

Effect of Pollination Methods on Fruit Set, Yield, Physical and Chemical Properties of Hayani Date Palm Cultivar

Alasasfa, M.

Department of Plant Production, Faculty of Agriculture, Mutah University, Mutah, Karak 61710, Jordan.

Received: 31 December 2020/ Revised: 10 January 2021/ Accepted: 15 January 2021/ Published: 31-01-2021

Copyright © 2021 International Journal of Environmental and Agriculture Research

This is an Open-Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted Non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract— *Field experiment was carried out at Ghour AlSafi in Jordan valley to study the effect of pollination methods on fruit set, yield and some fruit characteristics of Hayani date palm cultivars. Results showed that hand pollination method has better fruit set and yield, but it showed a reduction in fruit weight owing to the obvious increase in yield. The pollination method significantly affected fruit related traits particularly fruit diameter, fruit length to diameter ratio and total soluble solid (TSS).*

Keywords— *Fruit set, hand duster pollination, hand pollination, Hayani, pollen grain germination.*

I. INTRODUCTION

Date palm trees are classified as a evergreen dioecious fruit tree, where the male and female flowers exist on separated trees. In fruits with seeds, successful fruit set are dependent on the efficacy of pollination. Successful pollination is critical for kernal formation and fruit growth and development, especially in nuts and in drupe fruits with one seed like dates and stone fruits. Pollination in date palm is defined as a transfer of pollen grain from male to female tree either naturally or by hand or mechanical methods. Pollination of 60-80% of the female flowers is considered satisfactory and will usually lead to a good fruit set (Al-Ekidy, 2000).

The date palm naturally is wind pollinated, but this method was inefficient and economically unfeasible (AL-Bakr, 1972). The traditional pollination method in date palm that commonly used in Middle East region is hand pollination. However the mechanical pollination requires mixing the pollen grains with a filler material to minimize the amount needed from pollen grains. Different filler materials were tried such as wheat flour, wheat bran, starch and crushed dry male flowers after the pollen grains extraction. (El-Refaey and El- Dengaw, 2017 and Samouni, et al, 2016)

The pollination methods could affect physical and chemical properties on date fruits. There are many opinions to determine which pollination method is better in date palms. Most of the research results showed that the hand pollination in date palm is very effective to obtain a high fruit set. For example, in ‘Samani’ date, wind pollination method gave significantly higher in fruit length, diameter, weight, flesh weight, flesh/seed weight ratio and TSS than hand pollination, but gave lower fruit set percentage than in hand pollination (Bakr, et al, 1988).

Previous studies focused on studying the effect of different pollination methods on physical characteristics of the date fruits (Hamood and Mawlood, 1986; Shabana et al, 1986 and Ibrahim, 1988). In general, these studies suggested that mechanical pollination increased labor efficiency, produced comparable yield with lower fruit set, required more pollen and offered greater returns compared to hand pollination. Many previous studies showed that fruit set, yield and fruit quality in mechanical pollination were close to those of hand pollination (Brown et al. 1969; Brown et al, 1970; Hamood and Shalash, 1987 and Shabana et al, 1998). El- Mardi et al, (2002), pointed out that many factors could influence the efficiency of mechanical pollination, including weather, physiological conditions of the palms and their arrangement and spacing in the orchard.

In ‘Kustawi’ date palm, Al-Khafaji, (1993), did not obtain any significant differences between hand and mechanical pollination with regard to fruit set, bunch weight, water content, TSS and total sugar using different pollen grain dilutions 1:6 or 1:9 or 1:12 (pollen: filler ratio). These results indicated that the economic advantages of using the mechanical pollination compared to the difficult and the cost of hand pollination method.

Othman et al. (1990) explained that the hand pollination on 'Sayer' flower date gave higher fruit weight and mesocarp during Khalal stage, where mechanical pollination gave higher fruit diameter, larger fruit size and higher moisture content, during Khalal and Rutab stage. However, there were no significant differences between both methods in regard to total soluble solid during Khalal and Rutab stages. EL-Makhtoun et al. (1995) found that the dust pollination treatment significantly increased fruit and flesh weight, seed weight, flesh/seed ratio, fruit dimensions, TSS, total sugar and reducing sugar, than those of normal hand pollination in 'Zaghloly' date.

