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RESPONSE OF BARHEE DATE PALM CULTIVAR TO DIFFERENT POLLINATION METHODS

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Abstract

Pollination is a critical process in the date palm production series that affect yield and fruit quality. This study aimed to evaluate the effect of different pollination methods (spray a solution with different combinations or dusting with pollen grain powder) with or without bagging on yield, fruit set (%) and fruit physical and chemical properties of "Barhee" cultivar. This study was conducted at a private farm at El-Ismailia Governorate, Egypt over 2017 and 2018 seasons. The viability testing showed that the pollen viability was 100% using acetocarmine method. Results showed the most beneficial treatment in this concern is spraying female spathes with 100 g/L sugar and dusting with 1g pollen + 2g flour with bagging, which gave high fruit set % and a reasonable yield (similar yield as the traditional pollination) as well as high fruit weight and dimensions with high content of total and reducing sugars and low content of in dols and phenols (which meaning fruit quality). Moreover, it distinguished to saving time, effort, labour and cost and more practical suitable for big farms and could be consider as recommended treatment under conditions of this experiment. In addition to it is a promising technique in the future.

Key word: Barhee date palm, pollen grains suspension, pollination, physical and chemical properties.

Introduction

Date palm (*Phoenix dactylifera* L.) is considered as one of the important trees in the arid regions of the world, especially in North Africa as well as Arab world, especially in Egypt and all Muslim countries. In 2018, there are about 100 million palm trees around the world, of who about 70% are in the Arab world and Egypt's production amounts to about 16% of world production and about 24% of the production of Arab countries (Boubaker *et al.,* 2018). Date palm is dioeciously with male and female inflorescences on separate individual trees. Actually, fruit set always done by natural pollination by wind and bees is observed in various areas of date growing countries, female flowers fail to fertilize in the absence of natural pollination, resulting into the development of parthenocarpic fruit of no commercial value (Zaid and De Wet, 1999; Hafez *et al.,* 2014; Anushma *et al.,* 2018). Therefore, artificial pollination is considered to be the most important factor affecting fruit set and yield (Khushk *et al.,* 2009), as well as artificial pollination is well recognized to reducing the number of male palms in the farm. The male to female palms ratio in a modern plantation is 1:25 respectively (Zaid and De Wet, 1999; Johnson *et al.,* 2013; Ghazzawy *et al.,* 2010). Economic yield depends on higher percentage of normal fruit setting which further relies on pollination and its techniques efficiency. The common techniqueuusually done by placing strands of freshly opened male flowers within the strands of female spathe (Dowson, 1982). There are many pollination techniques were use in date palm production as using fresh male strands, dried pollen and pollen suspensions (Sayed *et al*., 2018; Munir*et al*., 2020). Newly, some investigators use other techniques in date palm production; Ahmed and Jahjah, (1985) found that spraying pollen grains suspension containing 10% sucrose and 20 ppm GA_3 increased the fruit set % and fruit quality. Also Abdalla *et al*., (2011) concluded that applying pollen suspension contains 1.5 g/L of pollens plus either 2 g/L ascorbic acid or 0.2 g/L boric acid mixed with 10% Vinous increased the yield and fruit quality of "Zaghloul" cv. Promoting yield and improving quality of date palm fruits cvs. "Khalas" and "Sagae" were obtainedby spraying pollen grains extract at 800 ppm. (Sayed *et al*., 2018). On the other hand, Soliman *et al.,* (2017) observed the highest fruit quality in "Segae" dates can be obtained by spraying palms with suspension culture consists of 2 g/L pollen grains powder mixed with 2g/L

sugar. Thus, the objective of this study to evaluate the effect of different pollination methods (spray a solution with different combinations or dusting with pollen grain powder) with or without bagging on yield, fruit set (%), as well as physical and chemical properties of "Barhee" fruits.

Materials and Methods

This investigation was conducted at private farm at El-Ismailia Governorate, Egypt during 2017 and 2018 seasons. Twenty-seven date palm trees in full production stage (15-years old) selected from "Barhee" cv. for the application of different pollination methods and were divided into nine treatments including control treatment (traditional pollination) and each treatment had three replicates. The palms were grown on sandy soil with 10×10 meters apart under drip irrigation system and received to the same horticultural practices. Only ten spathes nearly equal size was left on each palm, these spathes were pollinated by using pollen grains from the same male palm in both seasons, in order to avoid pollen incompatibility problem and metaxenia effect (effect of pollen grains on fruit characteristics) Hussein *et al*., 1979. The pollinating treatments were arranged in Randomized Complete Block Design (RCBD), in which each treatment was replicated three times with one palm for each replicate.

