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EFFECT OF POLLEN SOURCE ON YIELD AND FRUITS QUALITY OF DATE PALM (*Phoenix dactylifera* L.) CV. 'MEJHOUL' IN MOROCCAN OASES

HAKIM OUTGHOULIAST, ZERHOUNE MESSAOUDI, AMINA OUAZZANI TOUHAMI, ALLAL DOUIRA* AND LHOUSSAIN AIT HADDOU

Laboratory of Botany, Biotechnology and Plant Protection, Faculty of Sciences, University Ibn Tofail, Kenitra, Morocco [HO, AOT, AD].

National School of Agriculture, University Ibn Tofail, Meknes, Morocco [HO].

Laboratory of Pomology, Arboriculture-Viticulture, National School of Agriculture, Meknes, Morocco [ZM, LAH].

[*For Correspondence: E-mail:douiraallal@hotmail.com]

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ABSTRACT

The study was undertaken to determine the influence of pollen sources on fruit set, yield and fruit quality of date palm (*Phoenix dactylifera* L.) cv. 'Mejhoul'. Six different male trees (symbolized from M1 to M6) and six 'Mejhoul' female trees were selected for experiment, on female tree, six spathes were selected, each spathe were pollinated by one pollen grains source. The results indicated that pollen source significantly affected all parameters measured, the maximum fruit set percentage was obtained for spathes pollinated by M1 (67.90%), however, this percentage were minimal for spathes pollinated by M4 (30.22%). As for the yield, the M1 pollinizer engendered a net yield enhancing of 36.50% compared to the average yield (42.52 kg/palm). Pomological characteristic of the fruit like fruit weight, flesh weight, fruit length, fruit width and flesh/ seed ratio were significantly improved with pollination from M5 compared to other male trees. The obtained values of dietary mineral matter ranged from 1.64 to 2.03% for dates from M2 and M5 pollinizers respectively. Total individual sugars content of the dates varied from a minimum of 70.80 g/100 g dry matter obtained for dates from M4 to a maximum of 84.81 g/100 g dry matter recorded for the dates from M6. The results suggested that best pollen source (male palm) should be selected for 'Mejhoul' dates to get most desired characteristics.

Keywords: Date palm (*Phoenix dactylifera* L.); pollinizers; cv. 'Mejhoul'; fruit set; yield; fruits quality; Pomological characteristic;individual sugar.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is a very important fruit trees throughout the world [1]. In Morocco, date palm planted areas had increased in the last years exceeded 59 127 hectares, with a total production of 111701 tons of dates, mostly in Tafilalet oases [2].The 'Mejhoul' is one of the important date palm variety cultivated in Morocco. It is well known as 'date king' for its meritorious characters i.e. large fruit size and high sweetness.

Botanically, date palm is a dioecious plant having male and female flowers on separate trees. Accordingly, pollination is normally done by wind

or insects, however, due to varietal differences and variation in flowering time, artificial pollination is needed, in which mature male inflorescence are cut off before spathe splits, and strands are placed in the female flower cluster so pollens will be transferred onto female flowers [3,4], this practice is necessary to improve fruit setting and enhance economical yield[5,6].

The male palm trees locally named “Dokkars” are form heterogeneous populations. They are sometimes identified by the name of the female cultivar which resembles to it phenotypically [7]. The pollen source from different male type is one of major factors affecting palm pollination, pollen has an effect on fruit set yield and fruit characteristics is known as metaxenia [4,8,9], the pollen also controls the time of ripening[10], Delaimy and Ali [10] reported that pollen from ‘Ghannami’ and ‘Werdi’ shortened the ‘Khalal’ stage of ‘Zehdi’ and increased the matured fruit percentage, while ‘Rissasi’ and ‘Werdi’ pollen increased fruit set.

In the world, many researchers reported that the direct effect of male parent on fruit set, yield and fruit characteristics varies according to the male parent used on different cultivars of female Palm [5,6,11,12,13].

However, in Morocco, in our knowledge, there is a few papers published related to this phenomenon, very little is known about the role of pollen source pollination on yield and fruit quality of date palm cv. ‘Mejhoul’. The present investigation is a step for improving the productivity of ‘Mejhoul’ date palm. Therfore, the purpose of this research was to determine the effect of six pollen males on fruit set, yield and fruit quality of ‘Mejhoul’ date palm variety under agroclimatic conditions of Errachidia region. It is important to select and identify superior male for pollination to optimize yield and fruit quality.