El-Mardi et al, (2002) used different pollination methods (hand pollination, hand duster and motorized duster in various ratios with filler). The motorized duster produced lower fruit set than hand duster, and that was probably due to the large amount of pollen being blown away from the target, and the lowest fruit set was obtained in hand pollination. But they found that, there was no significant effect of pollination method on yield and physical or chemical properties during the same stage of fruit development.

Soilman et al, (2017) examined the impact of water suspension spray at different concentrations on some physical and chemical fruit properties on Segae date palm cultivar, they found the highest bunch weight and yield was produced from spray pollination at 2 gm pollen with 3 gm sugar per liter followed by hand pollination.

The aim of this study is to make a comparison between the hand and dusting pollination methods in relation to fruit set, yield, physical and chemical characteristics of date palm fruits under Ghour Al-safi / Jordan environmental conditions for Hayani dates palm cultivar.

II. MATERIAL AND METHOD:

2.1 Location

The field work of this experiment was carried out at Ghour Al Safi agricultural station, Ministry of Agricultural, Jordan. The laboratory work was done at Faculty of Agriculture at Mutah University, Karak, Jordan.

2.2 Plant material

Hayani cultivar of date palm was selected for this study. The trees for this experiment were chosen according to their uniformity, and they received the same cultural practices during growing season. The pollen grains were obtained from one source and the male spathes were collected after they had been mature. Pollination was done on March, 19.

2.3 Experimental works

2.3.1 Pollen grain germination test

The pollen grains germination was determined according to Albert, (1930) using media contains 15% sucrose and 1% agar. This media was poured in 12 petri dishes, then autoclaved for 2 hours at 120°C at 1.5 bars for sterilization.

Half gram of pollen grains was sprayed on this medium; the petri dishes were placed in an incubator at 27°C for four days. Initiation of a pollen tube growth is an evidence of germination. Percent of pollen grains germination was calculated as follow:

$$\% \text{ of germination} = \frac{\text{Number of germinated pollens}}{\text{Total number of pollens}} \times 100 \quad (1)$$

2.3.2 Pollination methods

Six spadixes were determined for each tree by removing the early and late showing ones. Two pollination methods were used in this experiment. The first one was hand pollination (T1), while the second was hand duster pollination (T2). Each of these two-pollination methods had three spadixes in each tree (replicate). The first treatment was done by separating four strands of male flower from freshly opened male spathe and insert them, length wise and in an inverted position, between the strands of the female inflorescence spadix.

The second pollination method was hand duster pollination; it was developed mostly in the USA (Zaid and De wet, 2002). Pollen grains were extracting from male flowers and mixing with filler agent (White wheat flour, grade zero) in (1:5, pollen grains: filler agent). Then the mixture was put in a hand plastic sprayer and sprayed to female spadix. The pollination process was carried out two days after the opening female spadix. Each treatment was done separately from other treatments, by isolating the bunch with pieces of carton.

2.4 Measurements

2.4.1 Fruit set percent

Ten strands were chosen randomly from each female spadix to calculate fruit set percent. Number of fruit, on each strand was counted, and fruit set was calculated in two different stages during fruit growth. The first count, was done six weeks after pollination (Hababuk stage), the second count, was done 10 weeks after pollination (Kimri stage). Fruit set percentage was calculated by the following equation:

$$\% \text{ of fruit set} = \frac{\text{Number of setted fruits}}{\text{Total number of flowers}} \times 100 \quad (2)$$

2.4.2 Yield

Fruit were harvested on August, 10 and the yield was recorded in Kg.

2.4.3 Physical and chemical measurements of fruit:

2.4.3.1 Physical properties

Samples of 10 fruits were randomly selected from each replicate for each spadix, to calculate the weight of fruit, seed weight, flesh weights (g) , ratio between flesh and seed weight, length and diameter (cm) by using caliper, and the ratio between length and diameter(L/D), then the means of these traits were calculated.

2.4.3.2 Chemical properties

A. Estimation of moisture percentage

The moisture percent was estimated by cutting five fruits from each replication for each spadix after seed were isolated, and then samples of 5 g from these fruits were taken. Therefore, they were put in vacuum oven at 65-70°C until constant weight was obtained. Finally the percent of moisture was calculated by the following equation:

$$\frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100 \quad (3)$$

B. Total soluble solids

Four fruits from each spadix were chopped into small pieces and then crashed, place in cloth and squeezed. For juice extracting, Abbe refractometer was used for TSS.

C. Total soluble sugar determination:

Anthron method, used to estimate the total soluble sugar, the absorbance in spectrophotometer at 620 nm was read.

