

Improvement of the Pollination Technique in Date Palm

El-Refaey F. A. El-Dengawy

Pomology Department, Faculty of Agriculture, Damietta University 34517, Damietta/Egypt

Email: dengawy@gmail.com or dengawy @du.edu.eg



ABSTRACT

The present research was carried out during two successive seasons 2013 & 2014 for improving pollination technique of Hayany date palm cultivar grown in clay sandy soil of private orchard located at Om-Elreda region, Damietta Governorate, Egypt. Uniform 32 date palms 45 years old were divided to 8 groups. Each group was labeled and its female spathes were subjected to different pollination treatments during April of both two seasons. The tested pollination technique include traditional pollination (TP) by using 5 inverted male strands/female spathe (control) and dusting with pollen mixture (PM) at 5%, 10% and 20% alone or preceded by spraying stimulative solution of pollen germination (SSPG). Effects of pollination treatments on the growth characteristics of Aerjon, Fruit set%, fruit drop%, yield/palm and physical and chemical fruit qualities were determined. The obtained results proved that the most tested pollination treatments markedly improved the growth characteristics of Aerjon, fruit set%, yield/palm and fruit quality. Applying SSPG on female inflorescences before TP and dusting PM at 5%, 10% or 20% significantly increased the fruit set%, reduced fruit drop% and consequently increased yield/date palm comparing with TP. Moreover, these pollination techniques greatly resulted in enhancing the physical and chemical characteristics of fruit qualities that include increasing weight, size, flesh/seed ratio and their contents of total sugars and vitamin C as well as reducing titratable acidity percentage. From the present study, it could be recommended with using the combination of spraying SSPG and dusting 10% PM as an improved pollination technique. It saved the required pollen grains comparing with applying 20% PM and also produced high yield/ palm has the high physical and chemical qualities. The combination of mixing pollen grains with carrier and SSPG is useful in establishing mechanical pollination and getting an economical yield with good fruit quality as well as minimizing the cost of pollination process.

Keywords: Hayany date palm, Pollination, pollen germination, pollen mixture, fruit set and drop, Yield, physical and chemical fruit quality, Aerjon growth.

INTRODUCTION

Dates palm is one of the oldest fruit trees which was cultivated in the world. In Egypt, date palm is one of the most important fruits and distributed at large scale in different districts. There are three main groups of dates based on fruit moisture content, i.e., soft, semi-dry and dry cultivars. Damietta governorate is considered one of the main districts of soft date production in Egypt, especially "Hayany" cultivar. This local variety is playing an important role in the economic development of the area as well as of the country by earning handsome amount of foreign exchange.

The date palms are dioecious and thus require the transfer of pollen from the male palm to female one in order to obtain a considerable economically yield. The traditional pollination technique of hand pollination which includes climbing the palm has become impractical under the changing socio-economic structure in regions where date palms are intensively grown. It requires experienced pollinators and a high labor cost (Ibrahim, 1988). Several previous researches indicated that the pollination is one of the major horticultural practices and it is a necessary operation as a mean to ensure good fruit setting and yield (Khan and Ghaffoor, 1993; Beachar *et al.*, 1999 and Soliman and Kasany, 2006). Similarly, Attalla *et al.*, (1998) observed that the effect of different pollination techniques by dusting various proportions of pollen powder significantly increased the average fruit set percentage as compared to other treatments. Hussain, *et al.* (1984) reported reduction in pollen viability within half an hour in all suspension media, resulting poor fruit setting. The pollination techniques included dusting of pollens, placement of male spathe, liquid spraying of pollens as well as natural process of pollination (control) were

carried out on female flowers (Iqbal, *et al.*, 2010). Their results revealed that different pollination techniques had significantly affected the fruit setting and other quality parameters. Moreover, the highest fruit set was recorded in the placement method while the lowest fruit set was observed in the control.

As for activation of pollen grain germination, at concentrations of 10-100ppm, boron was shown to motivate in vitro pollen grain germination and promote growth of the pollen tubes in *Pyrus communis* (Stanly and Lichtenberg, 1963). Moreover, a pollen germination medium containing sucrose, calcium, potassium, boron and magnesium was effective for germination of pollen from many plant species and calcium was more essential (Brewbaker and Kwack, 1963 and Kavand *et al.*, 2014). Some researches indicate that the growth of some plants is affected by additions of vitamin B, to the medium while other plants are not affected by the same treatment (Bonner and Greene, 1939 and Minarik, 1942).

