In vitro study on germination of date palm pollen grains and its impact on fruit quality

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Abstract: Pollen of date palm has an effect on shape and size (Xenia) of the resulted seeds as well as development, quality and ripening time of date palm fruits. This study aimed to find out the effect of *in vitro* germination rate of pollen grains using different sources of pollen (male trees) on fruit quality and maturity of date palm (Zaghloul and Samany cv.). In order to determine the effect of sucrose on *in vitro* germination rate of date palm pollen grains, four different sources of date palm pollen grains (M1, M2, M3 and M4) were used. A factorial experiment involving four sucrose concentrations (10, 15, 20 and 25%) were added to Brewbaker and Kwack's (1963) basal medium, which used for germination of pollen grains. M1 pollen grains significantly observed the highest percentage of germination with both of tested cultivars (Zaghloul and Samany) on the medium contained 10% sucrose after 72 hours of incubation compared to all other treatments. As for the evaluation of fruit quality of both tested cultivars (Zaghloul and Samany) in the field, M1 significantly proved to be the most effective in increasing the fresh weight, fruit length, fruit size, mature fruit setting, fruit tasting and TSS compared to all other pollinators. Moreover, M1 and M4 showed the highest value in total sugars compared to M2 and M3, the significant highest value of tannin contents with Zaghloul and Samany cultivars fruits were achieved M2 which surpassed all the pollinators which showed lower values with no significant difference between each other. In conclusion pollinators have obvious metazenic effects especially on fruit fresh weight, fruit length, fruit size, fruit setting, fruit tasting, total soluble solids (TSS), total sugars and tannin contents.
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1. Introduction

The date palm (*phoenix dactylifera* L. 2n=36) is one of the most important members of the palmate family (Arecaceae). There are 11 other species in the genus *Phoenix,* some of which are used as ornamentals. All species of *Phoenix* are dioecious with male and female flowers produced in clusters on separate palms in the axils of leaves from the previous year's growth. The exact centre of origin is unknown with suggesting to be Iraq as a possible sit, Nixon and Carpenter (1978). Although date palm are primarily cultivated for their fruits, many other parts of the palm can be used, e.g. trunks for building, leaves (10 – 20 feet long) for thatch, and the spathes may be tapped for palm wine. As many as 800 uses have been recorded in the Middle East. Pollen plays a critical role in plant cycle, as viable pollen is crucial for efficient sexual plant reproduction. The capacity of pollen to germinate and grow normally is termed as viability. High viable pollen will increase the percentage of fruit set and ultimately will produce high yield. Viability test helps in selecting pollen types that are highly viable. Pollen viability may be measured after pollination, by analyzing germination on the stigma or seed set derived from that pollination. Both methods are time consuming and may lead to an overestimation of pollen viability if the pistil is over-pollinated (Bots and Mariani, 2005). Pollen germination and the growth of pollen tubes are, in principle, necessary for fertilization and seed formation in flowering plants. Studies on *in vitro* pollen germination and pollen tube growth are very useful for explaining the lack of fertility (Pfahler *et al*., 1997). *In vitro* pollen germination is one of the most convenient and reliable methods used to test the viability of fresh or stored pollen grains. Different substances used in the germination media are needed to compensate for the difference between the *in vitro* environment and the natural conditions on stigma. Because of the rapid rate of tube formation *in vitro* exhibited by some species, pollen tube formation has become a model system for studying growth and development in plants. Artificial pollination of date palm spathes is one of the major practices that are necessary for successful fruiting. It has been documented and reported that there is a direct effect for the type of pollens on some fruit characteristics outside the embryo and the endosperm such effect is known as the metaxenia. The metaxenia effects were reported on fruit size by Swingle (1928), El-Ghayatyi (1983), Abdelah *et al*. (1983) and Shaheen *et al.* (1989), on fruit color and the time of ripening by Al-

