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Effect of Pollination and Thinning Treatments on Fruiting of Some Date Palm Cultivars under New Valley Conditions

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Abstract

Pollination and thinning are considered among the important basic procedures for Madjool, Segae, and Khodry palms in terms of their effect on yield and fruit quality, in addition, regularizing the annual production of the date palm. The development of pollination technology, which leads to an acceptable level of fruits with the use of a small amount of pollen as well as economic thinning methods are necessary to improve the productivity of date palms, especially in dry conditions. This examination was carried out on Madjool, Segae, and Khodry date palms for the progressive seasons 2020 and 2021 in Dakhla Oasis, New Valley Governorate, Egypt.

Pollination with 0.5 and 1.0 g of pollen grains supplemented with 100 gm sugar/L water as well as fruit thinning by removing 10, 20, 30, and 40% of fruit /spathe were done. The results showed that the use of pollen suspension at 0.5 g + 10% sugar solution as well as fruit thinning at 20 or 30% had a decrement percentage of bunch weight by about 5.65, 8.44 and 13.01 % over the control, as an average of the two studied seasons, respectively. The highest fruit weight (18.60, 19.48, and 20.87 g) were obtained from spraying the pollen suspension solution as well as removing 20 and 30% of the fruits, which resulted in an increment percentage of 20.00, 25.68 and 34.65% over the control, respectively. Similarly, using pollen suspension and removing 20 or 30% of the fruits gave the highest percentages of TSS and sugar, while control gave the lowest percentage. It can be concluded that pollination with pollen grains at 0.5 g added to 100 gm sugar/L water or removing 30% of setting fruit produced a good crop with high fruit quality.

Keywords: Pollination, Fruit thinning, Yield, Fruit quality, Date palm, New Valley.

Introduction

Date palm is a major fruit crop in the dry regions of North Africa and the Middle East and has an important impact on the economy of many countries in these regions.

Different agricultural manual industries mainly depended on date palm products and by-products, which resulted in maximizing the profitability of date palm products. It can be planted everywhere under different environmental conditions because it tolerated the most unsuitable conditions. Apart from the date palm farms, it can be planted on roads, channels, home gardens, landscaping and boundaries (Osman *et al.*, 2010 and Hasnaoui *et al.*, 2011).

Recently, Egypt is the leader among the most important countries in global palm production. It is one of the means of food security for the inhabitants of the desert, as it is the tree of life in the desert areas, which is known as the fruits of the rich and the food of the poor. The total cultivated area and the number of females reached 117073 feddan and 14379648 palms, respectively produced about 1644417 tons of fruits (M.A.L.R., 2019).

Several workers have evaluated the effect of different pollination techniques and fruit thinning on fruiting of some date palm cultivars. The construction of the pollination procedure and the change from the traditional method of pollinators to the pollination strategy by suspension of pollen grains in a sugar solution by spraying improved the perfection of the fruit set without thinning process and similarly improved the quality of the fruiting traits. The immediate yield of the palm crop is due to the high percentage of fruits. Achieving this rate depends on a range of variables, for example, pollen quality, pollination efficiency, duration of pollination process, male and female compatibility, and environmental conditions. (El-Salhy *et al.*, 2012 and Iqbal *et al.*, 2012). The utilization of technology for pollination by pollen suspension with water reduces labor effort and the cost of thinning process. Using 0.5 to 2.0 g of pollen suspension was sufficient to obtain a high yield with good fruit quality. Besides, since the amount of pollen grains utilized is lower and less labor is required in mechanical pollination, it is increasingly efficient techniques and increment the pollination efficiency compared to hand pollination. (Ghnaim and Al-Muhtaseb 2006; El-Salhy *et al.*, 2010; Awad, 2011; El-Salhy *et al.*, 2012; Ahmed, 2014; Samouni-Mona *et al.*, 2016; Shaaban *et al.*, 2019 and El-Salhy *et al.*, 2021).

Fruit thinning is commonly used in most of the date palm orchards in order to avoid the phenomenon of alternate bearing, improve the quality of the remaining fruits, ensure early ripening and reduce the hardness of fruit sets. Fruit thinning is generally practiced either manually or chemically (Mostafa and El-Akkad, 2011, Samouni-Mona *et al.*, 2016, Mukhtarand Ali 2019 and Moustafa *et al.*, 2019).

There is great concern regarding the use of chemicals in environmental pollution and health aspects. Accordingly, the development of more efficient and economical thinning methods for date palms is particularly required under arid and semi-arid conditions. The thinning of the date fruit can be achieved by reducing the number of spikes per palm and reducing the number of spathes per palm. (Abdel-Galil *et al.*, 2008 and Awad, 2011). Thinning by removing 10-30% of bunches number significantly increased the bunch weight, advancing ripening and fruit quality compared to control (Mostafa and El-Akkad, 2011; El-Assar and Refaat 2013 ; Al-Wasfy, 2014 and Moustafa *et al.*, 2019).

The present work aimed to evaluate the different pollination methods and fruit thinning and their possible consequences on yield and fruit quality as for some physical and chemical properties of some date palm cultivars under New Valley conditions.

Materials and Methods

This study was conducted during two successive seasons of 2020 and 2021 on three date palm cultivars (Madjool, Segae and Khoudary) It was grown on Al-Madina Al-Munawaarah farm in western Mowhob located in Dakhla Oasis, New Valley Governorate, Egypt (latitude 25° and longitude 29°. All tested palm cultivars belong to the group of semi-dry dates and were in the production stage and planted in sandy soil. They were 13 years old at the beginning of the experiment. Five healthy palms of the same size for each cultivar were chosen. The number of spathes was adjusted to ten by removing the undesired ones. The retained spathes have been thinned to a fixed number of threads. Seven treatments for pollination and fruit thinning are arranged as follows:

- Hand pollination by embedding 8-10 strands/bunch (control, T₁).
- Spraying the pollen suspension at 0.5 g pollen plus 100 gm sugar/L (T₂).
- Spraying the pollen suspension at 1.0 g pollen plus 100 gm sugar/L (T₃).
- Thinning by removing 10% of the fruits/strand (T₄).
- Thinning by removing 20% of the fruits/strand (T₅).
- Thinning by removing 30% of the fruits/strand (T₆).
- Thinning by removing 40% of the fruits/strand (T₇).