D. Reducing sugar determination

Luff Schorl method was used to estimate the reducing sugar in date fruits

The experimental design was Randomized Complete Block Design (RCBD) with 6 replications. Data were statistically analyzed using Duncan's Multiple Range Test (DMRT) for means comparison at 0.05 % probability level.

III. RESULT AND DISCUSSION:

3.1 Pollen grain germination test

The pollen grains were cultured in media contains sucrose and agar on April, 13. After 4 days (April, 17), the germination percent was calculated for 12 samples and the mean of these samples was 72.8%.

3.2 Fruit set percent

3.2.1 Hababuk stage

Results showed that the highest fruit set percentage (47.02%) in 'Hayani' at Hababuk stage, was obtained by hand pollination (Table 1).

3.2.2 Kimri stage

Results showed that there were significant differences among the treatments in fruit set percent in Kimri stage for 'Hayani' cultivar (Table 1). The highest fruit set percentage 32.53% was obtained by hand pollination. The lowest fruit set percentage was obtained by hand duster method (27.97 %). In general, the best fruit set percentage obtained through hand pollination, in contrast with hand duster pollination method. There was a 5% decrease in fruit set percent by using hand dust pollination compared to hand pollination. This reduction in fruit set might be due to the lack of pollen grains arrives to female flower in hand duster pollination, or this probably due to keeping the male strands in place in hand pollination by tied the female cluster 5-7 cm from the outer end.

3.3 Yield per bunch:

Results of yield indicate that there were significant differences among different pollination treatments as shown (Table 1). The highest yield per bunch (10.46 kg), was obtained from hand pollination, while the hand duster pollination gave the lower yield (9.36 Kg). In general, the hand pollination gave the highest yield compared with hand duster pollination that decreased the yield to 1% in 'Hayani'. The hand pollination gave higher yield than the hand dust pollination.

The present results are in disagreement with results obtained by many authors Brown *et al.* 1969; Brown *et al.* 1970; Hamood and Shalash, 1987 and Shabana *et al.* 1998), who found that the mechanical pollination was close to hand pollination in yield characteristics. Also these results were disagreement with Al Khafaji (1993), when he compared the mechanical pollination (pollen filler ratios were 1:6 or 9 or 12) with the hand pollination.

3.4 Physical properties

3.4.1 Average fruit length

Results indicate that pollination method did not affect fruit length (Table 1). The longest fruit was obtained from hand duster pollination and shortest one was by hand pollination.

Similar results were obtained by previous reports (Hamood and Mawlood, 1986; Shabana, *et al.* 1988. AlJuuburi, 1995; El-Mardi, *et al.* 1998), where they found no significant differences between hand and hand duster pollination with regard to fruit length .

3.4.2 Average fruit diameter

Fruit diameter was not significantly affected by pollination method in 'Hayani' (Table 1). The widest fruit diameters (2.34 cm) for 'Hayani' were obtained from hand duster pollination and the narrowest fruit diameters (2.17 cm) were obtained from hand pollination method.

These results were in disagreement with El-Makhtoun *et al.* (1995), who found that the dust pollination significantly increased the fruit dimension.

3.4.3 Length/Diameter Ratio

The data in table (1) illustrated that there were significant differences among the pollination methods in relation to length/diameter ratio in 'Hayani' date. The highest ratio was obtained from hand pollination (2.35), and the lowest (2.18) was from hand duster pollination. So that, the hand pollination resulted fruits were more elongated than fruits from hand duster pollination. These results are in agreement with El Makhtoun *et al.* (1995); they found that dust pollination treatment increased the fruit dimension.

3.4.4 Average fruit weight

It was noticed that the fruit weight was not significantly affected by pollination method (Table 1).

The hand duster pollination has the highest fruit weight in contrast with hand pollination.

These results are in agreement with results obtained by El-Makhtoun *et al.* (1995), who reported, that dust pollination treatment increased the fruit weight, and also agreed with Hussein and Hassan, (2001), who found that hand pollination produced the lowest fruit weight. The present results are in disagreement with Othman *et al.* (1990), who worked on 'Sayer' date, and they found that, the higher fruit weight was obtained from hand pollination in contrast with mechanical pollination.

3.4.5 Average flesh weight

Flesh weight was not significantly affected by pollination methods applied (Table1). In general, higher flesh weight was obtained from hand duster pollination. This was possible due to the highest fruit weight in this treatment that cause highest flesh weight.