The ten spathes on each palm were treated with one of the following treatments:

T1- Control (Placing 20-25 male strands within the strands of female spathe with bagging).

T2- Spray a suspension (10 g/L sugar + 1g pollen grains) without bagging.

T3- Spray a suspension (10 g/L sugar + 1g pollen grains) with bagging .

T4- Spray a suspension (1g/L pollen grains) without bagging.

T5- Spray a suspension (1g/L pollen grains) with bagging.

T6- Spraying 100 g/L sugar and dusting with 1g pollen + 2g flour without bagging.

T7- Spraying 100 g/L sugar and dusting with 1g pollen + 2g flour with bagging.

T8- Dusting with 1g pollen + 2g flour without bagging.

T9- Dusting with 1g pollen + 2g flour with bagging.

Pollen grains viability was determined before its usage by staining with acetocarmine according to the method described by Moreira and Gurgel, (1941); Munir *et al*., (2020).

Average number of flowers and number of fruits setting on 10 strands/bunch were recorded and fruit set percentage was calculated at 4 weeks after pollination in both seasons using the following formula:

At harvest time (at full color stage) all fruit bunches were harvested. Total yield per palm was recorded. *A sampling of 10 fruits were randomly taken from each bunch on the experimental palms to* study different physical properties concerning of fruit weight, seed weight and flesh weight as gm. and fruit dimension (length and diameter in cm. Total sugars, reducing and non-reducing sugars content were determined and calculated as % of dry weight according to AOAC, (2005). Total indoles (%) was also determined in the methanolic tissue extract using p-dimethyl amino benzaldehyde (PDAB, 1g was dissolved in 50 ml HCl conc. and 50 ml ethanol 95%) test according to Larsen *et al*., (1962). Total phenols (%) determination was carried out according to Daniel and George, (1972).

The collected data during both seasons were statistically analyzed according to Snedecor and Cochran, (1972). The mean values were compared using LSD test at 0.05 level. Also, the percentages were transformed to the arcsine to find the binomial percentage according to Steel and Torrie, (1980).

Results and Discussion

Pollen grains viability

The viability testing showed that the pollen grains viability was 100% using acetocarmine method. Shaheen, (2004) revealed that the viability of pollen grains ranged from 44.6 to 100% according to male type.

Yield and Fruit setting

The results of both seasons tables 1 revealed that all tested pollination methods significantly decreased yield/palm of "Barhee" cv. as compared with the control treatment (Placing 20-25 male strands within the strands of female spathe with bagging) which produced significantly the highest yield/palm (181.40 kg as average of two seasons), followed by palms pollinated by spraying 100 g/L sugar and dusting with 1g pollen + 2g flour with bagging (T7) or without bagging (T6) which produced 177.90 and 152.70 kg/palm, respectively, while palms of T4 (Spray a suspension 1g/L pollen grains without bagging) produced significantly inferior yield (100.45 kg). Yield of the other pollination methods vary significantly which ranged from 118.80 to 139.55 kg/palm.

Concerning the fruit set % data of the same table reveal the same trends as observed on yield/palm *i.e*. all different pollination methods significantly decreased the

Table 1: Effect of different pollination methods on Yield and fruit set % of Barhee cultivar, (over 2017 and 2018 seasons).

Treatments	Yield (Kg)			Fruit set (%)		
	1st	2nd	Av.	2nd	1st	Av.
T1	180.3a	182.5a	181.40	86.79 a	88.77 a	87.78
T2	118.0h	119.6h	118.80	33.18 h	33.86 h	33.52
T3	127.5f	131.6f	129.55	46.16 f	48.66 f	47.41
T4	98.6i	102.3i	100.45	23.59 i	27.15 i	25.37
T5	123.8g	128.3g	126.05	43.67 g	45.41 g	44.54
T6	152.1c	153.3c	152.70	76.98c	77.18c	77.08
T7	177.1b	178.7b	177.90	82.88 b	83.85b	83.37
T8	133.1e	134.4e	133.75	60.61 e	60.53 e	60.47
T9	138.3dh	141.0d	139.55	64.66 d	65.46d	65.06
LSD 0.05	0.88	0.75		6.80	0.55	