The pollen grains were taken from well-known male source. Spraying pollen grain suspension treatments were applied on the third day of spindle crushing, as well as fruit thinning treatments were carried out after fruit setting.

Fruit set, bunch weight and fruit quality

Fruit retention percentage was evaluated at harvest time, five strands lead for each bunch were randomly selected from each repeat, and then the percentage was calculated as follows:

Samples of thirty dates from the yield of each bunch were taken randomly and the following physical and chemical characters were measured.

Physical characters

Average Fruit weight, seed and flesh (g.) were estimated in a top pan balance of 0.01 g. sensitivity. Fruit dimensions and fruit moisture percentage were recorded. The percentage of flesh was estimated by dividing the weights of flesh by the whole weight of fruit and multiplying the product $\times 100$.

Chemical characteristics

The fruit fresh was well minced with an electric blender and the past was squeezed and the total soluble solids % was determined by using a hand refractometer.

The percentages of total and reducing sugars were determined according to a volumetric method (Lane and Eynon) outlined in (A.O.A.C., 2000). Total acidity % was determined as g. malic acid per 100 g pulp.

Also, the percentage of tannins in the fruits was determined using the Indigo Carmen indicator according to Balbaa (1981). Titration was carried out using 0.1 N potassium permanganate solutions. Tannins in fresh weight were calculated (as total tannins percentage) according to the following equation: 1 ml potassium permanganate (0.1 N) = 0.00416 g. tannins.

Statistical analysis

The experiment was conducted in a randomized complete block design in a split plot with five replicates for each package. Data were tabulated and statistically analyzed according to Steel and Torrie (1980). Separation of means was performed according to least significant differences (LSD) at the 5% level of probability.

Results

Yield components

Data in tables (1 and 2) show the effect of certain pollination and fruit thinning treatments on fruit retention and bunch weight of Madjool, Segae and Khodry date palm cultivars during 2020 and 2021 seasons. It is worth mentioning that results are similarly in the two studied seasons. In general view all pollination or fruit thinning treatments significantly decreased the fruit retention and bunch weight compared to the traditional treatment (control) during the two studied seasons. Also, data showed that the fruit thinning treatments were higher than the different pollination treatments in their effects on the fruit retention and bunch weight. Likewise, the decrement of bunch weight was related to diminishing the pollen grains suspension concentration from 1.0 to 0.5 g pollen and expanding the fruit thinning level from 10 to 40%. There was no significant difference in the fruit retention and bunch weight due to pollination either by splashing with pollen grains suspension at 0.5 g or 1.0 g pollen/liter plus 10% sugar as well as fruit thinning at 10 or 20%. The decrement in bunch weight due to thinning the fruits/strand to 20, 30 or 40% was attained 8.44, 13.02 and 18.83 % as the average for the two seasons compared to the traditional treatment, respectively.

Regardless of pollination methods, data listed in previously tables showed that studied cultivars significantly varied for their fruit retention bunch weight The fruit retention was (60.59, 49.43 and 56.65) and (62.12, 50.50 and 65.16) for Madjool, Segae and Khodry date cultivars during two studied seasons, respectively. The corresponding bunch weight was (7.23, 8.50 and 9.66) and (7.51, 8.68 and 9.50 kg), respectively.

The interaction between the two studied factors, Tables (1 and 2) indicated that all combinations of Madjool cultivar gave the highest fruit retention compared to either Segae or Khodry cultivars. Contrarily, all combinations of Khodry cultivars recorded the highest bunch fruit content compared to other studied cultivars. The highest fruit retention (73.88 and 75.81g) was recorded on Madjool dates that pollination by traditional hand pollination T₁ during the two studied seasons, respectively. Also, the heaviest bunch weight (10.52 and 10.46 kg) was recorded on Khodry date palm that pollination by traditional hand pollination during the two studied seasons, respectively.

Table 1. Effect of pollination and thinning treatments on fruit retention of some date palm cultivars during 2020 and 2021 seasons

| Cultivars (A) \ Treat (B) | 2020 | | | | 2021 | | | |
|---|---------|---------|---------|-------|---------|---------|---------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollination T ₁ | 73.88 | 57.13 | 68.80 | 66.60 | 75.81 | 58.39 | 68.11 | 67.44 |
| Splashing (0.5 g pollen) T ₂ | 63.40 | 55.62 | 58.80 | 59.27 | 63.38 | 56.81 | 55.83 | 58.45 |
| Splashing (1.0 g pollen) T ₃ | 62.11 | 54.93 | 56.11 | 57.72 | 65.11 | 56.13 | 57.42 | 59.78 |
| Removing (10% fruits) T ₄ | 67.43 | 52.87 | 63.82 | 61.37 | 69.12 | 53.98 | 63.51 | 62.20 |
| Removing (20% fruits) T ₅ | 59.95 | 47.50 | 56.84 | 54.76 | 61.56 | 48.52 | 56.18 | 55.42 |
| Removing (30% fruits) T ₆ | 52.43 | 41.81 | 49.90 | 48.05 | 53.64 | 42.66 | 49.30 | 48.53 |
| Removing (40% fruits) T ₇ | 44.96 | 36.15 | 42.25 | 41.12 | 46.19 | 36.98 | 42.78 | 41.98 |
| Mean | 60.59 | 49.43 | 56.65 | | 62.12 | 50.50 | 56.16 | |
| LSD 5% | A= 2.41 | B= 3.68 | AB=6.36 | | A= 2.83 | B= 4.38 | AB=7.58 | |