Delamiy and Ali (1970), on fruit and seed weight by El-Ghayatyi (1983) and Abdelah *et al*. (1983), Al-Hamoudi *et al.* (2006) and Abd El-Zaher (2008) on TSS by Al-Hamoudi *et al.* (2006). Many researchers reached to the conclusion that there is a direct effect for the used male parent on date palm qualities even the flavor or aroma of the fruit by Ben Salah and Hellali (1998). It has been reported that the metaxenic influence on accelerating fruit maturity was considerable in the marginal areas since in arid regions high temperature was the dominant factor influencing the time of fruit maturity and ripening by Farage (2005). The interest in the metaxenic effects was extended to study such possibility on the mineral contents of the fruit Shaheen *et al.* (1989). The increasing demand to the organic production systems of main fruit crops including date palm emphasizes the need for more research on the metaxenic effects of used pollens and their explanations. Thus, the objectives of this study were to investigate the metaxenic effects of some date palm pollen grains on physical and chemical properties of Zaghloul and Samany c.v date palm (*Phoenix dactylifera* L.) and to find out the concentration of sucrose required in the culture medium for optimum pollen germination *in vitro*. This study was focusing not to repeat previous other studies, but to use different new techniques and select male trees cultured in El-Behera Governorate, Egypt, which have a good pollen viability, big fertility and high compatibility with the commercial female cultivars cultured in the same region, the offshoots of the chosen male trees were used as source of explants to micropropagat these male trees.

2. Material and Methods

This work was carried out during the period from 2012 to 2014 at Plant Tissue Culture Laboratory, of Plant Biotechnology Department, Genetic Engineering and Biotechnology Research Institute (GEBRI), University of Sadat City, Sadat City, Egypte.

Date palm pollen used in this study was obtained from trees grown at the date Palm farms, Egypt, El-Behera, governorate, these trees were selected on the basis of uniformity in the age. Male palm trees were selected from four local farms in El-Behera, governorate, as one pollinator from each and named M1, M2, M3 and M4.

Effect of different sucrose concentrations on *in vitro* germination of date palm pollen grains (M1, M2, M3 and M4) after different incubation periods (24, 48 and 72hrs)

In this experiment, to determine the effect of sucrose on *in vitro* germination rate of the four different sources of date palm pollen grains, a factorial experiment involved four sucrose concentrations (10, 15, 20 and 25%) and four different sources of pollinators (M1, M2, M3 and M4) leading to 16 treatments. Each treatment contained 3 jars of 150 ml size each (replicates). Each jar contained 0.5 g of pollens and 25 ml of Brewbaker and Kwack (1963) basal liquid medium contained 0.5 g/l boric acid (H_3BO_3), 0.3 g/l $Ca(NO)_3.4H_2O$, 0.2 g/l $MgSO_4$ 7H $_2O$ and 0.1 g/l KNO_3. All jars were incubated at 27 ±2 ^oC for 24, 48 and 72 hours. Then, random sample of the liquid media contained some pollen grains was taken from each replicate to examine the germination rate under inverted microscope after each period of incubation**.**

Effect of different pollinators (M1, M2, M3 and M4) on percentage of fruit setting, physical and chemical characteristics of date palm fruits

As for the female trees, six trees were chosen [three of Zaghloul cultivar named Z1, Z2, and Z3 and three of Samany cultivar named S1, S2, and S3], 12 spathes were selected on each female tree and the rest of spathes was removed, each pollinator of the male trees (M1, M2, M3 and M4) was used to pollinate three spathes on each female tee of the two cultivars mentioned above. To carry out this part, the spathes of each male tree were taken to the traditional drying room (27 ±2^oC), as soon as the spathes cracked, hand pollination is performed by trained operators who climbed the female tree and placed five parts (each 30cm long) of the male flowers in each female spathe.