MATERIALS AND METHODS

Experimental Conditions

This study was carried outduring 2015 season, in a model orchard forproduction of 'Mejhoul' dates (organic, 8 x 8m, drip irrigated), located in South-East of Tinjdad village, according to pedoclimatic conditions of Errachidia region in Morocco (Fig. 1).

Experimental Design

The pollen was collected from six male trees (symbolized from M1 to M6) used by elite farmers. The mature male spathes were collected and dried, then strands were cut off and spread on paper sheets to dry slowly during few days in clean rooms. These inventoried individuals were phenologically adult and sexually mature that are located in palm groves with similar pedoclimatic conditions. Pollen sources were identified in six sites whose geographical coordinates are presented in the Table 1.

Six selected palms were healthy, same age (11 years) and uniform in growth vigor and fruiting. At creamy yellowish stage of the flowers i.e. 3 to 4 days after natural cracking of female spathes, hand pollination was carried out by placing desired male pollen strands (3-4 strands) inside the female spathe. On each female tree, six spathes were chosen and were pollinated with pollens collected from six pollens selected male parent (Each individual spathe was subject to one pollen grain source as replicate), inflorescences were covered by paper bags after pollination, for three days. All cultural practices in the field for the experimental palms were carried out according to the standard schedule.

Table 1. Localization of male palm pollinizers

Location	Male palm	Geographical coordinates	
		X	Y
Ait mâamar	M1	31°52’	-4°99’
Ait mâamarjdid	M2	31°52’	-4°99’
Akkerouz	M3	31°47’	-4°87’
HaboussAkkerouz	M4	31°47’	-4°87’
Akhdil	M5	31°53’	-4°84’
Istwalil	M6	31°53’	-4°85’

