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Effect of Pollen Source on Productivity of Medjool Date Palm Trees

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Abstract: This study was achieved during 2020 and 2021 seasons. The experiment was conducted at private farm located at Western desert rood, Malawi district, Minia Governorate (2400 km southern Cairo city) – Egypt. The target of this investigation was examining the effect of pollen grains source (Ghanami, Jarvis and Boyer pollinators *cvs.*) on fruit setting, fruit dropping, bunch weight and yield (kg/palm) of Medjool female date palm (*phoenix dactylifera L.*) grown in sandy soil, well drained water since water table depth is not less than two meters. In addition, the germination and viability of pollen grains of the pollinators were examined. The obtained results showed that, the germination and viability of pollen grains varied significantly in relation to temperature, conservation period and source of pollen grains. However, Ghanami pollen grains present superiority rather than those of Jarvis and Boyer. Using the pollen grains of Ghanami cultivar present the best bunch weigh (kg) and yield (kg/palm) rather than using the two other pollinators (Jarvis and Boyer). Furthermore, increasing the frequencies of pollination (from two to four times) has a significant effect on most studied traits.

Key words: Medjool date palm, pollen grains, metaxenia, fruit sett, fruit drop, yield.

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INTRODUCTION

The data palm tree (*phoenix dactylifera L.*) considered as one of the oldest fruit trees in the world. It is a dioecious fruit trees. So, male and female flowers being borne on separate trees. *phoenix dactylifera* classified as tropical or subtropical zone fruit. Addition to its commercial and nutritional value, date palm characterized by higher resistance to water stress, tolerates climate variables change, and tolerance of high salinity levels **(Zaid & Wet 2002; Hodel & Johnson 2007; Eshmawy, 2010 and Eshmawy, 2015).**

It is well known that date palm originated in the Arab's area and its cultivation is still intensive in Arabs region even today **(Eshmawy, 2015 and Al-Bakry, 2020)**. Egypt is one of the major countries in date palm cultivation and date production. For this reason, during the last ten years,

the cultivated area has decreased and the undesirable cultivars were replaced by other has good quality varieties required for foreign markets such Medjool *cv.* **(Egyptian ministry of agriculture 2022)**. Medjool cultivar is one of the most important international semi-dry varieties of date palms, which demand for foreign markets. It can grow successfully in warm climate conditions, so its cultivation intensive in middle Egypt region. Then, Medjool *cv.* considered as one of the main dates cultivars in Egypt.

Will the pollen grain source have an essential role on 'Medjool' fruit setting and tree production? This is what we will try to answer through the current study, which focuses on the effect of three pollen sources namely; Ghanami, Jarvis and Boyer *cvs.* as well as the frequencies of pollination on fruit sett and productivity of Medjool female palms, grown in sandy soil under El-Minia Governorate conditions.

MATERIAL AND METHODS

This study was conducted during 2020 and 2021 seasons on twenty-seven 'Medjool' date palms uniform in vigor, the palms were fifteen years, grown in private orchard located at Western desert rood, Mallawi district El-Minia Governorate – Egypt. Where, the orchard soil texture is sandy, well drained and the ground water depth not less than two meters. The farm was irrigated through drip irrigation system, using groundwater well water. Pruning was performed to maintain leaf / bunch ratio at 8:1. However, the number of female spathes per palm was adjusted to 10 spathes by removing excess bunches (earliest, latest and small bunches). The Pollination was achieved by inserting five male strands into the female bunch. To prevent pollens contamination or cross pollination, the bunch was bagged after inserting the mal strands by paper bags which were tied at the ends using a piece of cotton for aeration. The bags were shaken lightly to ensure pollen distribution and were removed after completed fruit setting (four weeks) according to **Hussein *et al.*, 1993** and **Dammas, 1998**. The selected Medjool female palms are subjected to regular horticulture practices commonly applied in Medjool orchard trees.

Soil characters

A composite sample of soil and irrigation water were collected and subjected to Physical and chemical analysis according to the procedures outlined by **Chapman & Partt (1961) and Wilde *et al.* (1985),** the obtained data are illustrated in Table (1).