fruit set % than that of the control, the highest value of fruit set % was obtained in spathes of palms pollinated by traditional pollination (87.78 % as average of two seasons), followed by palms pollinated by T7 (83.37%) and T6 (77.08%), whereas palms subjected to T4 was more effective as it decreased fruit set % (25.37). Fruit set % of the other pollination methods ranged from 33.52 to 65.03%. These results are in agreement with that of (Al-Wasfy, 2014) observed highest fruit setting in Zaghloulcv. when 4-6 g/L^{-1} pollen suspension was applied and similar results were obtained by Awad, (2006 and 2010) on Lulu and Khenazy *cvs* dates.

Fruit physical properties

The results of both seasons table 1 and 2 indicated that increasing fruit set caused a decrease in fruit weight. In other words; fruit weight was decreased as fruit set increased. According to this relationship, all different pollination methods significantly increased the average fruit weight of "Barhee" dates than that of the control except T9 (dusting with 1g pollen + 2g flour with bagging) in both seasons and T3 (Spray a suspension (10 g/L sugar + 1g pollen grains) with bagging) and T8 (Dusting with 1g pollen + 2g flour without bagging) in the first one. On the other hand fruit weight of T9 recorded lower value (15.42g as average of two years) than that of the control (16.12g). Fruits of palm pollinated by Spray a suspension (1g/L pollen grains) without bagging (T4) or with bagging (T5) were the heaviest weight among the tested treatments (19.60 and 19.19g, respectively), while fruits weight of other tested pollination methods ranged between 16.21 to 18.33 g. This increment in fruit weight, which occurred by different pollination methods, may be due to the reduction in fruit number, which prevents their accumulation within bunch, consequently, it permits the fruits to take sufficient amount of carbohydrates, water and nutrients, which finally, caused the increase in fruit weight as compared with the control palms which had the highest yield and smallest fruit weight.

Regarding flesh weight the data of table 2 reveal the same trends as observed in fruit weight, *i.e*. all tested pollination methods significantly increased the flesh weight as compared with the control in both seasons except T3, T8 and T9 in the first season and T9 in the second one. The average of two years show that fruits of T9 were lower values in flesh weight (14.25 g) than that of the control (14.69 g), while the upper most values were obtained by T4 (18.39g), followed by T5 and T2 which gave 17.97g and 17.13g, respectively. Flush weight of other tested pollination methods ranged between 15.07 to 16.15 g.

In regard to seed weight the obtained data in table 2 show that there is no consistent trend in seed weight between different pollination methods, also there are no significant differences were detected in this respect between different treatments including the control. This

Table 2: Effect of different pollination methods on physical properties of Barhee fruits, (over 2017 and 2018 seasons).

Treat-ments	Fruit weight (g)			Flesh weight (g)			Seed weight (g)			Fruit width (mm)			Fruit length (mm)		
	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.
T1	16.09cd	16.16f	16.12	14.91d	15.01e	14.96	1.17	1.15	1.16	2.72d	2.68c	2.70	3.25c	3.26c	3.26
T2	18.47 a	18.20c	18.33	17.16b	17.10c	17.13	1.31	1.10	1.20	2.83b	2.84a	2.84	3.3ab	3.28bc	3.33
T3	15.34 d	18.10c	16.72	14.18e	16.99c	15.59	1.16	1.11	1.13	2.75cd	2.76b	2.76	3.27c	3.26c	3.27
T4	19.01a	20.15a	19.60	17.85a	18.9 a	18.39	1.16	1.25	1.21	2.94a	2.78ab	2.86	3.35b	3.29b	3.32
T5	18.70 a	19.68b	19.19	17.54ab	18.39b	17.97	1.16	1.29	1.22	2.98a	2.84a	2.91	3.38a	3.35a	3.37
T6	17.31 b	17.17de	17.24	16.26 c	16.04dc	16.15	1.04	1.13	1.09	2.76 c	2.82ab	2.79	3.34b	3.34a	3.34
T7	17.19bc	17.36 d	17.28	16.04 c	16.21 d	16.12	1.14	1.14	1.14	2.73cd	2.79ab	2.76	3.34b	3.35a	3.35
T8	15.55 d	16.86 e	16.21	14.39 d	15.74 c	15.07	1.16	1.12	1.14	2.68 e	2.77 b	2.73	3.34b	3.34a	3.34
T9	15.62 d	15.22 g	15.42	14.39de	14.10 f	14.25	1.23	1.12	1.17	2.67 e	2.68 c	2.68	3.34b	3.34a	3.34
LSD 0.05	1.11	0.33		0.68	0.33		NS	NS		0.04	0.06		0.03	0.02	