After three weeks of fertilization, data were recorded as, the percentage of immature fruit setting. At the end of the season, the mature fruit setting percentage, fruit fresh weight (g), fruit length (cm), fruit size (cm^3), and fruit tasting were recorded as, physical parameters according to Sauer (1993), Wrigley (1995) and Hemeida *et al.* (2008). As for chemical parameters, data were recorded as, total soluble solids (TSS) according to Howrtiz (1975), total sugars of each fruit sample which was extracted according to Dubois *et al.* (1956) and tannin contents which was determined according to Association of Official Analytical Chemists (AOAC, 1970).

Statistical analysis

The data were statistically analyzed using Analysis of Variance (ANOVA). Comparisons among means were made via the least significant differences multiple range tests according to Snedecor and Cochran (1989). The data were analyzed using MSTAT software program.

3. Results and Discussion

3.1. Effect of different sucrose concentrations on *in vitro* germination of date palm pollen grains (M1, M2, M3 and M4) after different incubation periods (24, 48 and 72hrs)

Data presented in Table (1) indicate the Effect of the different sucrose concentrations on the germination of the pollen of the four pollinators after 24 hrs of incubation, as data of the main effect of sucrose on germination of pollen grains was obtained with the concentration 15% (7.06). That was followed by the concentration 10% and 20% without significant difference. Concerning the main effect of the pollinator source, it was obvious the M1 significantly showed the highest number of germinated pollen grains (13.88) followed by M4 (5.43). The lowest value was recorded by M2 and M3 (2.50 and 2.68 respectively) without significant difference. As for the interaction, a higher number of germinated pollen grains (16.0) was recorded when M1 pollen grains were placed on the medium contained 15% sucrose. However, significant similar values were obtained with the same source of grains when the medium had sucrose at 10% and 20% (14.75 and 13.25, respectively). Lower numbers of germinated grains were recorded with the rest of treatments.

Data of the same Table (1) show the effect of the same sucrose concentrations on pollen germination of the same pollinators but after 48 hrs. Data of the main effect of sucrose concentrations reveal that, the concentration 10% and 15% observed higher effect on germination and followed by the concentration 20% without significant difference. As for the main effect of pollinator source, data proved that, the pollinator M1 had the significant greatest number of germination grains (17.0) compared with the other pollinators. The pollinator M2 and M3 showed the lowest significant value in that concern (3.5 and 5.06 respectively). Regarding the interaction, interestingly M1 pollinator observed significant similar number of germinated pollen grains with all sucrose concentrations and these values of M1 surpassed the all other treatments.

The same Table (1) and Fig (1) contained the values of 72 hrs of incubation. Data of the main effect of sucrose concentrations indicate that, the two concentrations 10% and 15% observed similar significant higher effect on the rate of germination (14.00 and 13.31, respectively) compared with the other concentrations. As for the main effect of pollinators, M1 significant gave the highest record of germination (17.31) followed M4 (12.94). The lowest value was obtained with M2 and M3 without significant difference. Concerning the interaction, there was a significant obvious record of germination with the pollinator M1 combined with 10% sucrose (29.50). Sporadic lower values were observed with other treatments. Pollinators differed in their ability to germinate *in vitro* where the results showed pollinator M1 has outperformed the rest of the other pollinators in the number of pollen grains germination and during all incubation periods with sucrose concentrations of 10% and 15%. While the pollinators M4 and M3 came in the second place in the number of pollen grains germination, while the pollinator M2 was weakest pollinators in its ability to germinate. In this concern, Myint *et al.* (2012) found that the solid sucrose medium increased the germination percentage in dura and tenera pollen at 60, 120, and 180 min after incubation. Tandon *et al*. (1999) suggested that the sucrose liquid medium containing 2.5% sucrose, 100-ppm boric acid and 10% polyethylene glycol (PEG) with 10000 M is the most suitable medium for viability of oil palm pollen (Tenera). However, Jayaprakash and Sarla (2001) stated that liquid media gave the inconsistent germinability results in *Cajanus cajan* (L.) pollen. Sugar is utilized as an energy sources for the synthesis of cell wall material such as pectins, cellulose and callose (Mascarenhas, 1993 and Derksen *et al.,* 1995). Stadler *et al.* (1999) claimed that sucrose was the only one carbohydrate that supports growth of arabidopsis pollen.

