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Comparative Study of The Physico-Chemical Properties between Some Pollinizers for "Bartamoda" Dates in Aswan Governorate

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Abstract

This study was carried out during the 2020 and 2021 seasons to select and evaluate some male date palm trees for pollinating "Bartamoda" cultivar in Aswan governorate, Egypt. For this purpose, twenty-three different Maghal date palm male types, which are grown in Aswan governorate, were chosen to evaluate and recommend the best to be used as a pollinizer for "Bartamoda" date palm cultivar. Pollen grains from each male type were used as a pollinizer to test the impact of each male type on fruit set and fruit quality. Data showed that Male 22 had higher values for the initial fruit set percentage, retained fruit percentage, fruit weight, flesh weight, fruit length, fruit diameter, total soluble solids, total sugars, reducing sugars and non-reducing sugars, and lower values for seed weight, seed length, seed diameter, and pH value of "Bartamoda" date palm fruits compared to the other males grown in the rest of the locations under study in Aswan governorate.

Keywords: Date palm; (*Phoenix dactylifera* L.); "Bartamoda"; male types; pollinizers; fruit set; fruit quality.

1. Introduction

The date palm (*Phoenix dactylifera* L.) is one of the oldest cultivated fruit trees in the world [1], belongs to the family Arecaceae, and can live for over 100 years [2]. It has been cultivated in the Middle East and North Africa for over 5,000 years [3]. The date palm is one of the most important treasures in the Arab Republic of Egypt. Its food value has been known for centuries in the oases and other agricultural areas of Egypt. Therefore, Egypt is ranked first among some of the date-generating international regions all over the world. Despite producing more than 1.7 million tons of dates [4], Egypt ranks poorly in terms of exports to the global date market. The strategy seeks to increase exports from 38,000 tons in 2016 to 120.000 tons over five years [5].

Date palms develop in a very hot and dry climate. These trees require a long, extremely hot summer with little rain and very little humidity, especially from pollination through harvest, to yield a significant crop [3]. The ideal temperature for date palm growth is between 25 and 32 °C; for flowering, a temperature above 18 °C is required; and for fruit ripening, a temperature above 25 °C is required [6]. Aswan governorate has one of the hottest climates in Egypt and is ideal for the cultivation and expansion of date palms. Aswan is located at 24°5′11″N and 32°56′27″E latitude. The most important dry date varieties in Egypt are Bartamoda, Sakouti, Gondaila, Gargoda, and Shamia. These varieties are grown well in Aswan and Qena Governorates, where the heat requirements are met for these varieties. The date tree is a dioecious plant; it has both female and male flowers that are very similar to each other [7]. In a dioecious plant, pollen grains transportation from male to female flowers promotes seed formation; hence the direction of the pollinizer is a crucial factor [8]. The size and shape of the seeds are affected by the Xenia effect depending

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on the pollen grains source. Pollen grains can also have a Metaxenia effect, influencing the tissue outside the embryo and endosperm of date palms [9,10].

Therefore, the pollen grains source is a second crucial factor in determining the quality of date palm fruit. The pollination process of date palms is considered the most important horticultural practice in date palm orchards for maximizing profits and improving fruit quality. The traditional method of pollination involves placing seven to ten male strands inside each female spathe once it opens [11]. One male tree can pollinate fifty female trees. The female date flower typically has three carpels, but only one develops normally into the fruit after efficient pollination; the other two dropped [12]. Variations in pollen grains quality exist amongst male palm trees [13,14,15,16]. Therefore, choosing superior males for crossing and breeding is crucial for increasing yield and improving the quality of the product [17]. In most countries that grow date palms, including Egypt, growers used to pollinate female palms with pollen grains from male trees. These males exhibit substantial variability in terms of growth, vigor, blooming period, spathe features, and pollen grains quality [18,19]. As a result, there is a direct effect on the yield and fruit quality of the palms. Many investigators have concluded that different pollen grains sources have a direct effect on fruit set, fruit quality, and the time of fruit ripening on several date cultivars [16,20,21]. In addition, they noted that the impact varied depending on the male parent utilized to pollinate female palm trees [21].