Table (1). Physical and chemical analysis of orchard soil and irrigation water

Constituent	Value	Constituent	Value
Sand %	82.2	E.C (µS/cm)	853
Silt %	10.5	Hardness	17.6
Clay %	7.3	pH	7.31
Texture	Sandy	Ca (mg/L)	28.2
EC (1 : 2.5 extract) mmhos / cm / 25 C	2.5	Mg (mg/L)	20.3
Organic matter %	0.75	K (mg/L)	4.17
pH (1 : 2.5 extract)	7.63	Na (mg/L)	78.7
Active lime %	6% ($CaCO_3$)	Alkalinity (mg/L)	165
N (mg/kg)	173	Chlorides (mg/L)	119
Phosphorus (ppm)	19.8 ppm	Nitrate (mg/L)	9.1
Available K (meq/100g)	0.46	Sulphates (mg/L)	44.1

Experimental work

The present study was achieving in order to declare the effect of the source of pollen grains and frequency of pollination on female palms fruit sett and productivity of Medjool date palm. The investigation included the following nine treatments from three sources of pollen grains (Ghanami, Jarvis and Boyer pollinators *cvs.*) and three frequencies of pollinations (two, three and four times). Then, experiment included nine treatments were arranged as followed: Pollination two times with 'Ghanami' pollen grains, Pollination three times with 'Ghanami' pollen grains, Pollination four times with 'Ghanami' pollen grains, Pollination two times with "Jarvis" pollen grains, Pollination three times with 'Jarvis' pollen grains, Pollination four times with 'Jarvis' pollen grains, Pollination two times with 'Boyer' pollen grains, Pollination three times with 'Boyer' pollen grains, Pollination four times with 'Boyer' pollen grains. Treatments were arranged in a complete randomized block design (CRBD) according to **Snedecor, and Cochran (1990)**. Each treatment was replicated three times, one palm per each one.

Measurements and determination: The following characteristics were studied during the two experimental seasons (2020 and 2021).

1- Pollen grains germination and viability

Percentage of pollen germination was calculated for vitro germination of fresh or conserved pollen grains. It was estimated by culturing the pollens on a medium containing 1% agar, 8% sucrose and 100 mg/L boric acid. After 24 hours at room temperature (20:25 ℃) pollen grains were microscopically examined for germination (according to Furr and Enriquez, 1966). Microscopically determined was achieves by using acetocarmine pigment examination. Little quantity of pollen grains was placed on sugar solution (at 8 % sucrose) for four hours. Then, pollens were examined under compound microscope (Bx-51). However, colorless or unstained pollen grains were considered non-viable (according to **Al-Tahir and Asif, 1983**).

2- Fruit set %

Just after manual pollination, female bunches were packed with paper bags, piece of cotton was placed at the base of the bunch before tying them. The paper bags were removed at three weeks after pollination. Then, the number of fallen flowers and setting flowers were counted. Then, the percentage of fruit set was calculated.

3- Fruit drop %

At beginning of hababuk stage, the bunches were bagged with fine perforations paper bags. Every 20 days, the bags are opened and the fallen fruits were counted. Then, the total number of fallen fruits was counted. At harvest time the ripe fruits were counted for each bunch. Then, the number of total fruits, the number of fallen fruits, and the number of fruits retention on the strands were calculated. So, the percentage of fruit drop was calculated.

4- Bunch weight (kg) and Yield (Kg/palm)

Bunches of Medjool date palm were picked at the optimum commercial harvesting time under El-Minia Governorate region conditions (around mid-August). The weight of each bunch was taken and recorded. The yield (kg/palm) was recorded.

RESULTS AND DISCUSSION

1- pollen grains germination

Data illustrated in Table (2) shows the pollen grains germination of the three examined pollinators (Ghanami, Jarvis and Boyer) and the effect of effect of conservation temperature and conservation period on germination %. Data obtained from the microscopic scan declared that the germination of the three pollinator's pollen grains significantly varied according to the pollinator *cv.*, as well the conservation temperature and conservation period has a significant effect on the germination %, as shown in Table (2). It is clear that, Ghanami pollinator present superior germination % of fresh pollen grains rather than the two others pollinators (Jarvis and Boyer). The same table also, showed that the conservation temperature exerts a significant effect on the pollen grains germination %. However, conserved the pollen grains under room temperature caused a sharp and significant decrease in pollen germination %. Whereas, after 4 months of conservation in room temperature the germination of Ghanami pollen was 5%, however Jarvis and Boyer completely failed in germination. After 1 year at room temperature conservation all the three examined pollinators pollen grains completely failed to germination.