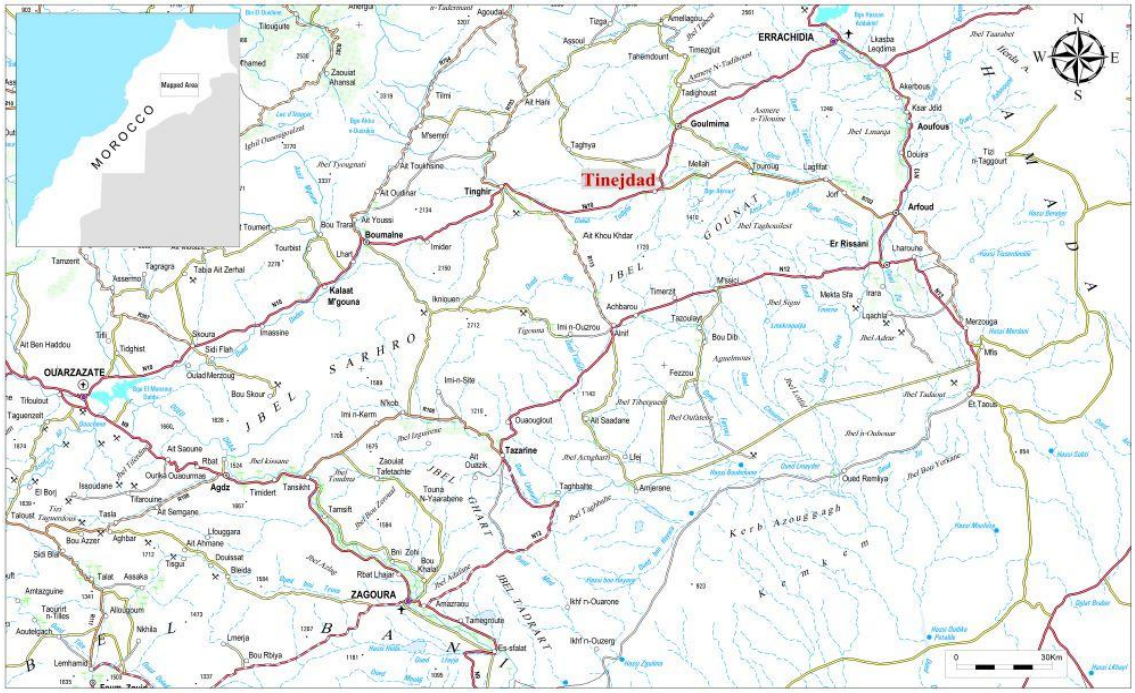

Fig. 1. Topographic map illustrating geographical location of experimental site

Agronomic Parameters

Fruit set percentage

Fruit set percentage was calculated by counting normal (fertilized) and abnormal (unfertilized) fruits on each spathe selected after four weeks of pollination, the following formula was proposed by Iqbal et al. [6]:

$$\text{Fruit set \%} = \frac{\text{Number of normal fruits} - \text{Number of abnormal fruits}}{\text{Total number of fruits}} \times 100$$

Yield quantification

On each palm, all spathes were harvested at 'Tmar' stage and weighed by an electronic balance; values of treatment were expressed in Kg/palm tree.

Pomological Characters

Fruit, pulp and seed weights

Morphometric measurements were carried out on a composite sample containing 60 fruits from each site. The fruit weight, fruit pulp weight and seed weight were measured using an analytical balance (Denver mark. Germany).

The quality ratios were measured according to the following formulas:

$$\text{P/D ratio (\%)} = \frac{\text{Flesh weight}}{\text{Date weight}} \times 100$$

$$\text{S/D ratio (\%)} = \frac{\text{Seed weight}}{\text{Date weight}} \times 100$$

Fruits dimension

Fruit length (cm) and fruit width (cm) were measured with a digital calliper (Mitutoyo CD - 15GP. Mitutoyo Co., Japan).

Physico-chemical Traits

Dry matter content

Dry matter of fruit is determined by evaporation of their moisture without causing volatilization of constituent substances. It was obtained by drying fruits with in an oven (Ehret TK 3064, Germany)

at 102±3°C, for 24 hours and until a constant weight was obtained yield [14].

The percentage of dry matter is calculated according to the following formula [15]:

$$\text{Dry matter} = \frac{(\text{Dry sample weight} - \text{Container weight})}{(\text{Fresh sample weight} - \text{Container weight})} \times 100$$

Determination of ashes

According a modified version of AOAC method 923.03. Total ashes were determined by incineration of the dry matter, obtained after baking, in a muffle furnace (Volca MC18, France) at 550°C for 2 hours and ignited to drive off volatile organics.

Determination of Individual Sugars by HPLC

Samples preparation

Analysis of the individual sugar was carried out according to the modified method described by Kafkas et al. [16]. Lyophilized flesh fruit is crushed manually using a ceramic mortar. 250 mg is taken for each sample and was dissolved in 25 mL of aqueous ethanol 80% and sonicated for 15 minutes at 80°C, the solvent was filtered by Whitman filter paper using Buchner funnel. The extraction was repeated 3 times by adding 25 ml of ethanol 80%, the filtered extracts are combined and placed in the steam to remove the solvent, the residues are dissolved with 1 mL of deionized water and the pH was adjusted to 9-10 with diluted NaOH (0.1 M). A cartridge of 1 g/6 mL is preliminarily packaged with 6 ml of methanol and 6 ml of deionized water. Then, the recovered sample (1 mL) was eluted slowly through the cartridge and the sugars (neutral compounds) was carried out in solvents twice with 2 mL of deionized water (pH = 7). Finally, the sugars eluted (4 mL) was diluted with filtered distilled water to a final volume of 100 mL.So the sample was prepared for HPLC analysis.

HPLC analysis conditions

An HPLC system (Jasco LC-Net II/ADC, Japan) was used for determination of individual sugar content. The separation was carried out using a REZEX RHM monosaccharide H^+ column with exclusion of ions (300 x 7.80 mm; Phenomenex), contained in an isothermal oven at an adjustable temperature.