To conclude, the main goal of this study is to find the best male palm trees to pollinate the female "Bartamoda" date palm cultivar.

2. Materials and Methods

This study was carried out during two successive seasons, 2020 and 2021, in Aswan Governorate, Egypt. Twenty-three male palm trees, healthy and nearly as uniform in vigor as possible, were selected (Table 1). All trees were subjected to the same cultural practices commonly adopted in the orchard. The mature male spathes were cut off from each of the selected twenty-three male types. Also, "Bartamoda" date palm cultivar is grown in El-alfeya region (24°02′46″N:33°04′00″E), Aswan Governorate, uniform in vigor, was carefully selected as being representative of date palm cultivars in Aswan. Pollen grains from the twenty-three males were collected in the morning to pollinate the female one. Mature male inflorescences were cut immediately after the breaking of the spathe and kept in paper bags, and later transferred to a shaded and moisture-free area for drying. Spathe was removed carefully, and bunches were spread over clean paper and frequently changed from paper to paper to avoid moisture logging. After one day of drying, the strands were separated out from the rachis and again spread over clean paper for further drying.

To avoid any possible mixing of pollen grains, each sample was dried separately [22]. The pollen grains were separated from the strands using a sieve, and then transferred to stoppered bottles and stored in a dry place at room temperature. A total of 69 females of "Bartamoda" cultivars were chosen for the pollination process with 9 spathes on each one. All selected date palms were grown in sandy soil, planted 8×8 meters apart, irrigated by the drip irrigation system, and received normal cultural practices. Each of the three female "Bartamoda" palms was pollinated directly after spathe cracking with one of the twenty-three male types since each female palm was treated as a replicate. Hand pollination was done by dusting the dry pollen grains, and then they were placed within the strands of the female spathe. Each spathe was pollinated with an equal amount of pollen grains. After pollination, the female spathes were covered with perforated paper bags to prevent any contamination with foreign pollen grains. The bags were carefully tied around the end of the spathe and then shaken gently to insure the spread of pollen grains among the female flowers. After two weeks, the bags were removed, and the following characteristics were measured to evaluate which male could be recommended to be used as a pollinizer for "Bartamoda" date palm cultivar.

2.1. Fruit set percentage (%)

2.1.1. Initial fruit set (%)

Fruit set number was counted using 10 strands of each bunch per replicate after thirty days from pollination. The average percentage of the initial fruit set per treatment was calculated according to Hafez *et al*. [21] using the following equation:

Initial fruit set (%) = (No. of set fruit per strand / No. of set fruit + No. of flower scars) ×100.

Table 1: List of date palm pollinizers and their localities.

Pollinizers	Site in Aswan	Geographic location
Male 1	El Alfeya	24°02′46″N: 33°04′00″E
Male 2	El Eman	24°05′19″N: 32°53′20″E
Male 3	Antar	24°05′19″N: 32°53′20″E
Male 4	Hager El Arab	24°05′16″N: 32°54′45″E
Male 5	El Aqula	24°05′19″N: 32°53′20″E
Male 6	El Qarah	24°05′18″N: 32°53′20″E
Male 7	Kom Mir	24°12′29″N: 32°38′10″E
Male 8	El Masry	24°05′38″N: 32°54′03″E
Male 9	El Kharaza	24°05′02″N: 32°53′37″E
Male 10	El Awadly	24°05′21″N: 32°53′44″E
Male 11	El Bosaileya	24°04′58″N: 32°54′15″E
Male 12	Kelh El Gabal	24°06′06″N: 32°53′20″E
Male 13	El Ramady	24°06′21″N: 32°53′05″E
Male 14	Abou El Rish	24°06′22″N: 32°53′59″E
Male 15	El Mansoureya	24°05′16″N: 32°53′32″E
Male 16	El Gaafrah	24°05′43″N: 32°52′14″E
Male 17	Baharef	24°05′34″N: 32°54′04″E
Male 18	Daraw	24°24′13″N:32°55′53″E
Male 19	Ballanah	24°21′13″N: 32°56′51″E
Male 20	El Mafalsa	24°04′48″N: 32°53′37″E
Male 21	Hager Edfou	24°58′41″N: 32°52′28″E
Male 22	El Qarah	24°05′18″N: 32°53′20″E
Male 23	El Sheikh Amer	24°05′23″N: 32°52′48″E

2.1.2. Retained fruits (%)

At the harvest stage (Tamr stage), the number of nods and retained fruits in fifteen strands per treatment were counted. The percentage of the retained fruits was calculated according to Hafez *et al*. [21] using the following formula:

number of retained fruits (%) = (No. of retained fruits /No. of retained fruits + No. of flower scars) ×100.