was true in both seasons. The average values of the two seasons show that seed weight ranged between 1.09 and 1.22g. In other words, the increase in fruit weight by different pollination methods could be mainly attributed to the increase in flesh weight without regard to the changes of seed weight.

In regard to fruit dimensions, data of tables 2 reveal a nearly similar trend as discussed for fruit weight. All pollination treatments significantly increased both fruit length and diameter as compared with the control in both seasons. T5 was the most effective in increasing fruit dimensions as compared with other pollination treatments in the two seasons of study which recorded the highest value (3.37cm in length and 2.91cm in diameter as average of two years) followed by fruits of T7 (3.35 cm in length and 2.76cm in diameter) in compared with the control which gave the lowest value in this respect (3.26cm in length and 2.70cm in diameter), fruit dimensions of other pollination treatments were ranged between 3.27 and 3.34 cm. in length and from 2.68 to 2.86 cm in diameter. These results are in close similarity with the discoveries of Marashi and Mousavi, (2007); Iqbal *et al*., (2010); Abdalla *et al*., (2011); El-Salhy *et al*., (2012); Damankeshan and Panahi, (2013); Bashir *et al*., (2014); Amouni-Mona *et al*., (2016); Ghazzawy *et al*., (2019) and Munir *et al*., (2020). On the other hand, Abdalla *et al*., (2011); Al-Wasfy, (2014); Soliman *et al*., (2017); Sayed *et al*., (2018) and Abu-Zahra and Shatnawi, (2019) on different palm cvs, who indicated that application of 6 g/L pollen suspension enhanced significantly fruit and flesh weight and fruit length.

Chemical properties:

Results shown in able 3 indicated that fruits of palms pollinated by traditional pollination (Placing 20-25 male strands within the strands of female spathe with bagging), were highest in total sugars content, followed by T7 (spraying 100 g/L sugar and dusting with 1g pollen + 2g flour with bagging), T9 (Dusting with 1g pollen + 2g flour with bagging) and T5 (Spray a suspension (1g/L pollen grains) with bagging), the differences between them did not reach the level of significance, whereas T2 (spray a suspension (10 g/L sugar+ 1g pollen grains) without bagging) significantly decreased total sugars content than that of the other treatments. This was true in the two seasons. The average values of the two years show that fruits of palm pollinated by traditional pollination (control), treatments 7, 9 and 5 were highest in total sugars content (86.50%, 85.92, 84.98 and 84.25%, respectively), followed by fruits of T4 (81.25) and T6 (80.17%), while fruits produced from bunches received T3, T8 and T2 were lowest in total sugars content (71.08, 69.55 and 66.91%, respectively). Results show also that most of these sugars were found as reducing sugars.

As for reducing sugars content % data of the same Table reveal the same trends as observed in total sugars, i.e. Fruits of palm pollinated by traditional pollination (the control) were the highest in reducing sugars content descending followed by those of treatments 4, 5, 6, 7 and 9 the differences among them not big enough to be significant in the second season, then by fruits of palm subjected to T3, T8 and T2 which attained the lowest reducing sugars content with no significant among them in both seasons. Data recorded show that fruits of control treatment were highest in reducing sugars content (59.66% as average of two years) followed by treatments 4, 7, 9 and 5 (56.58, 55.92, 55.66 and 55.33%, respectively) while fruits of treatments 3, 8 and 2 were the lowest in this respect (50.20, 49.23 and 46.09%, respectively).

In regard to non- reducing sugars content % data of the same table indicated that there is no consistent trend in non- reducing sugars content No significant differences were also found between the different pollination treatments including the control in the first season, whereas, in the second season, the differences between

Table 3: Effect of different pollination methods on chemical properties of Barhee fruits, (over 2017 and 2018 seasons).