The mobile phase consists only of filtered deionized water discharged into the system by a PU-2089 Plus quaternary gradient pump. The HPLC system is connected to an intelligent RI-2031-Plus detector. The flow rate and the injection capacity were adjusted, respectively, to 0.5 mL / min and 20 µL. Separation of sugars from organic acids was carried out by cartridges of 1g/ 6 ml and Chrompure SAX type. The identified sugars were quantified based on peak areas related to two external standards consisting of a mixture of sucrose, maltose, glucose and fructose at concentrations 0.2 and 0.4% each. The baseline was made by a white consisting only of filtered distilled water. The areas of the peaks were determined by the Chrom Nav software and sugar content of each sample was calculated from the corresponding chromatogram, with respect to calibration curve. Results are expressed in g / 100 g dry matter.

The calculation of sugar concentrations was carried out using methods described by several authors [17,18,19,20], with certain modifications, as following formula:

$$C = \left(C1 \times \frac{A}{A1} \times \frac{V}{M}\right) \times 100$$

Where:

C: Sample concentration;
C1: Standard concentration;
A: Area of peak sample;
A1: Area of peak standard;
V: Volume of dilution water (100 mL);
M: sample weight (0.250 g).

Standard samples

Pure samples (+) Glucose, D (-) Fructose, D (+) Sucrose and D (+) Maltose were used as standard.

Statistical Analysis

Collected data were statistically analyzed by ANOVA according to Randomized Complete Block design with three replicates, and mean

separation was calculated according to the Student Newman Keuls (SNK) method at the 5% level of significance.

RESULTS AND DISCUSSION

Date palm Production Parameters

Fruit set percentage

Results in Fig. 2 indicated that pollen source affected fruit set percentage of 'Mejhoul' date palm**.** Pollinizer M1 produced a maximum fruit set percentage (67.90% a). However, a minimum value is recorded for spathes pollinated by M4 (30.27% d), pollinizer M5 engendered 53.25% bc. These results are in perfect agreement with those reported by Aly [21] and Omaima et al. [22], who reported metaxenic effect of different pollen sources on fruit set percentage. Different males vary in their pollen viability, germination percentage and genetic makeup which ultimately affect the retention of the fruit after fertilization [13].

Economical Yield

Fig. 3 shows the yield in kg of dates/palm from the spathes pollinated by the six male palms. Bunch weight is considered as an index for the total yield. Data revealed that spathes pollinated by M1 produced a maximum yield 58.04 kg/palm, which far exceeds minimum yield recorded for spathes pollinated by M4 which is around 23.36 kg/palm. Indeed, M1 pollinizer has resulted in a net yield improvement of about 36.50% compared to the average yield (42.52 kg/palm). These results confirm direct effect of the pollen source on yield and its components reported in previous investigations [6,13,22]. In addition, it can be assumed that the different male pollens have a potential that may be beneficial for date production [6]. Rahemi[23] did not found the effect of pollen on yield of dates.

Pomological Characteristics of Dates

Data in Table 2 shows that 'Mejhoul' dates varied significantly from each other in terms of morphometric measurements. The significantly highest weight of about 15.90 g was recorded for dates derived from M5 pollinizer, followed by those derived from M6 (12.34 g) and M1 (12.06 g). Dates pollinated by M4 had a minimum weight (10.66g). This parameter is essential and determines dates shape intended for consumers. The maximum length (4.05 cm) was observed in the fruit from M4. On the other hand, fruits from M4 and M6 pollinizers had statistically similar lengths (3.91 cm and 3.92 cm respectively). However, the shortest fruits (3.77 cm) were obtained for dates from M2 (3.77 cm). As for dates width, pollinizer M5 produced dates with maximum width (2.42 cm) and M4 produced a minimum value (2.09 cm).