3.2. Effect of different pollinators of date palm (M1, M2, M3 and M4) on immature fruit setting of Zaghloul and Samany cv. after three weeks of fertilization

In Table (2) and Fig (2) a data show the effect of different pollinators on immature fruit setting number and percentage of Zaghloul and Samany **cv** after three weeks of fertilization, as data of the main effect of the type of female cultivars (Zaghloul and Samany) indicate that Zaghloul cv resulted in the highest significant value of fruit setting number and percentage (35.75 and 55.75%) compared with Samany cv (30.50 and 52.34, %). As for the main effect of pollinator source, it was obvious that M1 significantly showed the highest number and percentage of fruit setting (48.83 and 71.79%) followed by M4 (41.67 and 64.35%). The lowest value was record by M2 (11.83 and 19.04 respectively) compared to other pollinator source. Concerning the interaction, a higher values of fruit setting number and percentage were recorded when M1 pollinated the both female cultivars (Zaghloul and Samany) without significant difference of fruit setting number (50.00 and 47.67 respectively) and percentage (81.48% and 82.10% respectively). That was followed by values obtained when M4 pollinated both of female cultivars (Zaghloul and

Samany) without significant difference of fruit setting number (38.33 and 35.0respectively) and percentage (66.18 % and 62.51% respectively). Although, M2 and M3 pollinators significantly showed lower values, M2 observed the lowest value in that concern.

3.3. Effect of different pollinators of date palm (M1, M2, M3 and M4) on mature fruit setting of Zaghloul and Samany cv.

In Table (3) and Fig (3 and 4) data show the effect of different pollinators (M1, M2, M3 and M4) on mature fruit setting number and percentage of Zaghloul and Samany **c.v**, as data of the main effect of female cultivar indicate that no-significant difference between both of Zaghloul and Samany cv of mature fruit setting number (31.50 and 30.58, respectively) and percentage (48.43% and 47.26% respectively) Data on the main effect of different pollinators on number and percentage of mature fruit setting of female cultivars indicate that M1 significantly gave the highest value of mature fruit setting number and percentage (46.50 and 71.35%) followed by M4 (38.83 and 61.13%). The lowest value was record by M2 (12.83 and 18.25%) compared to other pollinator source. Concerning the interaction, M1 significantly showed similar higher values with the both cultivars of mature fruit setting number (47.67 and 45.33, respectively) and percentage (71.40 and 71.30, respectively) compared with all other values. Variation in fruit setting, with different pollen sources, reported by workers (Nixon and Carpenter 1978, El-Hamdi *et al*. 1977, Al-Delaimy and Ali 1969). These results are in agreement with those contained by Shaheen *et al*., (1989), Aly (2001), Al-hamoudi *et. al.,* (2006) and Omaima *et. al*., (2014) they reported that pollen source has metaxinic effects on fruit percentage, but those differed the male sources.

Table 1. Effect of different sucrose concentrations on *in vitro* germination of date palm pollen grains (pollinators M1, M2, M3 and M4) after different incubation periods (24, 48 and 72hrs)