Table 2. Effect of pollination and thinning treatments on bunch weight (kg) of some date palm cultivars during the 2020 and 2021

| Cultivars (A) \ Treat (B) | 2020 | | | | 2021 | | | |
|--|---------|---------|----------|------|---------|---------|---------|------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollination T ₁ | 7.93 | 9.24 | 10.52 | 9.23 | 8.17 | 9.46 | 10.46 | 9.36 |
| Splashing (0.5g pollen) T ₂ | 7.36 | 8.95 | 9.85 | 8.72 | 7.65 | 9.08 | 9.73 | 8.82 |
| Splashing (1.0g pollen) T ₃ | 7.40 | 8.90 | 9.88 | 8.73 | 7.61 | 8.99 | 9.59 | 8.73 |
| Removing (10% fruits) T ₄ | 7.22 | 8.60 | 9.95 | 8.59 | 7.49 | 8.76 | 9.75 | 8.67 |
| Removing (20% fruits) T ₅ | 7.30 | 8.50 | 9.66 | 8.49 | 7.52 | 8.68 | 9.38 | 8.53 |
| Removing (30% fruits) T ₆ | 6.85 | 7.95 | 9.30 | 8.03 | 7.18 | 8.15 | 9.10 | 8.14 |
| Removing (40% fruits) T ₇ | 6.58 | 7.38 | 8.43 | 7.46 | 6.78 | 7.64 | 8.48 | 7.63 |
| Mean | 7.23 | 8.50 | 9.66 | | 7.51 | 8.68 | 9.50 | |
| LSD 5% | A= 0.31 | B= 0.48 | AB= 0.83 | | A=0.35 | B= 0.51 | AB=0.88 | |

Fruit quality

Physical fruit properties

Data presented in Tables (3 to 7) show the effect of spraying pollen grains suspension at different concentrations with 10% sugar and fruit thinning on physical fruit properties of Madjool, Segae and Khodry date cultivars during 2020 and 2021 seasons. It is obvious that results took a similar trend during the two studied seasons. It was clearly noticed that there was a positive relationship between both improving the fruit's physical characteristics in terms of increasing fruit weight, fruit dimension and flesh percentage and decreasing the fruit moisture contents on one side and pollination by using a dilution pollen grains suspension or incrementing fruit thinning levels in the other side compared with traditional hand pollination (control).

The improvement in these characteristics was associated with decreasing the used pollen grain suspension concentration from 1.0 g/L to 0.5 g/L plus 10% sugar, as well as increasing levels fruit thinning 10% to 40% of fruit/strand.

Moreover, an increase in fruit weight was recorded by decreasing the concentration of suspended pollen used as well as thinning the fruits/strand from 10% to 40%. This increase was significantly increased by dilution using pollen suspension concentration from 1.0 and 0.5 g/L as well as the increasing thinning levels from 10% to 40% compared to the control. No significant differences in fruit weight and fruit moisture content were observed due to the use of pollen grain suspension concentration namely 1.0 or 0.5 g pollen grain/L. as well as fruit thinning at 10% or 20% of fruits/strand. The heaviest fruits and latest moisture contents fruit were detected on palm that fruit thinning to 40% of fruit/strand. The recorded fruits weight (17.61, 16.77, 18.54, 19.69 and 21.59 g) and (19.50, 18.70, 20.42, 22.05 and 23.61 g) were as a result of T₃ to T₇ during the two seasons studied, respectively. Hence, the increment percentage of fruit weight due to use 0.5g pollen grain suspension as well as fruit thinning from 10 to 40% over control was attained (22.22, 15.73, 27.95, 35.98 and 48.99) and (17.98, 13.20, 23.61, 33.40 and 42.92) due to T₃ to T₇ compared to T₁ during the two studied seasons, respectively. On other hand, the decrement percentages of fruit moisture (9.38, 10.70, 11.24, 11.56 and 12.59%) and (8.71, 9.18, 11.22, 11.04 and 11.87%) due to T₃ to T₇ during the two studied seasons, respectively.

Regardless of pollination methods, data listed in previously tables showed that studied cultivars significantly varied for their fruit physical properties, i.e., fruit weight, fruit dimension, flesh percentage and fruit moisture contents. The fruit weight was (20.91, 16.78 and 16.30) and (23.43, 19.10 and 17.52g) for Madjool, Segae and Khodry date cultivars during two studied seasons, respectively. The corresponding fruit moisture content were (20.93, 25.30 and 30.13) and (21.60, 24.51 and 30.39%), respectively.

The interaction between the two studied factors, Tables (5 to 9) indicated that all combinations of Madjool cultivar gave the highest fruit weight and flesh percentage compared to either Segae or Khodry cultivars. Contrarily, all combination of Khodry cultivars recorded the highest fruit moisture content compared to other studied cultivars. The heaviest fruit weight (25.15 and 27.73g) was recorded on Madjool dates that thinning 40% during the two studied seasons, respectively. Also, the highest fruit moisture content (32.58 and 32.81%) was recorded on Khodry dates that pollination by traditional and unthinning fruit (control) hand pollination during the two studied seasons, respectively. Moreover, the increment percentage fruit weight attained (51.05 and 44.05), (47.55 and 39.43) and (47.87 and 45.13%) due to thin by 40% of fruits/strand of Madjool, Segae and Khodry dates compared to unthinned was (control) during two studied seasons, respectively. These results show that Madjool cultivar is responsive and effective for fruit thinning compared to other studied cultivars. It can be arranged these cultivars as descends order as follow Madjool, Khodry and Segae, respectively.