Ghanami pollen grains present highest and significant germination percentage rather than those of Jarvis and Boyer pollinators during the conservation under room temperature conditions. In the same contents, conservation of three pollinator's pollen grains at 4 ºC showed higher and significant germination percentages rather than those conserved under room temperature. The germination % of the three pollinator's pollen grains was parallel significantly decreased with increasing the conservation period. This decrement was low for Ghanami pollen grains and sharp for Jarvis and Boyer pollen grains. After one year on conservation at 4 ºC, the Ghanami pollen grains present higher % of germination (30%) rather than Jarvis (21%) and Boyer (20%).

The decrement in pollen grains germination as a result of increase the storage period or conservation temperature was also showed by others authors in different date palm pollinators. **Rahnama and Rahkhodaei (2014)** examined the properties of pollen grains of six pollinators namely; Ahmar, Akhzar, Fard, Khnizy, Maghool and confirmed that the period and temperature of conservation significantly affected the main properties of pollen grains. Microscopically scanned and examining of pollen grains of four male date palm pollinators widely distributed and uses in Egypt was studied by **Aly (2018)**. The author mentioned some important specific variation of morphological properties of pollen grains (i.e. pollen grain length and width), pore characteristics (i.e. length, numbers and dimension) as well as pollen germination and pollen viability, of the four examined pollinators.

Table (2). Effect of temperature and conservation period on pollen grains germination % of Ghanami, Jarvis and Boyer pollinators

Pollinators	Fresh pollens	1 month of conservation		2 month of conservation		3 month of conservation		4 month conservation		1 year conservation	
		Room °C	4 °C	Room °C	4 °C	Room °C	4 °C	Room °C	4 °C	Room °C	4 °C
Ghanami	83	57	84	34	77	21	66	5	51	0	30
Jarvis	77	49	70	22	63	12	57	0	46	0	21
Boyer	68	41	62	19	51	8	43	0	38	0	20
LSD at 5%	14	8	10	11	10	9	8	NS	10	NS	11

2- Pollen grains viability

Data concerning the effect of conservation period and conservation temperature on pollen grains viability of the three examined pollinators (Ghanami, Jarvis and Boyer pollinators *cvs*.) are shown in Table (3). it is obvious from the obtained data that, exposure the pollen grains to two level of temperature (room temperature "22 ± 2 ºC" and 4 C) during 1month, 2 months, 3 months, 4 months and 1 year has a significant effect on the percentage of pollen grains viability. It is clear that, the viability % was higher and satisfactory, may be higher than the stander % of the most famous pollinators *cvs*. Gradual and sharp decrement of pollen viability was showed, as a result of increasing the conservation period. This decrement was raped and sharp in the case of conservation under room temperature conditions (22 ± 2 ºC) rather than those conserved in refrigerator at 4 ºC. Whereas, Jarvis and Boyer the pollen grains of conserved at room temperature completely loss the viability after 4 months of conservation. However, of Ghanami pollen grains present negligible an in-significant viability at the fourth month of room temperature conservation. While, pollen grains conservation at 4 ºC present significantly higher viability % rather than those conserved at room temperature, this data was true in all conservation periods. This may be led us to confirm that, the temperature of pollen grains conservation plays a main and important role on its viability. Regarding the duration of conservation period, during the conservation period from time 0 (fresh pollen grains) to one year of conservation, a significant decrement in the pollen grains viability was observed in the three pollinators pollen grains. This decrement was slow in Ghanami pollen grains and sharp in of Jarvis and Boyer pollen grains. It is clear from the obtained data that Ghanami pollen grains present higher and significant pollen grains viability rather than Jarvis and Boyer pollen grains, waterier the temperature of conservation or the duration period of conservation, except the case of conservation under room temperature for 4 months or one year. Contrary, the lowest percentage of pollen grains viability was obtained from Boyer pollinator.

The effect of conservation temperature and duration period of storage on viability of pollen grains of date palms may be attributed to a decrease in the protoplasm vitality and moisture concentration. **Rahnama and Rahkhodaei (2014)** examined the properties of pollen grains of six pollinators (Ahmar, Akhzar, Fard, Khnizy, Mejedol and Maghool) and confirmed that the period and temperature of conservation significantly affected the viability of the six pollinator's pollen grains. Furthermore, **Aly (2018)** through a microscopically scanned and examining of pollen grains of four male date palm pollinators widely distributed and uses in Egypt confirmed that some important specific variation of morphological properties of pollen grains such as germination and pollen viability.