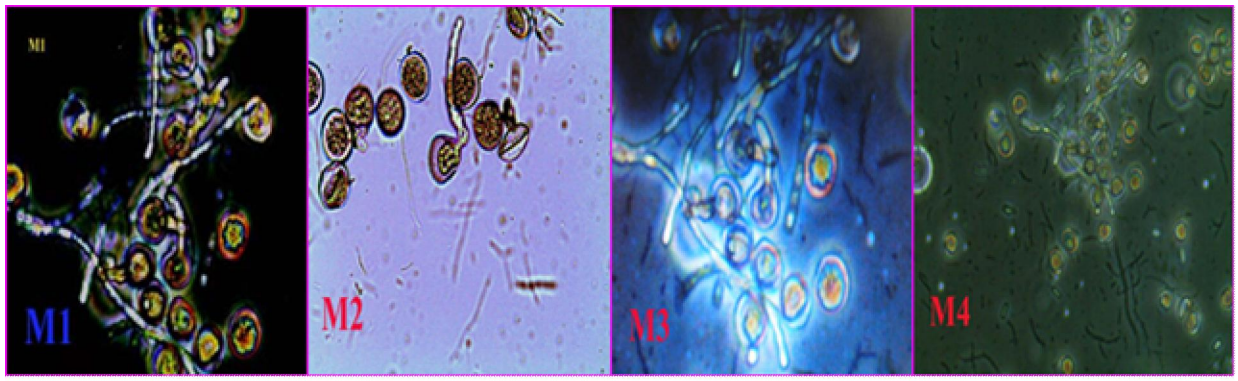
Numbers of pollen grains germination *in vitro*															
Incubation periods	**24 hrs**					**48 hrs**					**72 hrs**				
Pollinators / Sucrose Conc.	**M1**	**M2**	**M3**	**M4**	**Mean (A)**	**M1**	**M2**	**M3**	**M4**	**Mean (A)**	**M1**	**M2**	**M3**	**M4**	**Mean (A)**
10	14.75	4.50	2.00	3.50	6.18	19.5	7.50	3.50	7.75	9.56	29.50	7.50	4.25	14.75	14.00
15	16.00	2.00	3.75	6.50	7.06	16.5	3.25	8.75	8.00	9.12	16.50	7.50	13.0	16.25	13.31
20	13.25	1.50	3.25	7.75	6.43	15.0	2.00	5.50	7.00	7.37	11.50	2.75	4.50	10.75	7.37
25	11.50	2.00	1.75	4.00	4.81	17.0	1.75	2.50	5.25	6.50	11.75	1.25	5.50	10.00	7.12
Mean (B)	13.88	2.50	2.68	5.43		17.0	3.50	5.06	7.00		17.31	4.75	6.81	12.94	
LSD 5%															
A	2.212					2.52					2.855				
B	2.212					2.52					2.855				
A*B	4.425					5.040					5.70				

Table 2. Effect of different pollinators of date palm on fruit setting of Zaghloul and Samany cv. after three weeks of fertilization

Type of female cv.	**Fruit setting (numbers) (after three weeks of fertilization)**				**Mean (A)**	**Fruit setting (%) (after three weeks of fertilization)**				**Mean (A)**
	Pollinators					**Pollinators**				
	M1	**M2**	**M3**	**M4**		**M1**	**M2**	**M3**	**M4**	
Zaghloul	50.00	15.00	29.67	38.33	35.75	81.48	23.65	51.71	66.18	55.75
Samany	47.67	8.66	30.67	35.00	30.50	82.10	14.44	50.31	62.51	52.34
Mean (B)	48.83	11.83	30.17	41.67		71.79	19.04	51.01	64.35	
LSD at level 5%										
A	2.368					2.091				
B	3.349					2.957				
A*B	4.736					4.182				

Table 3. Effect of different pollinators of date palm (M1, M2, M3 and M4) on mature fruit setting of Zaghloul and Samany cv.

Type of female cv.	Mature fruit setting (numbers)				Mean (A)	Mature fruit setting (%)				Mean (A)
	Pollinators					Pollinators				
	M1	M2	M3	M4		M1	M2	M3	M4	
Zaghloul	47.67	13.00	26.00	39.33	31.5 0	71.40	17.93	42.47	61.93	48.43
Samany	45.33	12.67	26.00	38.33	30.58	71.30	18.57	38.83	60.33	47.26
Mean (B)	46.50	12.83	26.00	38.83		71.35	18.25	40.65	61.13	
LSD at level 5%										
A	2.265					2.013				
B	3.204					2.847				
A*B	4.531					4.027				