2.2. Physical properties of fruits and seeds

After configuring the fruits, their physical and chemical properties were studied. All spathes were harvested at Tamr stage in the middle of October in both seasons. Fruits were transported to The Central Laboratory of Date Palm Researches and Development, Agricultural Research Center, Giza, Egypt. Fifty fruits were randomly chosen from each replicate of each treatment, then washed, air dried, and placed into plastic baskets. Physical properties of fruits and seeds were evaluated including fruit weight (g), fruit length (cm), fruit diameter (cm), fruit volume (cm^3), fruit flesh weight (g), seed weight (g), seed length (cm), and seed diameter (cm). Using a vernier caliper, the length and width of the fruit were measured in centimeters. The weight of the fruit, flesh, and seeds was measured in grams using an electronic balance. The volume of the fruit was measured by water displacement procedures (cm^3).

2.3. Chemical properties of fruits

2.3.1. Total soluble solids in (ºBrix)

Total soluble solids were determined in date palm fruit juice using a digital refractometer (Model PR-32, Atago, Japan) by squeezing the juice.

2.3.2. pH value

The pH value of a fruit juice sample was measured by using a pH meter according to A.O.A.C. [23].

2.3.3. Total, reducing, and non-reducing sugars

Total sugars (mg/100 g FW) and reducing sugars (mg/100 g FW) were determined according to A.O.A.C. [23], and non-reducing sugars were estimated by difference using the formula:

Non-reducing sugar (mg/100 g FW) = total sugars – reducing sugars

2.4. Statistical analysis

All data were statistically analyzed as a completely randomized design with three replicates per treatment, by analysis of variance (ANOVA) using the statistical program SPSS, and significance between means was differentiated using L.S.D. value at a significance level of 5% according to Snedecor and Cochran [24].

3. Results and Discussion

3.1. Effect of different pollinizers on fruit physical properties

3.1.1. Initial fruit set and retained fruits (%)

The obtained data showed that there are significant differences in the initial set and retained fruits of "Bartamoda" date palm cultivar in both studied seasons, as shown in Table (2). Pollinizer No. 22 gave the highest significant values of the initial set and retained fruits in both studied seasons, as compared with the other pollinizers. On the other hand, pollinizer No. 5 gave the lowest values of the initial set and retained fruits in both studied seasons.

3.1.2. Fruit weight, length, and diameter

In this regard, some fruit physical properties, i.e., fruit weight, length, and diameter, were evaluated for "Bartamoda" cultivar in response to different twenty-three pollinizers during 2020 and 2021 seasons as presented in Table (3). It was clearly noticed that fruit

properties were significantly affected by different pollinizers in both study seasons.

Pollinizer No. 22 recorded the highest fruit weight, fruit length, and fruit diameter, while the lowest fruit weight, fruit length, and fruit diameter were recorded with pollinizer No. 5 in the two seasons.

3.1.3. Fruit volume, flesh weight, seed weight and length

In contrast, pollinizer No. 5 recorded the lowest fruit volume and flesh weight in both studied seasons.

Table 2: Effect of different pollinizers on the initial fruit set (%) and retained fruits (%) of "Bartamoda" during 2020 and 2021 seasons.