3.4.6 Average seed weight

Seed weight was not significantly affected by pollination method applied (Table 1)

3.4.7 Flesh/Seed Ratio

Flesh/ seed ratio was not significantly affected by pollination method (Table 1)

These results are disagreement with El-Makhtoun *et al.* (1995), who found that the dust pollination compared to hand pollination could significantly affect seed, flesh weight and seed/ flesh ratio.

3.5 Chemical properties

3.5.1 Moisture percent (Fresh weight)

There were no significant differences among the treatments of the fruits in related to moisture percent (Table 2). Generally, the hand pollination method gave higher moisture percent than in hand duster pollination method.

These results are in agreement with Hussein and Hassan (2001), who found that hand pollination gave highest moisture percent in their fruits.

3.5.2 Total Soluble Solid (TSS)

The TSS percent by hand dust pollination was lower than hand pollination in 'Hayani' date (Table 2).

These results disagree with the results obtained by El-Makhtoun *et al.* (1995) and Othman *et al.* (1990) who found that the hand pollination treatment significantly decreased TSS percent compared with dust pollination.

3.5.3 Total and reducing sugars:

It was noticed that the pollination method did not show any significant effect on total and reducing sugar (Table 2).

These results are in agreement with the results obtained by El-Makhtoun *et al.* (1995), who found that the dust pollination treatment increased total and reducing sugars.

TABLE 1
MEANS FOR PHYSICAL PROPERTIES IN 'HAYANI' DATE.

	T2	T1
Fruit set % at Hababuk stage	41.25 b	47.02 a
Fruit set % at Kimri stage	27.97 b	32.53 a
Yield (Kg)	9.36 b	10.46 a
Fruit length (Cm)	5.11 a	5.10 a
Fruit diameter (Cm)	2.34 bc	2.17 c
Length/diameter	2.18 b	2.35 a
Fruit weight (gm)	19.0 bc	18.73c
Flesh weight (gm)	17.23 a	16.98 a
Seed weight (gm)	1.56 a	1.51a
Flesh/seed	11.04 a	11.25 a
Moisture %	23.65 a	24.91a
TSS %	48.50bc	50 abc
Total sugar %	0.51 a	0.51 a
Reducing sugar %	0.35 a	0.23 a

* Values within same rows that have different letters are significantly different at 0.05 level of probability according to DMRT.

TABLE 2
MEANS FOR CHEMICAL PROPERTIES IN 'HAYANI' DATE

	T2	T1
Moisture %	24.91a	23.65 a
TSS %	50 abc	48.50bc
Total sugar %	0.51 a	0.51 a
Reducing sugar %	0.23 a	0.35 a

* Values within same rows that have different letters are significantly different at 0.05 level of probability according to DMRT

IV. CONCLUSION

The study aims to identify the effect of pollination method on the fruit set and yield of Hayani date palm cultivars. Pollination methods have significantly affected fruit set, yield and fruit weight; the percentage of fruit set and yield have increased using hand pollination compared to hand duster. Using hand duster has resulted in the highest fruit weight.

There is a significant effect of pollination method on the fruit diameter, length / diameter and TSS with 'Hayani' date. But there is no significant effect of pollination method on the fruit length, flesh weight, seed weight, flesh/ seed, moisture percentage and total and reducing sugar. There is a significant effect of pollination method on fruit diameter and length/ diameter in 'Hayani' date.

The hand pollination method was most preferable at Ghour-AL-Safi environmental condition than hand duster pollination. The hand duster pollination method must be repeated more than one time during pollination period, to obtain best fruit set percent.