Table (3). Effect of temperature and conservation period on pollen grains germination % of Ghanami, Jarvis and Boyer pollinators

Pollinators	Fresh pollens	1 month of conservation		2 month of conservation		3 month of conservation		4 month conservation		1 year conservation	
		Roo m ºC	4 ºC	Roo m ºC	4 ºC	Roo m ºC	4 ºC	Roo m ºC	4 ºC	Roo m ºC	4 ºC
Ghanami	98	58	89	38	79	21	73	5	49	0	40
Jarvis	90	49	80	29	71	13	68	0	41	0	33
Boyer	81	42	73	22	64	14	60	0	39	0	21
LSD at 5%	4	12	6	6	8	NS	6	NS	9	NS	7

3- Effect of pollen grain source on fruit setting and fruit dropped

The results pertaining to the effect of pollen grains source (Ghanami, Jarvis and Boyer pollinators) and frequencies of pollination (two, three and four times) on "Medjool" female date palm fruit setting and fruit dropped are presented in Table (4). The perusal of data reveals that, pollen grains source play an important role of fruit sett %. Whereas, the females of "Medjool" date palm pollinated with Ghanami pollen grains present a remarkable and significant superiority of fruit setting % rather than those pollenated with Jarvis or Boyer pollen grains. This data was true during the two experimental seasons. Furthermore, the data shows that, regardless the source of pollen grains, increasing the number of pollination frequencies (two, three and four times) significantly increase the percentage of fruit setting. However, the Medjool female's palms pollinated four times present the highest percentage of fruit setting, during the two experimental seasons. While, non-significant differences were observed between the palms pollenated three and four times. Contrary, the Medjool female palms pollinated two times present the lowest percentage of fruit set, whatever the pollinator used. Data illustrated in Table (4) shows the effect of pollen grains source (Ghanami, Jarvis and Boyer pollinators) and frequencies of pollinations (two, three and four times) on percentage of dropped fruit % of female "Medjool" date palm.

The obtained data, during the two experimental seasons displayed that, regardless the frequencies of pollination achieved, using Ghanami pollen grains significantly decreased the percentage of fruit propped of Medjool date palm rather than those pollinated with the two other pollinators (Jarvis and Boyer pollinators). It is clear that increasing the frequencies of pollination from two to four times significant decreased the fruit drop % in both experimental seasons. However, non-significant differences were observed between three and four frequencies of pollinations, neither in the first nor in the second season. Pollenated "Medjool" female date palm four times with Ghanami pollen grains present the lowest fruit drop %. While, those pollenated two times with Boyer pollen grains presented the highest percentage of fruit dropping, during the two experimental seasons respectively.

The Influence of pollen sources on fruit set and fruit drop were confirmed on "Barhi" *cv.* by **Rezazadeh *et al.* (2013),** when they examined 10 local pollinators and 2 internationally pollinators, the authors confirmed that the palms pollenated with M10 present the highest fruit set %, lowest fruit drop % and highest remarkable yield rather than the others pollinators, while, those pollenated with Jervis No.1 present the lowest fruit sett %. In the same context, **Rahnama and Rahkhodaei (2014)** studied the effects of pollinator type (Ghaname, Vardy, and Samesmave) and pollination time on fruit set and fruit drop. The authors confirmed that, varying the source of pollen grains significantly varied fruit sett% and yield (kg/tree). Furthermore, in Mexico **Torres *et al.* (2017)** examined the effect of four pollinators (Medjool, Zahidi, Khadrawy, and Deglet Noor *cvs.*) on fruit set and fruit quality parameters of "Mejdol", the authors found that fruit set % of "Mejdol" female palms significantly influenced by the source of pollen grains. Similar findings were observed by **Awad (2007)** on tissue culture-derived date palm *cv.* 'Nabt Saif, using five pollinators (Ahmar, Akhdar, Fard, Khenizy, Maghool and Sugar palm) *cvs.*, under United Arab Emirates. **Iqbal *et al.* (2011)** on 'Dhakki' date palm examined nine different local sources pollen grains on fruit setting and fruit drop percentages.

4- Effect of pollen grain source on bunch weight (kg)

Data illustrated in Table (5) shows the effect of different sources of pollen grains (Ghanami, Jarvis and Boyer *cvs.*) and frequencies of pollination (two, three and four times) on the bunch weight of 'Medjool' date palm during 2020 and 2021 seasons. It is clear from the obtained data that varying the

source of pollen grains significantly was followed by varied the average bunch weight (kg) of 'Medjool' female palms. Whereas, those pollenated with 'Ghanami' present superiority in average bunch weight (kg) than those pollenated with 'Jarvis' or 'Boyer' pollinators. This enhancing of bunch weight was significantly related to the frequencies of pollination. However, regardless the pollinator, pollenated 'Medjool' female palms four times present the highest bunch weight rather than two or three times. Furthermore, the 'Medjool' palms pollenated four times with 'Ghanami' pollen grains present the highest bunch weight (6.3 and 6.4 kg), contrary those pollenated two times with 'Boyer' pollen grains present the lowest bunch weigh (4.3 and 4.4 kg), during the two experimental seasons respectively.