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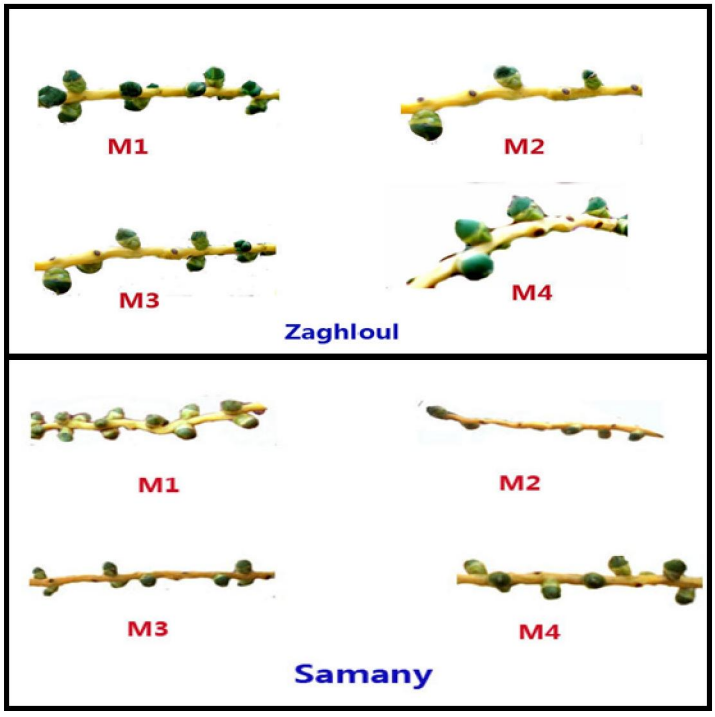

Figure 2. Effect of different pollinators (M1, M2, M3andM4) of date palm on immature fruit setting of Zaghloul and Samany cv after three weeks of fertilization

3.4. Effect of different pollinators (M1, M2, M3 and M4) on physical characteristics (Fruit fresh weight, Fruit length, Fruit size and Fruit tasting) of fruit of date palm

3.4.1. Fruit fresh weight (g/fruit)

Data presented in Table (4) and Fig (5) reveal the effect of different pollinators (M1, M2, M3 and M4) on fruit fresh weight of Zaghloul and Samany fruits. As for the main effect of pollinator source, M1and M4 gave the greatest record of fruit fresh weight (31.59 and 30.79 g/fruit, respectively) without significant difference followed by M3 (25.79 g/fruit) with Zaghloul fruits. However, the main effect of pollinator source on fruit fresh weight of Samany fruits, data showed that, there was a significant obvious record of fruit fresh weight with the pollinator M1 (36.70 g/fruit) followed by M4 (29.90 g/fruit). Variations of this study in the type of pollen samples and the response of fruit fresh weight are in agreement with those reported by Gasim (1993), Desoukey *et al*. (1993), El-Makhtoun and Abd-Elkader (1990), Ben salah and Hellali (1998). On the other hand**,** similar observations were recorded by workers on fruit fresh weight with many date palm cultivars in their respective areas (Nixon 1951, Ahmed *et al*. 1962, Hussein 1970, El-Hamadi *et al*. 1977, Khalifa *et al*. 1979, El-Ghayati 1983 and Higazy *et al*. 1983).

3.4.2. Fruit length (cm/fruit)

Data of the effect of different pollinators (M1, M2, M3 and M4) on fruit length of Zaghloul and Samany fruits are presented in Table (4) and Fig (5). Regarding the main effect of pollinators on Zaghloul fruit length, pollinator M1 significantly showed the highest response in increasing the fruit length (6.63 cm/fruit). However M4 with Zaghloul cv observed the second grade of response in that concern (5.90 cm/fruit). Data of the main effect of pollinators on Samany fruit length, pollinator M1 and M4 showed the highest response in increasing the fruit length (5.45 and5.43 cm/fruit, respectively) without significant difference compared with all other pollinators