Pollinizers	Initial fruit set (%)		Retained fruits (%)	
	2020	2021	2020	2021
Male 1	64.00	65.00	58.33	59.00
Male 2	65.00	66.33	59.66	60.66
Male 3	64.33	65.33	58.00	58.33
Male 4	59.00	60.66	55.00	56.66
Male 5	55.00	56.00	51.00	51.33
Male 6	80.00	81.66	75.66	76.33
Male 7	69.66	71.33	65.33	67.00
Male 8	71.00	72.33	66.00	67.00
Male 9	58.00	59.33	55.33	56.00
Male 10	68.33	70.33	63.33	64.33
Male 11	72.00	73.66	69.00	70.66
Male 12	62.00	63.33	57.33	58.66
Male 13	76.33	77.66	71.33	72.33
Male 14	63.00	64.33	58.66	59.66
Male 15	75.66	77.33	71.33	73.00
Male 16	74.66	76.33	70.66	72.00
Male 17	60.33	62.33	55.66	56.33
Male 18	74.66	75.33	69.33	71.00
Male 19	73.33	74.66	67.33	68.33
Male 20	77.33	78.33	73.33	73.66
Male 21	78.00	79.66	72.66	74.66
Male 22	82.33	85.00	77.00	78.66
Male 23	79.33	81.33	73.33	76.66
L.S.D	0.66	0.71	1.90	1.99

In addition, the data on seed weight indicated that pollinizer No. 6 gave the lowest seed weight in the first and second seasons. Regarding seed length, the values differed slightly between each other for all studied pollinizers, ranging from 2.15 cm with pollinizer No. 15 to 3.39 cm with pollinizer No. 23 in the first season. The same trend was observed in the second season.

Concerning seed diameter, pollinizer No. 5 recorded the highest seed diameter in both seasons (0.85 and 0.97 cm, respectively).

Table 3: Effect of different pollinizers on fruit weight, length, and diameter of "Bartamoda" cultivar during 2020 and 2021 seasons.

Pollinizers	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)	
	2020	2021	2020	2021	2020	2021
Male 1	10.12	11.08	4.42	4.98	2.38	2.43
Male 2	10.40	11.43	4.60	5.03	2.43	2.53
Male 3	10.30	11.36	4.51	5.00	2.40	2.50
Male 4	9.43	10.27	4.21	4.69	2.24	2.34
Male 5	9.05	10.12	4.03	4.49	2.11	2.23
Male 6	13.02	14.05	5.72	6.21	3.10	3.21
Male 7	10.53	11.61	4.71	5.11	2.59	2.58
Male 8	10.62	11.76	4.81	5.20	2.69	2.76
Male 9	9.33	10.60	4.12	4.59	2.21	2.46
Male 10	10.42	11.35	4.62	5.10	2.56	2.54
Male 11	10.81	11.79	4.93	5.29	2.70	2.75
Male 12	9.88	10.74	4.38	4.82	2.31	2.53
Male 13	11.76	12.63	5.24	5.89	2.91	2.86
Male 14	10.04	11.09	4.40	4.92	2.36	2.64
Male 15	11.63	12.73	5.21	5.81	2.90	2.80
Male 16	11.31	12.34	5.17	5.74	2.86	2.98
Male 17	9.58	10.63	4.32	4.74	2.28	2.36
Male 18	11.11	12.06	5.11	5.62	2.83	2.94
Male 19	11.00	12.02	5.00	5.41	2.75	2.83
Male 20	11.94	12.91	5.31	5.93	2.95	3.11
Male 21	12.30	13.27	5.61	6.13	3.00	3.20
Male 22	13.30	14.44	5.98	6.49	3.10	3.24
Male 23	12.96	13.83	5.51	6.03	2.97	3.17
L.S.D	0.08	0.21	0.02	0.03	0.24	0.29

3.1.4. Effect of different pollinizers on fruit chemical properties

The obtained results in Table (5) indicate that the total soluble solids in (ºBrix); pH; total, reducing, and non-reducing sugars mg/100g FW were significantly differed by different male pollinizers for "Bartamoda" cultivar in both seasons. Pollinizer No. 22 gave the highest values of total soluble solids (75.42 and 76.91, respectively); pollinizer No. 7 gave the highest values of pH value in both seasons (5.71 and 5.64, respectively); the highest values of total sugars (58.31 and 60.64 mg/100g FW, respectively); reducing sugars (20.18 and 21.18 mg/100g FW, respectively), and non- reducing sugars (38.13 and 39.46 mg/100g FW, respectively).