Table (4). Effect of pollen grains source (Ghanami, Jarvis and Boyer cvs.) on fruit setting % and fruit drop % of Medjool date palm, during 2020 and 2021 seasons

Treatments		Fruit set %		Fruit drop %	
Pollinators	Frequency	2020	2021	2020	2021
Ghanami	2 time	54	52	40	38
	3 times	66	66	37	32
	4 times	69	70	30	30
Jarvis	2 time	49	50	48	43
	3 times	53	57	41	42
	4 times	57	60	40	39
Boyer	2 time	49	46	59	57
	3 times	55	56	47	45
	4 times	58	59	46	44
New LSD at 5 %		5	4	6	5

5- Effect of pollen grain source on yield (kg/palm)

Data concerning the effect of pollen grains source (Ghanami, Jarvis and Boyer pollinators *cvs.*) and frequencies of pollination (two, three and four times) on the yield (kg/palms) of 'Medjool' date palms, grown in sandy soil under El-Minia Governorate conditions, are presented in Table (5). It is noticed from these data that using the pollen grains of 'Ghanami' in pollination of Medjool female date palms was significantly accompanied with improving yield (kg/palm) relative to using the other two pollinator's pollen grains. Furthermore, the yield of 'Medjool' date palms significantly promoted as a result of increasing the frequencies of pollination from two to four times, these findings was true during the two experimental seasons. It is obvious that subjected 'Medjool' female palms to three sources of pollen grains (Ghanami, Jarvis and Boyer pollinators) as well as frequencies of pollinations (two, three and four times) was significantly accompanied with varying yield yield/tree (kg). 'Medjool' date palms pollenated four times with 'Ghanami' pollen grains present the highest yield (kg/palm), contrary those pollenated with 'Boyer' pollen grains two times present the lowest yield (kg/palm). However, those pollenated with Jarvis pollinator present the intermediate values.

The obtained results, concerning the effect of pollen grain sources on average bunch weight (kg) and yield/palm, are in harmony with those obtained by **Al-Wusaibai *et al.* (2012)** on Khalas and Sheshi *cv.*, **Rahnama and Rahkhodaei (2014)** and **Torres *et al.* (2017)** on 'Medjool' date palm, **Mohammadi**

***et al.* (2017)** on 'Barhi' date palm, **Aubied and Hamzah (2019)** on 'Sultani' date palm and **Kadri *et al.* (2022)** on 'Deglet Nour' date palm. This significant varying in bunch weigh (kg) and yield/palm in relation to varying the pollen grains source may be explained by increasing in fruit set % and decreasing the fruit drop %. In this regard, we can confirm that, the pollen grains source had a fundamental role in productivity of 'Medjool' date palms.

Table (5). Effect of pollen grain source on average bunch weight (g) and yield (kg/palm) of Medjool date palm, during 2020 and 2021 seasons

Treatments		bunch weight (kg)		yield (kg/palm)	
Pollinators	Frequency	2020	2021	2020	2021
Ghanami	2 time	5.2	5.2	52.0	52.0
	3 times	5.9	6.0	59.0	60.0
	4 times	6.3	6.4	63.0	64.0
Jarvis	2 time	4.8	4.7	48.0	47.0
	3 times	5.1	5.2	51.0	52.0
	4 times	5.6	5.8	56.0	58.0
Boyer	2 time	4.3	4.4	43.0	44.0
	3 times	4.8	4.9	48.0	49.0
	4 times	5.0	5.1	50.0	51.0
New LSD at 5 %		0.7	0.8	2.1	2.2

Conclusion: under the present study and resembling conditions, which focused on the role of three pollen grains sources (Ghanami, Jarvis and Boyer *cvs.*) on productivity and fruit quality of 'Medjool' female palms. The obtained data showed that, the germination and viability of pollen varied significantly in relation to temperature, conservation period and source of pollen grains. Using the pollen grains of Ghanami cultivar present the best bunch weigh (kg) and yield (kg/palm) rather than using the two other pollinators (Jarvis and Boyer). Increasing the frequencies of pollination (from two to four times) has a significant effect on most studied traits. However, non-significant differences were observed between three and four times of pollination.

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