Table 3. Effect of pollination and thinning treatments on fruit weight of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | | | | | |
|---------------------------------------|---------|-------|---------|-------|---------|-------|--------|-------|--------|--|---------|--|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean | | | | |
| Hand pollinationT ₁ | 16.65 | 13.88 | 12.95 | 14.49 | 19.25 | 16.18 | 14.16 | 16.52 | | | | |
| Splashing (0.5g pollen)T ₂ | 20.85 | 15.29 | 16.69 | 17.61 | 23.25 | 17.63 | 17.63 | 19.50 | | | | |
| Splashing (1.0g pollen)T ₃ | 20.40 | 15.60 | 15.89 | 17.30 | 22.83 | 17.60 | 17.50 | 19.31 | | | | |
| Removing (10%fruits)T ₄ | 18.93 | 16.22 | 15.16 | 16.77 | 21.71 | 18.21 | 16.18 | 18.70 | | | | |
| Removing (20%fruits)T ₅ | 21.50 | 17.63 | 16.49 | 18.54 | 23.65 | 20.10 | 17.50 | 20.42 | | | | |
| Removing (30%fruits)T ₆ | 22.88 | 18.39 | 17.80 | 19.69 | 25.60 | 21.45 | 19.10 | 22.05 | | | | |
| Removing (40%fruits)T ₇ | 25.15 | 20.48 | 19.15 | 21.59 | 27.73 | 22.56 | 20.55 | 23.61 | | | | |
| Mean | 20.91 | 16.78 | 16.30 | | 23.43 | 19.10 | 17.52 | | | | | |
| LSD 5% | A= 0.92 | | B= 1.41 | | AB=2.45 | | A=0.91 | | B=1.38 | | AB=2.40 | |

Table 4. Effect of pollination and thinning treatments on flesh percentage of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | | | | | |
|---------------------------------------|---------|-------|---------|-------|---------|-------|--------|-------|--------|--|---------|--|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean | | | | |
| Hand pollinationT ₁ | 91.85 | 90.45 | 91.46 | 91.25 | 92.21 | 90.88 | 92.00 | 91.70 | | | | |
| Splashing (0.5g pollen)T ₂ | 93.58 | 91.25 | 92.85 | 92.56 | 93.90 | 92.20 | 93.10 | 93.07 | | | | |
| Splashing (1.0g pollen)T ₃ | 94.10 | 91.71 | 93.50 | 93.10 | 94.18 | 92.56 | 92.85 | 93.20 | | | | |
| Removing (10%fruits)T ₄ | 92.68 | 92.39 | 93.68 | 92.90 | 93.05 | 92.83 | 93.60 | 93.16 | | | | |
| Removing (20%fruits)T ₅ | 93.82 | 93.11 | 93.92 | 93.62 | 93.98 | 93.45 | 94.08 | 93.84 | | | | |
| Removing (30%fruits)T ₆ | 94.11 | 93.87 | 94.10 | 94.03 | 94.27 | 94.10 | 94.38 | 94.25 | | | | |
| Removing (40%fruits)T ₇ | 94.48 | 93.90 | 93.89 | 94.09 | 94.30 | 94.18 | 94.50 | 94.33 | | | | |
| Mean | 93.52 | 92.39 | 93.49 | | 93.70 | 92.89 | 93.50 | | | | | |
| LSD 5% | A= N.S | | B= 2.28 | | AB= N.S | | A= N.S | | B=2.08 | | AB= N.S | |

Table 5. Effect of pollination and thinning treatments on fruit length of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | | | | | |
|---------------------------------------|---------|-------|---------|------|----------|-------|---------|------|---------|--|----------|--|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean | | | | |
| Hand pollinationT ₁ | 3.66 | 3.45 | 3.60 | 3.57 | 3.86 | 3.55 | 3.65 | 3.69 | | | | |
| Splashing (0.5g pollen)T ₂ | 4.10 | 4.10 | 3.93 | 4.04 | 4.50 | 4.10 | 4.12 | 4.24 | | | | |
| Splashing (1.0g pollen)T ₃ | 4.35 | 4.13 | 4.11 | 4.20 | 4.81 | 4.28 | 4.21 | 4.43 | | | | |
| Removing (10%fruits)T ₄ | 4.42 | 3.83 | 3.95 | 4.07 | 4.60 | 3.81 | 3.94 | 4.12 | | | | |
| Removing (20%fruits) T ₅ | 4.60 | 4.31 | 4.40 | 4.44 | 4.78 | 3.97 | 4.36 | 4.37 | | | | |
| Removing (30%fruits)T ₆ | 4.95 | 4.45 | 4.48 | 4.63 | 5.20 | 4.23 | 4.50 | 4.64 | | | | |
| Removing (40%fruits) T ₇ | 5.12 | 4.68 | 4.82 | 4.87 | 5.31 | 4.39 | 4.68 | 4.79 | | | | |
| Mean | 4.46 | 4.14 | 4.18 | | 4.72 | 4.05 | 4.21 | | | | | |
| LSD 5% | A= 0.13 | | B= 0.20 | | AB= 0.34 | | A= 0.12 | | B= 0.19 | | AB= 0.33 | |