Table 4: Effect of different pollinizers on some physical characteristics of "Bartamoda" date palm fruit during 2020 and 2021 seasons.

[a]FV = Fruit volume; [b]FW = Flesh weight; [c]SW= Seed weight; [d]SL = Seed length; [e]SD = Seed diameter.

Pollinizers	FV (cm^3)[a]		FW (g)[b]		SW (g)[c]		SL (cm)[d]		SD (cm)[e]	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Male 1	12.91	13.83	8.32	9.22	1.81	1.87	3.12	3.20	0.62	0.64
Male 2	13.26	14.28	8.98	9.80	1.42	1.62	3.22	3.29	0.64	0.73
Male 3	13.01	14.20	8.62	9.48	1.69	1.88	3.15	3.23	0.60	0.69
Male 4	12.10	13.13	7.86	8.53	1.57	1.74	2.35	2.64	0.65	0.76
Male 5	11.77	12.96	7.22	8.17	1.83	1.95	3.21	3.43	0.85	0.97
Male 6	16.04	17.81	11.63	12.57	1.39	1.48	3.15	3.35	0.70	0.83
Male 7	13.99	14.38	8.97	9.87	1.56	1.74	2.66	2.70	0.69	0.86
Male 8	14.01	15.03	8.79	9.84	1.83	1.91	3.20	3.46	0.56	0.63
Male 9	12.02	13.13	7.59	8.78	1.74	1.82	3.24	3.45	0.58	0.71
Male10	13.82	14.84	8.78	9.60	1.63	1.75	2.84	2.91	0.64	0.71
Male 11	14.32	15.41	9.26	10.13	1.55	1.66	2.71	2.94	0.59	0.63
Male 12	12.57	13.78	8.12	8.90	1.76	1.84	3.14	3.25	0.57	0.65
Male 13	15.04	16.13	9.99	10.77	1.77	1.87	2.63	2.83	0.62	0.68
Male 14	12.67	13.73	8.21	9.16	1.83	1.93	3.21	3.35	0.58	0.62
Male 15	15.00	16.03	9.80	10.81	1.83	1.92	2.15	2.27	0.52	0.63
Male 16	14.94	15.97	9.48	10.39	1.83	1.94	3.22	3.43	0.57	0.63
Male 17	12.35	13.45	7.79	8.72	1.79	1.91	2.22	2.39	0.62	0.72
Male 18	14.81	15.62	9.36	10.22	1.75	1.84	2.16	2.37	0.47	0.53
Male 19	14.62	15.23	9.27	10.19	1.73	1.83	3.15	3.35	0.43	0.52
Male 20	15.08	16.35	10.30	11.19	1.64	1.75	2.73	2.93	0.45	0.53
Male 21	15.05	16.14	10.68	11.53	1.63	1.74	3.13	3.25	0.55	0.73
Male 22	16.13	17.24	11.63	12.61	1.67	1.75	3.31	3.49	0.63	0.74
Male 23	15.14	16.18	11.42	12.08	1.54	1.75	3.39	3.66	0.64	0.81
L.S.D	2.08	2.86	0.14	0.20	0.11	0.14	0.07	0.10	0.09	0.04

On the other hand, pollinizer No. 6 gave the lowest values of pH value (5.36 and 5.25, respectively); total sugars (43.16 and 44.53 mg/100g FW, respectively); reducing sugars (15.36 and 16.10 mg/100g FW, respectively); non-reducing sugars (27.80 and 28.43 mg/100g FW, respectively); and the lowest significant values of total soluble solids in (ºBrix) in both seasons (59.10 and 60.11, respectively). The results of this study are consistent with those made by Nasr *et al*. [25]; Osman and Soliman [26]; Mohamed [27]; Diab [28]; Abo-Rekab *et al*. [29], who reported that the type of pollen grains used for date palm pollination had varying degrees of effects on fruit set, yield, and quality. Also, our findings are in accordance with those made by El-Salhy *et al*. [30] on the Zaghloul and Samany date palm cultivars under Assiut environmental conditions, Al-Hamoudi *et al*. [13] on Barhi date palm cultivar under Gharbia Governorate conditions, Abo-Rekab *et al*. [19] on Seewy and Barhee palm at Tamiya District, Fayoum Governorate, Merwad *et al*. [31] on Hayany cultivar under El-Badrashin district, Giza governorate conditions, Omaima *et al*. [32] on Samany cultivar under Abo-Rawash region, Giza governorate circumstances, and Islam [16] on Zaghloul and Samany cultivars under El-Kanater El- Khayreia, Qalyubia Governorate environmental conditions. The results of all studies confirmed that pollen grains sources influence the physical and chemical qualities of date palm fruits.

