to ovary cues.

Table 4. Effects of indigenous and foreign pollinizers of same species on the fruit fresh weight, fruit dry weight, fruit length, fruit volume, seed weight, seed length, seed volume, seed width, fruit moisture content, total soluble solids, total sugar, reduced sugars and non-reduced sugars of date palm cv. Khalas during 2017-2018

Parameters	Pollinizer-1	Pollinizer-2	Pollinizer-3	Pollinizer-4	Pollinizer-5	LSD (5%)
Fruit fresh weight (g)	12.13^{a} (±0.62)	11.91^{a} (±0.21)	8.59^{b} (±0.50)	9.22^{b} (±0.57)	8.44^{b} (±0.36)	1.53*
Fruit dry weight (g)	9.70^{a} (±0.49)	9.40^{a} (±0.14)	6.79^{b} (±0.39)	7.28^{b} (±0.45)	6.67^{b} (±0.28)	1.20*
Fruit length (mm)	35.60^{a} (±0.36)	34.17^{ab} (±0.52)	29.83^{b} (±3.17)	31.81^{ab} (±1.75)	30.24^{ab} (±1.26)	5.56*
Fruit width (mm)	23.38^{a} (±1.60)	23.89^{a} (±1.54)	20.29^{ab} (±0.89)	18.12^{b} (±1.25)	17.93^{b} (±0.97)	4.11*
Fruit volume (ml)	10.12^{a} (±0.33)	10.06^{ab} (±0.31)	8.92^{c} (±0.18)	9.12^{bc} (±0.32)	8.90^{c} (±0.48)	0.997*
Seed weight (g)	0.95^{b} (±0.07)	1.07^{b} (±0.01)	1.21^{a} (±0.05)	1.07^{b} (±0.01)	1.24^{a} (±0.04)	0.134*
Seed length (mm)	20.96^{b} (±0.47)	21.49^{b} (±0.60)	25.33^{a} (±0.82)	25.81^{a} (±0.43)	26.05^{a} (±1.04)	1.73*
Seed width (mm)	7.97^{c} (±0.56)	8.31^{bc} (±0.41)	9.78^{ab} (±0.31)	9.94^{a} (±0.68)	9.82^{a} (±0.34)	1.47*
Fruit moisture content (%)	18.31^{b} (±0.51)	18.84^{b} (±0.31)	21.16^{a} (±0.41)	22.14^{a} (±0.60)	21.91^{a} (±0.84)	1.61*
Total soluble solids (brix)	71.60^{a} (±0.71)	69.00^{a} (±1.89)	62.93^{b} (±1.71)	62.87^{b} (±1.72)	61.13^{b} (±2.31)	4.99*
Total sugar (%)	58.06^{a} (±0.44)	57.56^{a} (±0.60)	56.28^{a} (±0.67)	56.21^{a} (±1.11)	56.68^{a} (±0.64)	2.01^{NS}
Reduced sugars (%)	55.41^{a} (±0.45)	55.16^{a} (±0.41)	53.88^{a} (±0.55)	53.90^{a} (±1.07)	54.32^{a} (±0.74)	1.97^{NS}
Non-reduced sugars (%)	2.65^{a} (±0.20)	2.40^{a} (±0.25)	2.40^{a} (±0.21)	2.31^{a} (±0.35)	2.35^{a} (±0.14)	0.75^{NS}

Similar letter(s) in a row are non-significant statistically at 5% level of probability. Figures in parentheses represent the variability within replicates. * represents the significant statistical difference between the means of each treatment whereas NS indicates the non-significant statistical difference.

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