Table 6. Effect of pollination and thinning treatments on fruit diameter of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | | | | | |
|---------------------------------------|---------|-------|---------|------|----------|-------|---------|------|---------|--|----------|--|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean | | | | |
| Hand pollinationT ₁ | 2.28 | 2.13 | 2.26 | 2.22 | 2.19 | 2.15 | 2.18 | 2.17 | | | | |
| Splashing (0.5g pollen)T ₂ | 2.33 | 2.22 | 2.45 | 2.33 | 2.38 | 2.35 | 2.46 | 2.40 | | | | |
| Splashing (1.0g pollen)T ₃ | 2.45 | 2.38 | 2.50 | 2.44 | 2.46 | 2.42 | 2.50 | 2.46 | | | | |
| Removing (10%fruits)T ₄ | 2.63 | 2.50 | 2.48 | 2.54 | 2.68 | 2.63 | 2.68 | 2.66 | | | | |
| Removing (20%fruits)T ₅ | 2.84 | 2.63 | 2.66 | 2.71 | 2.76 | 2.70 | 2.80 | 2.75 | | | | |
| Removing (30%fruits)T ₆ | 3.05 | 2.69 | 2.75 | 2.83 | 2.87 | 2.75 | 2.88 | 2.83 | | | | |
| Removing (40%fruits)T ₇ | 3.10 | 2.95 | 2.98 | 3.01 | 2.98 | 2.83 | 2.98 | 2.93 | | | | |
| Mean | 2.67 | 2.50 | 2.58 | | 2.62 | 2.55 | 2.64 | | | | | |
| LSD 5% | A= 0.08 | | B= 0.12 | | AB= 0.21 | | A= 0.07 | | B= 0.11 | | AB= 0.19 | |

Table 7. Effect of pollination and thinning treatments on fruit moisture percentage of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | |
|--|---------|---------|----------|-------|---------|---------|----------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollination T ₁ | 22.96 | 28.55 | 32.58 | 28.03 | 24.12 | 26.75 | 32.81 | 27.89 |
| Splashing (0.5g pollen) T ₂ | 20.83 | 26.17 | 29.65 | 25.55 | 22.38 | 24.41 | 30.15 | 25.65 |
| Splashing (1.0g pollen) T ₃ | 20.58 | 26.11 | 29.51 | 25.40 | 22.21 | 24.32 | 29.86 | 25.46 |
| Removing (10%fruits) T ₄ | 20.83 | 24.65 | 29.62 | 25.03 | 20.98 | 24.61 | 30.41 | 25.33 |
| Removing (20%fruits) T ₅ | 20.62 | 24.18 | 29.84 | 24.88 | 19.75 | 23.94 | 30.58 | 24.76 |
| Removing (30%fruits) T ₆ | 20.59 | 23.79 | 30.00 | 24.79 | 20.91 | 23.88 | 29.65 | 24.81 |
| Removing (40%fruits) T ₇ | 20.11 | 23.67 | 29.73 | 24.50 | 20.83 | 23.65 | 29.25 | 24.58 |
| Mean | 20.93 | 25.30 | 30.13 | | 21.60 | 24.51 | 30.39 | |
| LSD 5% | A= 0.77 | B= 1.18 | AB= 2.05 | | A= 0.89 | B= 1.36 | AB= 2.36 | |

Fruit chemical constituents

It is evident from data in tables (8 to 12) that the pollination by dilution of pollen grain suspension concentrations at 0.5 or 1 g/L as well as fruit thinning at 10, 20, 30 or 40% significantly improved the fruit chemical constituents in terms of increasing the total soluble solids and sugar contents and reduction, total acidity and tannins content compared to pollination by traditional hand pollination and unthinned (control). The improvement of these fruit traits was associated with the reduction of pollen grain suspension concentrations from 1.0 to 0.5 g/L plus 10% sugar as well as increasing fruit thinning levels from 10 to 40% using dilution pollen grain suspension at 0.5 or 1.0 g/L as well as fruit thinning 10, 20, 30 or 40% significantly increased total soluble solids and sugar contents compared to control. The recorded total soluble solids were (64.42, 67.70, 67.08, 68.15, 68.32, 68.72 and 68.73) and (65.63, 69.51, 69.43, 68.08, 68.92, 96.18 and 69.89%) due to T₁ to T₇ during the two studied seasons, respectively. Hence the increment percentage of total soluble solids attained (5.09, 4.16, 5.79, 6.05, 6.64 and 6.69) and (5.91, 5.65, 3.73, 5.01, 5.41 and 6.49 %) due to T₂ to T₇ compared to T₁ during the two studied seasons, respectively.

Table 8. Effect of pollination and thinning treatments on TSS% of some dates cultivars during 2020 and 2021 seasons

| Treat (B) | 2020 | | | | 2021 | | | |
|--|---------|---------|----------|-------|---------|---------|----------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollination T ₁ | 69.74 | 60.11 | 63.41 | 64.42 | 68.47 | 63.27 | 65.16 | 65.63 |
| Splashing (0.5g pollen) T ₂ | 71.18 | 65.75 | 66.18 | 67.70 | 71.60 | 68.99 | 67.95 | 69.51 |
| Splashing (1.0g pollen) T ₃ | 70.11 | 65.28 | 65.85 | 67.08 | 71.55 | 68.75 | 67.71 | 69.34 |
| Removing (10%fruits) T ₄ | 72.82 | 66.25 | 65.39 | 68.15 | 70.85 | 66.77 | 66.63 | 68.08 |
| Removing (20%fruits) T ₅ | 73.55 | 66.13 | 65.27 | 68.32 | 72.31 | 66.80 | 67.66 | 68.92 |
| Removing (30%fruits) T ₆ | 72.93 | 67.12 | 66.12 | 68.72 | 72.58 | 68.11 | 66.85 | 69.18 |
| Removing (40%fruits) T ₇ | 72.71 | 67.73 | 65.75 | 68.73 | 72.86 | 68.59 | 68.23 | 69.89 |
| Mean | 71.86 | 65.48 | 65.42 | | 71.46 | 67.33 | 67.17 | |
| LSD 5% | A= 1.69 | B= 2.58 | AB= 4.46 | | A= 1.88 | B= 2.86 | AB= 4.95 | |