4. Conclusions

In this study, the effectiveness of 23 male pollinizers hand-picked from Aswan governorate on the productivity and fruit quality of "Bartamoda" date palm cultivar was evaluated. Compared to the primary pollinizer on the farm, pollinizer No. 22 had practically the greatest values for morphological, physical, and chemical properties.

Promising pollinizers are recommended to be employed or incorporated into upcoming breeding strategies.

Table 5. Effect of different pollinizers on some chemical characteristics of "Bartamoda" date palm fruit during 2020 and 2021 seasons.

[a]TSS = Total soluble solids; [b]TS = Total sugars; [c]RS = Reducing sugars; [d]NRS = Non-reducing sugars..

Pollinizers	TSS[a] (˚Brix)		pH value		TS[b] (mg/100 g FW)		RS[c] (mg/100 g FW)		NRS[d] (mg/100 g FW)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Male 1	66.32	67.17	5.64	5.51	50.26	51.64	17.27	17.76	32.99	33.88
Male 2	68.26	69.52	5.51	5.41	51.24	52.03	17.87	18.05	33.37	33.98
Male 3	67.65	68.48	5.42	5.31	50.82	51.23	17.74	18.00	33.08	33.23
Male 4	62.65	63.21	5.41	5.37	47.20	48.51	16.80	17.00	30.40	31.51
Male 5	59.10	60.11	5.66	5.53	43.16	44.53	15.36	16.10	27.80	28.43
Male 6	75.11	76.67	5.36	5.25	57.52	58.21	20.09	20.40	37.42	37.81
Male 7	70.21	71.33	5.71	5.64	52.62	53.23	18.07	18.23	34.54	35.00
Male 8	71.04	72.28	5.56	5.40	53.63	54.81	18.13	18.72	35.50	36.09
Male 9	61.19	62.28	5.57	5.41	46.17	47.24	16.21	16.85	29.96	30.39
Male10	69.27	70.36	5.55	5.50	51.23	52.18	18.01	18.16	33.22	34.02
Male 11	73.05	74.14	5.51	5.41	54.05	55.07	18.35	18.95	35.70	36.12
Male 12	64.21	66.31	5.50	5.48	49.71	50.22	17.07	17.32	32.64	32.91
Male 13	73.28	74.14	5.45	5.41	55.87	56.58	19.51	20.04	36.35	36.54
Male 14	65.91	66.31	5.52	5.32	50.06	51.23	17.21	17.68	32.85	33.55
Male 15	73.06	74.17	5.48	5.31	55.29	56.72	19.48	19.91	35.81	36.81
Male 16	71.65	72.83	5.41	5.39	54.61	55.61	19.12	19.82	35.50	35.79
Male 17	63.14	64.17	5.53	5.36	48.24	49.24	16.94	17.10	31.30	32.14
Male 18	71.11	72.65	5.53	5.31	54.34	55.50	18.85	19.16	35.49	36.35
Male 19	70.32	71.29	5.64	5.28	54.11	55.20	18.65	19.09	35.46	36.12
Male 20	74.23	75.01	5.60	5.48	56.30	57.02	19.73	20.11	36.58	36.91
Male 21	74.61	75.17	5.63	5.29	56.61	57.21	19.89	20.18	36.73	37.03
Male 22	75.42	76.91	5.41	5.34	58.31	60.64	20.18	21.18	38.13	39.46
Male 23	75.02	76.32	5.52	5.42	57.11	58.04	20.01	20.83	37.09	37.21
L.S.D	0.18	0.17	0.07	0.03	0.14	0.10	0.07	0.05	0.17	0.11

5. Conflicts of interest

The author declares there is no conflict of interest.

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