3.4.3. Fruit size (cm^3/fruit)

In Table (4) and Fig (5) data show the effect of different pollinators (M1, M2, M3 and M4) on fruit size of Zaghloul and Samany fruits, data showed that, the pollinator M1and M4 had the greatest value of fruit size (3.50 and 3.50 cm^3/fruit) without significant difference followed by M3 (2.50 cm^3/fruit). Data of the main effect of pollinators indicated that, the highest significant effect of pollinators on Samany fruit size was obtained with M1 (4.0cm^3/fruit) followed by M4 (3.5 cm^3/fruit). Lowest significant value was obtained with M2 pollinator in that concern (1.50cm^3/fruit). This trend of fruit size is agreement with the finding of Aly (2001) and Hussein *et al*. (1999). Also fruit size was recorded by Swingle (1928), Osman *et al.* (1974), El-sabrut (1979) and El-Ghayati (1983) in date palm cultivars.

3.4.4. Fruit taste

Data of the effect of pollinator source (M1, M2, M3 and M4) on fruit taste of Zaghloul and Samany fruits are presented in Table (4). Data of the main effect of pollinators source on Zaghloul fruit taste showed that, the highest value of fruit taste was obtained with M1 and M4 (3.13 and 2.75, respectively) without significant difference. The lowest effect of pollinator source on Zaghloul fruit taste was obtained with M2 pollinater (1.30). Concerning the main effect of the pollinator source on Samany fruit taste, it was obvious that M1and M4 gave a similar significant result (2.80 and 2.75, respectively) followed by M3 (2.13). The lowest significant value was obtained with M2 pollinator (1.46).

Table 4. Effect of different pollinators of date palm (M1, M2, M3 and M4) on fruit fresh weight, fruit length, fruit size and fruit taste of Zaghloul and Samany date fruit cv.

Female cv.	Zaghloul				Samany			
Parameters / Pollinators	Fruit fresh weight (g/fruit)	Fruit length (cm/fruit)	Fruit size (cm^3/fruit)	Fruit taste	Fruit fresh weight (g/fruit)	Fruit length (cm/fruit)	Fruit size (cm^3/fruit)	Fruit taste
M1	31.59	6.63	3.50	3.13	36.70	5.45	4.00	2.80
M2	13.70	4.55	1.50	1.30	16.52	4.14	1.50	1.46
M3	25.79	5.03	2.50	2.03	24.30	4.70	3.00	2.13
M4	30.79	5.90	3.5	2.75	29.90	5.43	3.50	2.75
LSD at level 5%	1.272	0.4795	0.3086	0.4866	0.9386	0.313	0.3384	0.6240

Figure 3. Effect of different pollinators (M1, M2, and M3andM4) of date palm on mature fruit setting of Zaghloul cv.

Figure 4. Effect of different pollinators (M1, M2, M3andM4) of date palm on mature fruit setting of Samany cv.

3.5.vEffect of different pollinators (M1, M2, M3 and M4) on chemical characteristics (Total soluble solids, Total sugars and Tannin contents) of fruit of date palm

3.5.1. Total soluble solids (TSS)

Data of the effect of pollinator source (M1, M2, M3 and M4) on total soluble solids percentage of Zaghloul and Samany fruits are reported in Table (5). Data of the main effect of pollinator source on total soluble solids percentage of Zaghloul fruits showed that, M1 produced the highest significant record in total soluble solids (9.8 %) followed by M4 (9.17%) M2 came in the lowest grade. As for the main effect of pollinator source on total soluble solids percentage of Samany fruits, M1 significantly gave the highest value of TSS (10.67%) followed by M4 (10.00%) compared with the all other pollinators. The obtained results are in the line with those reported by Omer (2004), Higazy *et al*. (1983), El-Makhtoun (1981), El-Hamadi *et al*. (1977) and Al-Delamy and Ali (1970).