Table 9. Effect of pollination and thinning treatments on total sugar of some dates cultivars during 2020 and 2021 seasons

| Cultivars (A) \ Treat (B) | 2020 | | | | 2021 | | | |
|---------------------------------------|---------|---------|----------|-------|---------|---------|----------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollinationT ₁ | 64.38 | 58.63 | 59.38 | 61.46 | 63.95 | 57.62 | 60.41 | 60.66 |
| Splashing (0.5g pollen)T ₂ | 66.83 | 62.83 | 61.80 | 63.82 | 64.70 | 60.98 | 62.18 | 62.62 |
| Splashing (1.0g pollen)T ₃ | 67.18 | 62.81 | 62.26 | 64.08 | 64.58 | 61.13 | 63.25 | 62.99 |
| Removing (10%fruits)T ₄ | 67.34 | 63.35 | 61.78 | 64.16 | 64.35 | 60.49 | 61.28 | 62.04 |
| Removing (20%fruits)T ₅ | 68.15 | 62.95 | 62.11 | 64.40 | 65.23 | 60.50 | 62.11 | 62.61 |
| Removing (30%fruits)T ₆ | 67.58 | 63.84 | 62.83 | 64.75 | 64.83 | 61.45 | 61.68 | 62.65 |
| Removing(40%fruits)T ₇ | 67.75 | 64.23 | 62.33 | 64.16 | 65.51 | 61.81 | 62.23 | 63.18 |
| Mean | 67.03 | 62.66 | 61.78 | | 64.74 | 60.57 | 61.88 | |
| LSD 5% | A= 1.49 | B= 2.28 | AB= 3.95 | | A= 1.23 | B= 1.89 | AB= 3.27 | |

Table 10. Effect of pollination and thinning treatments on reducing sugar of some dates cultivars during 2020 and 2021 seasons

| Cultivars (A) \ Treat (B) | 2020 | | | | 2021 | | | |
|---------------------------------------|---------|---------|----------|-------|---------|---------|----------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollinationT ₁ | 53.87 | 49.16 | 49.71 | 50.91 | 53.31 | 48.96 | 50.84 | 51.04 |
| Splashing (0.5g pollen)T ₂ | 56.85 | 51.21 | 52.48 | 53.51 | 56.48 | 50.84 | 53.11 | 53.48 |
| Splashing (1.0g pollen)T ₃ | 57.04 | 51.84 | 52.00 | 53.63 | 56.23 | 51.92 | 52.80 | 53.65 |
| Removing (10%fruits)T ₄ | 56.59 | 53.46 | 52.25 | 54.10 | 56.84 | 51.31 | 52.19 | 53.45 |
| Removing (20%fruits)T ₅ | 57.86 | 53.88 | 52.85 | 54.86 | 56.30 | 52.10 | 51.97 | 53.46 |
| Removing (30%fruits)T ₆ | 58.23 | 53.37 | 52.76 | 54.79 | 57.96 | 52.89 | 52.11 | 54.32 |
| Removing(40%fruits)T ₇ | 58.47 | 52.85 | 52.43 | 54.58 | 56.26 | 52.19 | 52.57 | 53.67 |
| Mean | 56.99 | 52.25 | 52.07 | | 56.20 | 51.46 | 52.23 | |
| LSD 5% | A= 1.38 | B= 2.11 | AB= 3.65 | | A= 1.44 | B= 2.21 | AB= 3.83 | |

On the other hand, data in tables (11 and 12) showed that all pollination and fruit thinning treatments significantly reduced the total acidity and tannins contents compared to using control. The improvement of these fruit traits was associated with the reduction of pollen grain suspension concentration from 1.0 to 0.5 g/L as well as increasing 10% to 40%. Using pollen grain suspension at 0.5 g plus 10% sugar as well as and fruit thinning at 30% or 40% gave the highest values of total soluble solids and sugar contents and lowest values of tannin contents and total acidity, whereas using traditional hand pollination and unthinning gave the minimum values of total soluble solids and sugar contents and highest values of tannin contents and total acidity.

Table 11. Effect of pollination and thinning treatments on acidity of some dates cultivars during 2020 and 2021 seasons.

| Cultivars (A) \ Treat (B) | 2020 | | | | 2021 | | | |
|---------------------------------------|----------|----------|-----------|------|----------|----------|------------|------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollinationT ₁ | 0.21 | 0.21 | 0.22 | 0.21 | 0.18 | 0.23 | 0.24 | 0.22 |
| Splashing (0.5g pollen)T ₂ | 0.18 | 0.16 | 0.17 | 0.17 | 0.15 | 0.19 | 0.17 | 0.17 |
| Splashing (1.0g pollen)T ₃ | 0.16 | 0.15 | 0.16 | 0.16 | 0.15 | 0.17 | 0.16 | 0.16 |
| Removing (10%fruits)T ₄ | 0.15 | 0.16 | 0.18 | 0.16 | 0.16 | 0.20 | 0.20 | 0.19 |
| Removing (20%fruits)T ₅ | 0.18 | 0.18 | 0.19 | 0.18 | 0.15 | 0.20 | 0.18 | 0.18 |
| Removing (30%fruits)T ₆ | 0.15 | 0.17 | 0.18 | 0.17 | 0.16 | 0.19 | 0.19 | 0.18 |
| Removing(40%fruits)T ₇ | 0.16 | 0.18 | 0.18 | 0.17 | 0.16 | 0.19 | 0.18 | 0.18 |
| Mean | 0.17 | 0.17 | 0.18 | | 0.16 | 0.20 | 0.19 | |
| LSD 5% | A= 0.006 | B= 0.009 | AB= 0.016 | | A= 0.006 | B= 0.009 | AB= 0.0016 | |

Moreover, increasing the fruit weight and sugar contents and reducing the fruit's tannin and moisture content are very necessary to improve the quality of these varieties resulting in an increase in the packable yield.