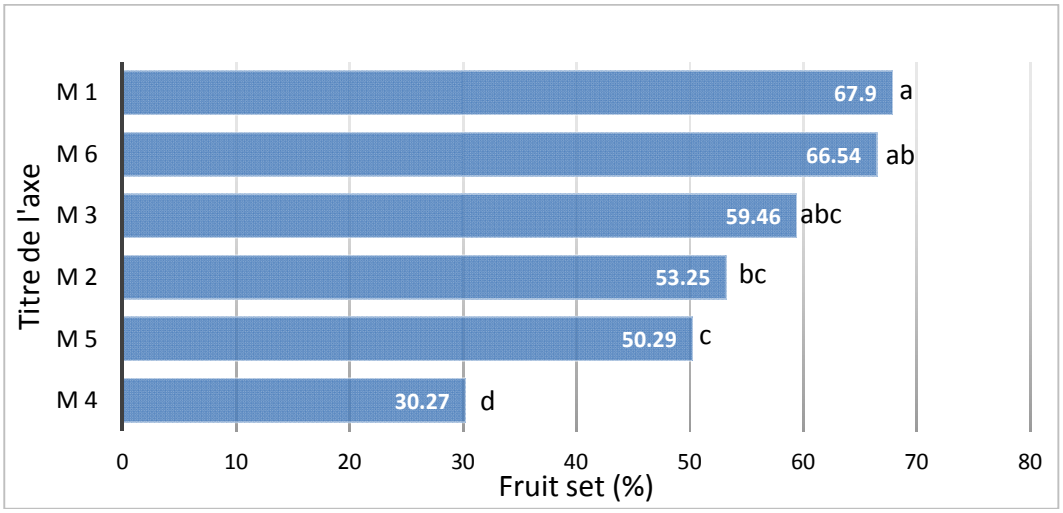

Fig. 2. Effect of six males palm on fruit set percentage of 'Mejhoul' date palm

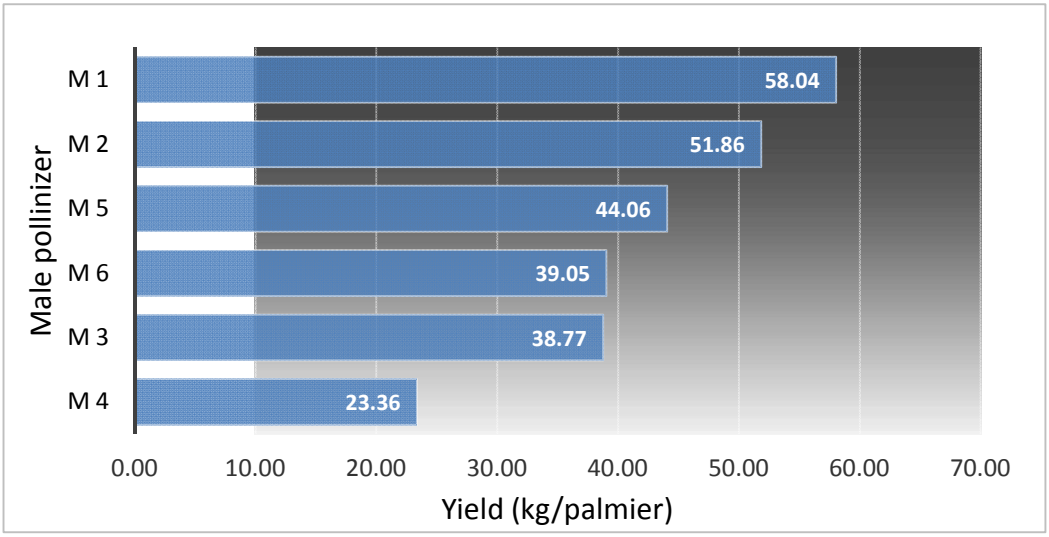

Fig. 3. Effect of six males palm on yield of 'Mejhoul' date palm

The pulp is the edible part of the fruit, so, pulp content plays an important role in dates quality. The maximum pulp weight (14.86 g) was recorded for dates developed from M5 pollen, a minimum weight was observed in dates pollinated by M4 (9.58 g). Indeed, the variation in pulp weight is correlated with weight of whole date, since seed weight is low and varied slightly from 0.98 to 1.10 grecorded for dates developed from M6 and M1 respectively.

These results corroborate those obtained by Nasser Al-Khalifah [8]; Iqbal et al. [6]; Alaa El-Din et al. [13] and Omaima et al. [22], they obtained metaxenic effect on all morphometric traits of many dates cultivars ('Zahidi', 'Dhakki', 'Zaghloul', 'Samany').

Physicochemical Properties

Relative humidity and dry matter

The results in the Fig. 4 shows that the moisture content of dates is affected by the pollen source. Dates from pollen source M6 are the wettest (38.87%) and dates from M4 are the driest (23.96%) compared to all pollinizers tested. Results of this study are in perfect agreement with those shown by other researchers; during two successive seasons (2005 and 2006), El-Kosary [1] proved the effect of three selected Egyptian male palms on water content of dates cv. 'Barhee'.