Treat-ments	Total sugars (%)			Reducing Sugars (%)			Non-Reducing sugars (%)			Total indole (%)			Total phenol (%)		
	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.	1st	2nd	Avg.
T1	87.00a	86.0	86.50	60.00a	59.33a	59.66	27.00a	26.67ab	26.84	0.376e	0.503e	0.440	1.546c	1.626d	1.586
T2	66.16e	66.67e	66.91	45.50c	46.67c	46.09	20.66a	20.00d	20.33	0.760a	0.70a	0.730	2.023a	2.166ab	2.095
T3	70.16d	72.00d	71.08	48.40c	52.00b	50.20	21.76a	20.00d	20.90	0.693ab	0.673ab	0.683	1.973a	2.070ab	2.022
T4	82.83bc	79.66bc	81.25	54.16b	59.00a	56.58	28.67a	20.66 d	24.66	0.670b	0.656bc	0.663	1.966a	1.983abc	1.975
T5	85.17ab	83.33ab	84.25	55.33b	55.33ab	55.33	29.84a	28.00ab	28.92	0.646b	0.673ab	0.660	1.946ab	1.986abc	1.966
T6	81.33c	79.00c	80.17	54.33b	56.00ab	55.17	27.00a	23.00cd	25.00	0.516cd	0.600cd	0.558	1.890ab	1.890bc	1.890
T7	86.33a	85.50a	85.92	56.33b	55.50ab	55.92	30.00a	30.00ab	28.33	0.456de	0.510e	0.483	1.806b	1.816cd	1.811
T8	65.83e	73.26d	69.55	45.33c	53.13b	49.23	20.50a	20.13d	20.07	0.546c	0.580d	0.563	1.993a	1.986abc	1.990
T9	86.83a	83.13ab	84.98	56.00b	55.33ab	55.66	30.83a	27.80ab	29.32	0.473cd	0.590cd	0.532	1.983a	1.956abc	1.970
LSD0.05	3.22	4.09		3.61	5.12		10.61	4.07		0.088	0.070		0.156	0.240	

control and treatment 5, 7 and 9 did not reach the level of significance, it was also found between treatments 2, 3, 4, 6 and 8. The average values of the two years show that fruits of palm pollinated by T9 were the highest in non-reducing sugars content (29.32%), followed by those of T5 (28.92%) and T7 (28.33%) as compared with the control (26.67), then by fruits of palm subjected to T6 (25.00%) and T4 (24.66%) whereas fruits of treatments 8, 2 and 3 contained the lowest non-reducing sugars content (20.90, 20.90, 20.33 and 20.07%, respectively).

Regarding indole and phenol content %, results presented in the same table indicated that all studied pollination methods significantly increased the indoles and phenols contentof "Barhee" fruitsas compared with the controlin both seasons. The average values of the two years show that fruits produced from bunches received T2 and T3 contained significantly higher total indols and phenols content (0.735 and 0.683% in indols and 2.095 and 2.022% in phenols, respectively) than those produced from control which contained the lowest value in this respect (0.440 in indols and 1.586%, in phenols). Meanwhile total indols and phenols content of other studied treatments ranged from 0.483 to 0.663% in indols and from 1.811 to 1.99% inphenols. *The obtained results were nearly in the same line with obtained by* Marashi and Mousavi, (2007); Iqbal *et al*., (2010); Abdalla *et al*., (2011); El-Salhy *et al*., (2012); Damankeshan and Panahi, (2013); Bashir *et al.,* (2014) and Samouni-Mona *et al*., (2016); Ghazzawy *et al.,* (2019). Likewise, Sayed *et al*., (2018) found that spray pollen grains extract enhancing fruit quality of Khalas and Sagae cvs under the two climates.

Conclusively, the obtained results give basis to conclude that artificial pollination of "Barhee" dates is considered one of the most important culture practices to obtain high yield and fruit quality. The most beneficial treatment in this concern is spraying female spathes with 100 g/L sugar and dusting with 1g pollen + 2g flour with bagging, which gave high fruit set% and a reasonable yield (similar yield as the traditional pollination) as well as high fruit weight and dimensions with high content of total and reducing sugars and low content of indoles and phenols (which meaning fruit quality). Moreover, it distinguished to saving time, effort, labour and cost and more practical suitable for big farms and could be consider as recommended treatment under conditions of this experiment. In addition to it is a promising technique in the future.

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