3.5.2. Total sugars

In Table (5) data, reveal the effect of different pollinator source (M1, M2, M3 and M4) on total sugars percentage of Zaghloul and Samany fruits, data proved that, both of M3 and M4 had the greatest values of total sugars (34.67% and 38.00%, respectively) without significant difference between each other followed by M1 (32.67%). Lowest significant value was obtained with M2 pollinator in that concern (16.00%). Data of the main effect of pollinator source on total sugars percentage of Samany fruits showed that, M1 and M4 significantly produced the highest value in total sugars (31.67% and 36.33%, respectively) without significant difference compared with the all other pollinators. Results of this study are in agreement with those reported by Shaheen *et al*. (1989) and El- Makhtoun (1981).

3.5.3. Tannins

In Table (5) data indicate the effect of different pollinator source (M1, M2, M3 and M4) on percentage of tannin contents of Zaghloul and

Samany fruits, as M2 significantly showed the highest value of tannin contents (1.43%) followed by M1, M3 and M4 which gave a lower significant similar result. Concerning the main effect of pollinator source on percentage of tannin contents of Samany fruits, M2 surpassed the all other treatments in increasing tannin contents followed by M1, M3 and M4 without significant difference between each other. The type of pollinators affected the tannin contents of date fruits and that was in agreement with Al-Hooti *et al*. (1997), Musa (1981) and Farag *et al* (2012).

4. Conclusion

According to the results of this study, it can be recommended that the germination of pollen grains *in vitro* is very important and useful to determine the best pollinator for pollination process. As it was obvious that the good pollinator strongly and positively affected the fruit set percentage, fruit fresh weight (g/fruit), fruit size (cm3/fruit), total soluble solids percentage and total sugars percentage in the two seasons of study.

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Table 5. Effect of different pollinators of date palm (M1, M2, M3 and M4) on total soluble solids, total sugars and tannins percentage of Zaghloul and Samany date fruit cv.

Female cv.	Zaghloul			Samany		
Parameters / Pollinators	Total soluble solids (TSS) (%)	Total sugars (%)	Tannins (%)	Total soluble solids (TSS) (%)	Total sugars (%)	Tannins (%)
M1	9.80	32.67	0.83	10.67	31.67	0.90
M2	5.37	16.00	1.43	6.80	18.67	1.43
M3	7.37	34.67	0.66	9.24	26.67	0.90
M4	9.17	38.00	0.56	10.00	36.33	0.70
LSD at level 5%	0.1419	5.039	0.3812	0.3756	5.003	0.3457

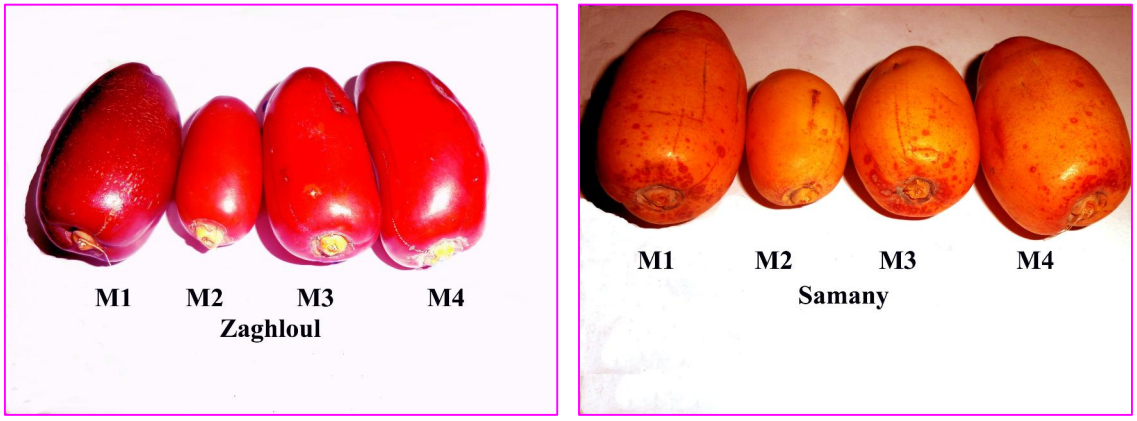

Figure 5. Effect of different pollinators (M1, M2, M3andM4) on physical characteristics fruit of Zaghloul and Samany cv.

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