Table 12. Effect of pollination and thinning treatments on tannins of some dates cultivars during 2020 and 2021 seasons

| Cultivars (A) Treat (B) | 2020 | | | | 2021 | | | |
|---------------------------------------|----------|----------|-----------|-------|----------|----------|-----------|-------|
| | Madjool | Segae | Khodry | Mean | Madjool | Segae | Khodry | Mean |
| Hand pollinationT ₁ | 0.181 | 0.225 | 0.168 | 0.191 | 0.160 | 0.205 | 0.180 | 0.182 |
| Splashing (0.5g pollen)T ₂ | 0.154 | 0.196 | 0.155 | 0.168 | 0.138 | 0.174 | 0.138 | 0.150 |
| Splashing (1.0g pollen)T ₃ | 0.145 | 0.194 | 0.158 | 0.166 | 0.136 | 0.185 | 0.130 | 0.150 |
| Removing (10%fruits)T ₄ | 0.138 | 0.170 | 0.136 | 0.148 | 0.145 | 0.175 | 0.150 | 0.157 |
| Removing (20%fruits)T ₅ | 0.165 | 0.165 | 0.148 | 0.159 | 0.140 | 0.178 | 0.135 | 0.151 |
| Removing (30%fruits)T ₆ | 0.140 | 0.184 | 0.140 | 0.155 | 0.145 | 0.170 | 0.143 | 0.153 |
| Removing(40%fruits)T ₇ | 0.140 | 0.190 | 0.145 | 0.158 | 0.140 | 0.170 | 0.140 | 0.150 |
| Mean | 0.152 | 0.189 | 0.150 | | 0.143 | 0.180 | 0.145 | |
| LSD 5% | A= 0.007 | B= 0.012 | AB= 0.020 | | A= 0.006 | B= 0.009 | AB= 0.016 | |

Regardless of pollination and thinning methods, data listed in previous tables showed that studied cultivars significantly varied for their fruit chemical constituents. The obtained TSS were (71.86, 65.48 and 65.42) and (71.46, 67.33and 67.17) for Madjool, Segae and Khodry date cultivars during two studied seasons, respectively. The corresponding total sugars were (67.03, 62.66 and 61.78) and (64.74, 60.57 and 61.88%), respectively.

The interaction between the two studied factors, Table (9 to 12) indicated that all combinations of Madjool cultivar gave the highest TSS and sugar contents compared to both Segae and Khodry cultivars. Contrarily, all combinations of Segae dates recorded the highest tannins content compared to other studied cultivars. The highest TSS (72.71and 72.86%) and total sugar (67.75and65.51%) were recorded on Madjool dates that thinning 40% of fruit setting contrarily, the highest tannins content (0.225and0.205%) was recorded on Segae dates due to use traditional hand pollination and unthinning (control).

Discussion

Pollination is one of the most difficult and costly practices to ensure a good yield of date palm. Limited amounts of pollen are the basis to justify the use of mechanical pollination by sprinklers and dusters. The positive effect of using pollen on yield and fruit quality is mainly due to its important role in enhancing the efficiency of pollination and fertilization. There was an improvement in the quality of dates such as an increase the fruit weight, size and sugar contents, and a decrease in fruit moisture and tannin contents due to decrease in the concentration of suspended pollen used. These results may be due to lower fruit yield since the use of suspended dilute pollen. This reduction in fruit set reduced the competition that occurred between fruit with adequate carbohydrates and other staple foods for the remaining foods, thus increasing fruit weight, promoting fruit ripening and improving their total soluble solids and sugar contents (Awad, 2011; Abdalla *et al.*, 2011; Basher *et al* 2014; Soliman *et al.*, 2015; Samouni-Mona *et al.*, 2016 and El-Salhy *et al.*, 2021). These effects were similar to those of fruit thinning in

improving the physical properties of the fruit. Therefore, it may be easy to determine the primary fruit set that gave the appropriate yield with good fruit quality either by using different pollination methods or fruit thinning. So it can be said that the use of diluted suspended pollen solution is similar to the effects of fruit thinning in improving the quality of fruit. Moreover, increasing the fruit weight and sugar contents and reducing the fruit's tannin and moisture content are very necessary to improve the quality of dates results will support those of (El-Salhy *et al.* 2010; Abdalla *et al.* 2011; El-Salhy *et al.* 2012) who recommended the use of suspended pollen to obtain an economic yield with good fruit quality, as well as to improve the efficiency of the pollination process.

Regarding the previously mentioned results, it could be recommended that inoculation of Madjool, Segae and Khodry date cultivars with suspended pollen concentrations at 0.5 to 1.0 g plus 10% sugar was sufficient to obtain a high yield with good fruit quality. These findings are important from an economic and horticultural point of view. Whereas, the amount of pollen used in traditional hand pollination (8 to 10 threads/scoop) is about 2 g. This quantity is sufficient to inoculate 20 possessions using a spray pollen suspension at a rate of 50 ml/g. Therefore, the use of traditional manual inoculation is equivalent to 20 times the use of spray suspension. Hence, the use of spray method reduces the amount of pollen to 0.05 of the amount used in the traditional method. Pollen suspension increases pollination efficiency, reduces pollen consumption, and reduces human effort and pollination costs, in addition, to improving the quality of the fruit and increasing the product income. These findings were corroborated by findings (El-Salhy *et al.*, 2010; Samouni-Mona *et al.*, 2016; El-Salhy *et al.*, 2021).