Mineral and organic matter

The Table 3 shows the results obtained for organic and mineral matter for dates from six male pollinizers, statistical analysis revealed three significantly different groups for mineral matter and organic matter, the maximum mineral matter content is observed in dates from M5 pollinizer (2.03 ± 0.08%), the minimum mineral matter is recorded for dates from pollinator M2 (1.64 ± 0.01%).

Individual Sugars

Fig. 5 shows chromatograms obtained by HPLC analysis. The sugars contained in the 'Mejhoul' dates are only reducing sugars, whereas, sucrose and maltose are not detected. 'Mejhoul' dates from M6 male palm are the richest in two sugars i.e. 45.27 g/100 g dry matter of glucose and 39.53 g/100 g dry matter fructose (Fig. 6). However, dates from M4 had minimum values of about 38.01 g/100 g and 32.79 g/100 g dry matter for glucose and fructose respectively.

Table 2. Effect of different pollen sources on morphometric characteristics of date fruits cv 'Mejhoul'

Pollen source	Fruit lenght (cm)	Fruit width (cm)	Fruit weight (g)	Flesh weight (g)	Seed weight (g)	Seed/Fruit Ratio (%)	Pulp/ Fruit Ratio (%)
M1	3.85 ± 0.25 bc	2.20 ± 0.17 bc	12.06 ± 0.20 bc	10.96 ± 0.20 bc	1.10 ± 0.01 a	9.31 ± 0.18 b	90.68 ± 0.18 c
M2	3.77 ± 0.22 cd	2.16 ± 0.12 c	11.37 ± 0.15 cd	10.29 ± 0.15 cd	1.08 ± 0.01 a	9.66 ± 0.13 b	90.33 ± 0.13 c
M3	3.69 ± 0.22 d	2.24 ± 0.14 b	11.35 ± 0.14 cd	10.34 ± 0.14 cd	1.01 ± 0.01 b	9.01 ± 0.12 b	90.98 ± 0.12 c
M4	3.92 ± 0.26 b	2.09 ± 0.14 d	10.66 ± 0.18 d	9.58 ± 0.18 d	1.08 ± 0.01 a	10.36 ± 0.16 a	89.63 ± 0.16 d
M5	4.05 ± 0.27 a	2.42 ± 0.16 a	15.90 ± 0.25a	14.86 ± 0.24 a	1.03 ± 0.01 ab	6.54 ± 0.12 d	93.45 ± 0.12 a
M6	3.91 ± 0.25 b	2.14 ± 0.15 cd	12.34 ± 0.15 b	11.35 ± 0.15 b	0.98 ± 0.01 b	8.08 ± 0.13 c	91.92 ± 0.13 b
Average	3.86 ± 0.24	2.21 ± 0.14	12.28 ± 0.17	11.23 ± 0.17	1.04 ± 0.01	8.82 ± 0.14	91.18 ± 0.14

Average value ± Standard error. Averages with the same letters in the same column are not significantly different at (p = 0.05)