REFERENCES

- [1] AL-Bakr, A. (1972). The date palm pollination and thinning of the fruits. The date palm. AI-Ani Press, Baghdad, Iraq. 340-389.
- [2] ALbert, D.W.1930.Viabilityof pollen and receptivity of pistillate flowers. Date growers Inst .rept.9: 5-6.
- [3] Al-Ekidy, 2000, Date palm tree, science and technology of agriculture and industrialization. Dar zahran, Amman, Hashemite kingdom of Jordan.
- [4] AL-Juburi, H. J. (1995). Effect of mechanical and hand pollination on some fruit characteristics and productivity of date palm trees (*Phoenix dactylifera* L.) 'Fardh' cultivar. J. King Saud Univ.7 (1): 97-126.
- [5] AL-Khafaji, M.A. (1993).Mechanical pollination effect on fruit set, bunch weight and fruit characteristics of 'Kustawi' date palm. The Iraqi Journal of Agricultural Sciences .24(2):51-56.
- [6] Bakr, E.I.; Selim, H.H. and Badawi, F.M. (1988). Effect of pollination method and some growth regulators spray on yield and fruit constituents in 'Samani' date. Propagation Symposium and palms cultivation in Arab countries, El-Ain, U.A.Emarat, :5-10.
- [7] Brown, G.K.; Perkins R.M. and VIS, E.G. (1969). Temperature and heat unit occurrences during date pollination in the Coachella Valley of California. Date Growers' Inst. Report 46: 21 - 24.
- [8] Brown, G.K.; Perkins R.M. and VIS, E.G. (1970). Mechanical pollination experiments with the 'Deglet Noor' date palm . Date Growers' Inst. Report 47: 19 - 24.
- [9] EL-Makhtoun, M.; Abdel-Kader, A.M.M. and Abdel-Ai, A.A. (1995).Effect of different pollination methods on yield and fruit quality of Zaghloul date cultivar. Zagazig J. Agric. 22(1):151-157.
- [10] EL-Mardi, M.O.; Esschie, H. and Abdelbasit, K.M. 2002. Effect of pollination method on changes in physical and chemical characteristics of date fruit during development. Agricultural science. 7(1):21-27.
- [11] El-Refaey, F. and El-Dengawy, A. (2017). Improvement of the pollination technique in Date Palm. J. Plant Production, Mansoura Univ.8 (2) : 307-314
- [12] Estimation of total Carbohydrates in plant tissue (1998). Measurement of total soluble sugar. Experiments in plant physiology: 148-151.
- [13] Hamood ,H.H. and Mawlood, E.A. (1986).The effect of mechanical pollination on fruit set , yield and fruit characteristics of date palm 'Zahidi' cultivar .Date palm J.4(2):175-184.
- [14] Hamood ,H.H. and Shalash, T.S. (1987). Effect of storage periods of pollination mixture on fruit set and fruit quality of date palm 'Khostawi' cultivar .Date palm J.5(1):23-37.
- [15] Hussein, F.H. and Hassan, A.S. (2001).Effect of hand and mechanical pollination on fruit set, yield and fruit quality of dry dates CV 'Gondeila' under conditions of Asswan governorate. Egypt. Zagazig J. Agric. Res. 28(6):1035-1049.
- [16] Ibrahim, A.A. (1988). Field performance of different types of mechanical pollination systems of date palm. J.Agric. Water. Reso. Res.7 (1):61-82.
- [17] Othman, A.K., Ghalib, H.H., and Alldany, A.J. 1990. Response of 'Sayer' Date fruit to method of pollination. Basrah J.Agric.Sci.3(182): 83- 90.

- [18] Reducing sugar content, Luff Schorl method, Food analysis.:144-163.
- [19] Samouni, M.T.M., El-Salhy A.M., Ibtesam F.M. Badawy and Ahmed, E.F. (2016). Effect of Pollination and Thinning Methods on Yield and Fruit Quality of Saidu Date Palms. Assiut J. Agric. Sci. 47 (3): 92 – 103.
- [20] Shabana, R.H ; Mawlood, E.A. ; Khalil, Th. and Ghalib, H.A. (1986). Mechanical pollen extraction and pollination. Journal of Agricultural water resources 5:227-240.
- [21] Shabana, R.H; Khalfan, R.M.; Safadi, W. and Akrouf, S.A. (1998). Mechanical pollination of date palm in U.A.E. 2nd Conf. on date palm , Murakish , 16-18:55-64 .
- [22] Shabana, R.H; Mawlood, E.A. and Khalil, Th. (1988). Date palm mechanical pollination. Report. Agric. Res. Water Resources Center. Scientific Research Council, Baghdad, Iraq.
- [23] Soliman, S.S., AlEbidi, A.I., Al-Saif, A.M. Al-Obeed., R.S. and Al-Bahelly, A.N. (2017). Impact of pollination by pollen grain water suspension spray on yield and fruit quality of Segae date palm cultivar (*Phoenix dactylifera*). Pak. J. Bot., 49 (1) : 119 – 123.
- [24] Zaid, A. and De wet, P.F. (2002). Climatic requirements of date palm .Date Production Support Program .United Arab Emirates.