These findings might be due to the reduction in the fruit retention percentage by using the diluted pollen grain concentration or remained fruits due to fruit thinning. Such reduction in fruits was effective on lowering the competition among the fruits and induces adequate carbohydrates and other essentials assimilated for the residual ones, which consequently enhance the fruit maturity and improves its contents of total soluble solids and sugar contents. In addition, fruit thinning, effectively lowered the competition occurred between fruits and consequently raised the total soluble solids and sugar contents for each fruit. So, it could be said that the use of diluted pollen grain concentration has a similar effect like the fruit thinning on improving the fruit quality. In general, it could be concluded that there is a positive relationship between fruit thinning and improvement of physical quality and the chemical constituents. On other hand, there is a negative relationship between the fruit retention and improvement of fruit quality. These results are in harmony with the results of (Haffer *et al.* 1997, Khayyat *et al.* 2007, El-Salhy *et al.* 2007, Ashour *et al.* 2008, Alabri *et al.* 2006, El-Salhy *et al.* 2010, El-Sese *et al.* 2010, Abdalla *et al.* 2011 and El-Salhy *et al.* 2012, Iqbal *et al.* 2012).

Conclusions

In light of the previous results, it can be concluded that the use of suspended pollen containing 0.5 g/L plus 10% sugar or fruit thinning by removing 30% of fruit setting to obtain a high yield with good fruit quality.

Accordingly, this method is good for producing a high crop with good fruiting characteristics, as well as reducing the amount of pollen used. It is also a process that combines pollination and thinning, which leads to the production of a high crop with good fruiting characteristics, as well as reducing the cost of production and improving the efficiency of pollination.

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تأثير بعض طرق التلقيح والخف على إثمار بعض أصناف النخيل تحت ظروف الوادي الجديد

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الملخص

أجريت هذه الدراسة خلال موسمين متتاليين 2020 and 2021، على ثلاثة أصناف من نخيل التمر (المجدول، الصقعي، الخضري) منزرعة في مزرعة المدينة المنورة في غرب الموهوب الواقعة في واحة الداخلة بمحافظة الوادي الجديد بمصر (خط عرض 25° وخط طول 29°). تنتمي جميع أصناف النخيل المختبرة إلى مجموعة التمور نصف الجافة حيث تم اختيار 5 نخلات لكل صنف عمرها 13 سنة ومتماثلة من حيث الحجم وحالة الاثمار وخالية من الأضرار التي تسببها الحشرات والأمراض. ومعاملة بجميع عمليات الخدمة البستانية وتم ضبط عدد السوباتيات / نخلة إلى عشرة وكذلك ضبط الشماريخ/ سوباتية إلى عدد ثابت وتم عليها اجراء سبع معاملات للتلقيح وخف الثمار كالتالي: -

التلقيح اليدوي بدمج 8-10 شماريخ / سوباتية، رش معلق حبوب اللقاح بمعدل 0.5 جم حبوب لقاح / لتر مضافاً إليه 10% سكر، رش معلق حبوب اللقاح بمعدل 1.0 جم حبوب لقاح / لتر مضافاً إليه 10% سكر، الخف بإزالة 10% من الثمار/سوباتية، الخف بإزالة 20% من الثمار/سوباتية، الخف بإزالة 30% من الثمار/سوباتية، الخف بإزالة 40% من الثمار /سوباتية. وقد تم تصميم التجربة بنظام قطاعات كاملة العشوائية بنظام القطع المنشقة مرة واحدة حيث مثلت الأصناف بالقطع الرئيسية والمعاملات بالقطع الثانوية.

يمكن تلخيص النتائج كالتالي :-

أدى استخدام التلقيح بمعلق حبوب اللقاح عند جم + 10% سكر / لتر ماء وكذلك خف الثمار بنسبة من 20 حتى 40% نقص معنوياً في نسبة الثمار الباقية ووزن السوباتية مقارنة بمعاملة الكنترول (تلقيح عادي بدون خف).

سببت جميع المعاملات السابقة زيادة معنوية في وزن الثمار ومحتواها من المواد الصلبة الذائبة والسكريات مع نقصاً معنوياً في نسبة الرطوبة والحموضة والتانينات.

سجل أعلى وزن للثمار ومحتواها من المواد الصلبة والسكريات عند استخدام الخف بإزالة 30% أو 40% من الثمار مع عدم وجود فروق معنوية مع التلقيح بمعلق حبوب اللقاح 0.5 جم + 10% سكر / لتر ماء.

سجل اعلي وزن للثمار المجدول مقارنة بالأصناف الأخرى وعليه يمكن ترتيب الأصناف حسب وزن ثمارها تنازلياً كالتالي المجدول والصقعي ثم الخضري. أوضحت نتائج التفاعل بين المعاملات والأصناف إن الصنف المجدول أكثر الأصناف استجابة لعملية التلقيح والخف مقارنة بالأصناف الأخرى.

توضح نتائج هذه التجربة ان التلقيح بمعلق حبوب اللقاح 0.5 جم حبوب اللقاح + 10% سكر/لتر او خف الثمار بمعدل 30% من الثمار العاقدة / سوباتية يعطى محصول عال ذو خصائص ثمرية جيدة للأصناف تحت الدراسة.

وعليه يمكننا أن نوصي بالتلقيح رشاً باستخدام 0.5 جم حبوب اللقاح + 10% سكر/لتر ماء للحصول على محصول عال ذو خصائص ثمرية جيدة اضافة الى زيادة كفاءة عملية التلقيح فضلاً عن تقليل كمية حبوب اللقاح المستخدمة والجمع بين عمليتي التلقيح وخف الثمار.