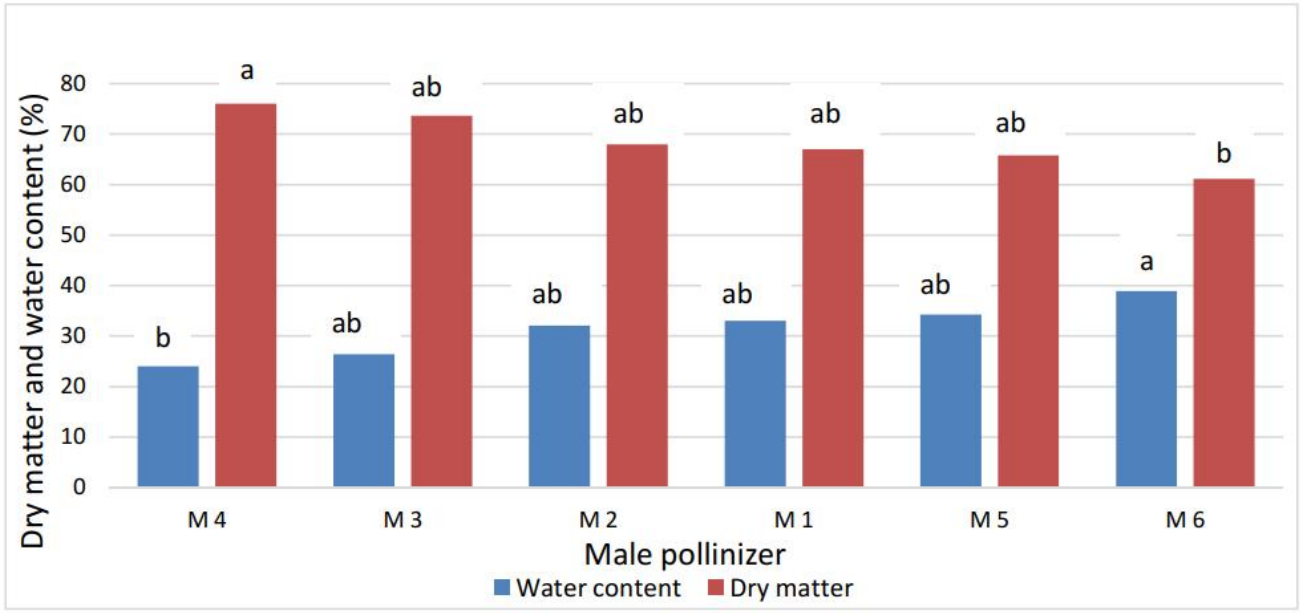

Fig. 4. Effect of six male palm on water content and dry matter

Two affected results of the same letter do not differ significantly at the 5% threshold

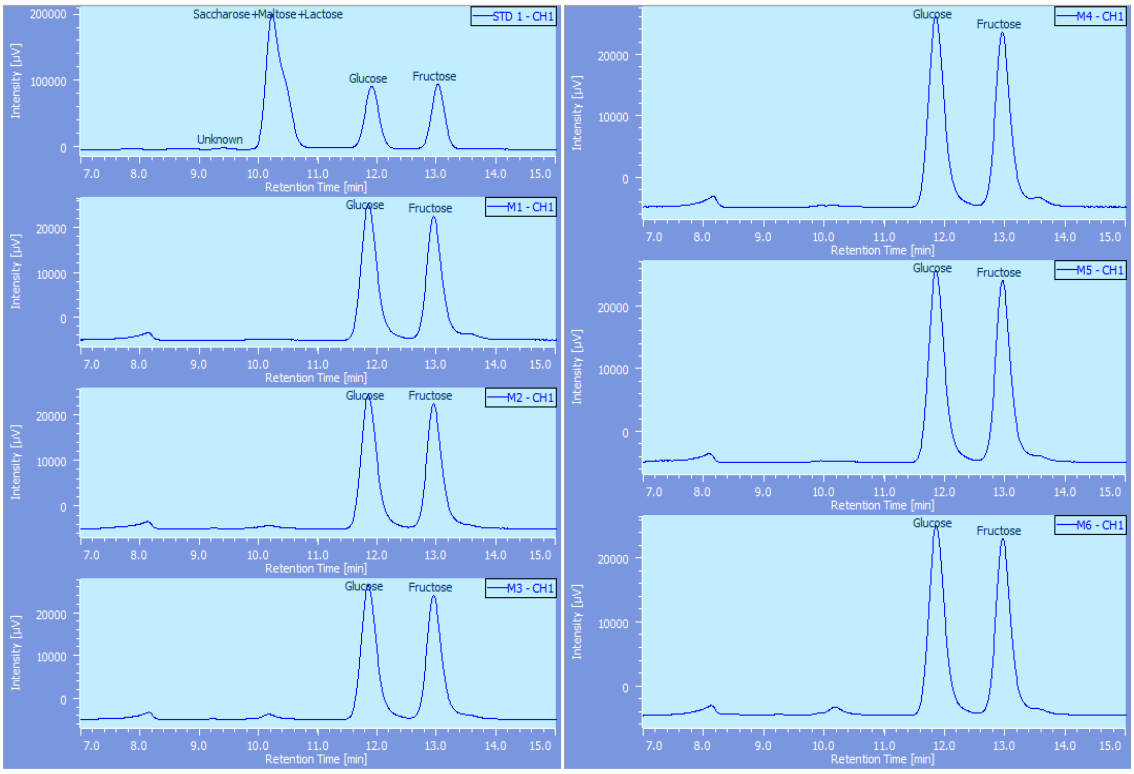

Fig. 5. HPLC chromatograms for flesh dates obtained by six males palm

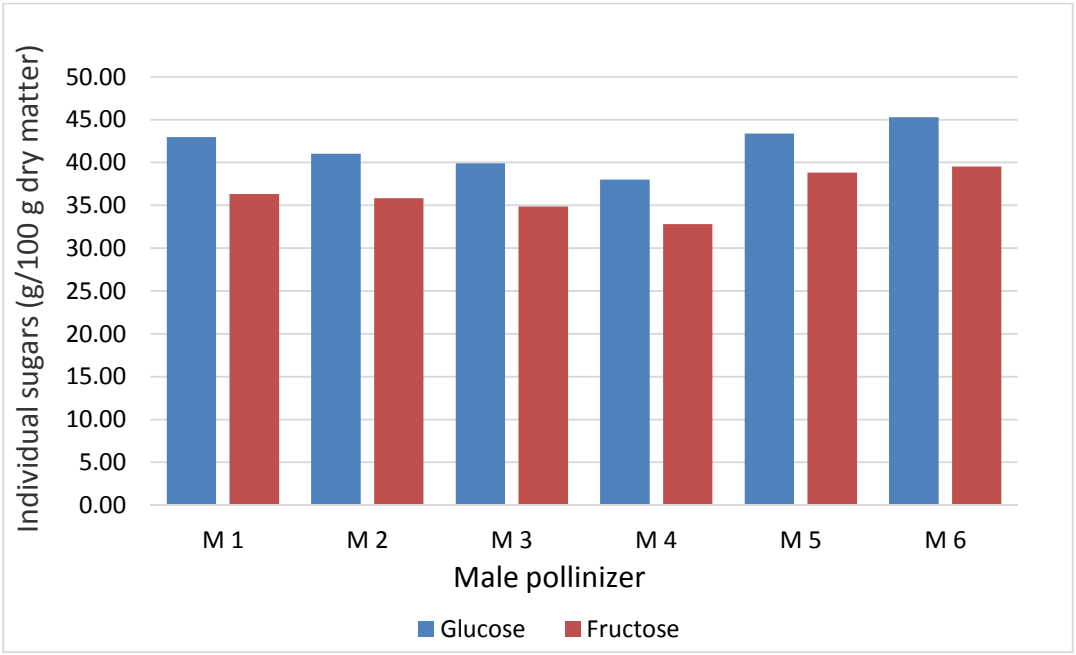

Fig. 6. Effect of six male palm on individual sugars of date fruits cv.'Mejhoul'

Table 3. Effect of six pollen sources on ash and organics content of 'Mejhoul' dates

Pollen source	Ash (%)	Organics (%)
M1	1.77 ± 0.07 ab	98.23 ± 0.07ab
M2	1.64 ± 0.01 b	98.36 ± 0.02 a
M3	1.69 ± 0.02 b	98.31 ± 0.02 a
M4	1.69 ± 0.10 b	98.31 ± 0.10 a
M5	2.03 ±0.08 a	97.97 ± 0.08 b
M6	1.46 ± 0.02 b	98.54 ± 0.02 a
Average	1.71 ± 0.05	98.29 ± 0.05

The results obtained are in perfect agreement with results published by Egyptian researchers, Farag et al. [24]found the metaxenic effect of two pollinizers on reducing sugars in dates cv. 'Zaghloul', for control (without pollination) very low values were observed. However, in Pakistan, Shafique et al.[12] showed no significant effect of three different males on reducing and total sugars of dates cv. 'Dhakki', but other biochemical parameters were affected (total soluble solids and ascorbic acid).

CONCLUSION

The obtained results for male pollinizers confirmed the direct effect of six pollen sources on fruit set, yield and date quality cv. 'Mejhoul'. Overall, it is suggested that for better yield and fruit quality, compatible pollinizers should be selected and used in pollination. Moreover, the physiological and molecular mechanism involved in the differential response of different pollen sources also need to be explained.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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