Growers of fruit trees are mostly interested in how and to what extent environmental factors, such as rain or heat, affect pollen viability and ultimate pollination of their crops (Pline *et al.*, 2002). A controversy regarding the effect of rain on fruit set is noted. Some people consider the negative effect of rain on fruit set as an indirect effect via low temperatures that synchronize or follow rain. Others consider rain that occurs just after pollination as a washing agent that takes away most of the applied pollen before it plays its role. Reuveni (1986) found that most of the pollen tubes reach the base of the style of Hayany variety flowers within 6 hours at temperatures between 25 and 28°, while pollen tubes do not reach the base of the style even after 8 hours at low temperature (15°C). The latter part of the pollination season, in most date palm growing areas, is usually described by severe dry and

hot wind which dries out the stigmas of the female flowers. Cold winds disturb the pollen germination. It seems, therefore, that dry wind storms lead to a faster drying of the styles before the pollen tube reaches the ovule (Henderson, 1986). Also according to PereauleRoy (1958) there is a limited period (4 to 6 hours either before or after pollination) during which, if rain occurs, pollination and fruit sets are affected and the pollination operation must then be repeated.

In Egypt, farmers mostly use hand pollination techniques by various ways. They are unaware of the best techniques of pollination, which may be easiest and most convenient. So it is needed to find the best pollination technique for improving fruit setting percentage. Therefore, the main aim of this study is to stimulate and accelerate the pollen germination by using stimulative solution of pollen germination (SSPG) to avoid the negative effect of rain, low temperatures and severe hot and dry wind on fruit set. As well as, maximizing pollination efficiency by investigating the effect of three pollen/filler ratios on fruit set, palm yield and date quality.

MATERIALS AND METHODS

The present work was accomplished during two successive seasons of 2013 and 2014, respectively on 32 female date palms (*Phoenix dactylifera*, L.) of "Hayany" cultivar. Palms were 45-year-old grown in a clay sandy soil at Om-Elreda village, Damietta governorate, Egypt. Such experimental palms were chosen uniform as far as possible on the bases of their height and growth vigor and subjected to the normal schedule of cultural practices to investigate different pollination techniques.

Procedure of the tested pollination techniques

Four replications were used with each treatment in a randomized complete block design (in a factorial experiment), one palm represented one replication. Eight female spathes on each palm were labelled and subjected to the following pollination techniques during both two seasons.

Traditional pollination (TP) by using 5 inverted male strands/female spathe (T_1), spraying stimulative solution of pollen germination (SSPG) followed with TP (T_2), dusting 5% pollen mixture "PM" (T_3), spraying SSPG followed with dusting 5% PM (T_4), dusting 10% PM (T_5), spraying SSPG followed with dusting 10% PM (T_6), dusting 20% PM (T_7), and spraying SSPG followed with dusting 20% PM (T_8).

Two pollination techniques were assessed by hand (traditional pollination) and with a hand pollen duster. The pollination was done during the April on opening or cracking spathe in both seasons by using the same pollen sources (two selected male date palms grown at the same orchard).

Applying Stimulative solution of pollen germination (SSPG)

Just before pollination, about 10ml of stimulative solution of pollen germination (SSPG) was sprayed on each tested female inflorescence (spathe) by hand sprayer. Brewbaker and Kwack's medium (1963)

with some modifications was used as SSPG. Such used medium consisted of 12% sucrose, 0.1g K_2SO_4 , 0.2 $MgCl_2$, 0.3g $Ca(NO_3)_2$, and 0.1g H_3BO_3 as well as vitamin $b_{1,6}$ and b_{12} at 200, 50, and 1.0 mg/l, respectively.

Preparing and handling pollen mixtures

For the hand dusters, the pollen grains were extracted by removing protective sheath and inflorescence was kept under sunlight on newspaper for one hour. After that, the flowers were opened and pollen grains released. The pollens were collected and mixed with wheat flour as filler at 1 part pollen to 19, 9 and 4 parts flour, respectively. Regarding traditional pollination, the pollinator climbed the palm and placed 5 inverted male strands into the female spathe cracked and then tied the distal end of it.

On each date palm in both seasons, eight female spathes nearly similar in vigor were selected and the others were removed. The daily period of pollination was between 10.00 am and 2.00 pm. All spathes were bagged, each in a large paper bag just after cracking and it remained covered after pollination for three weeks to prevent any contamination with other pollen grains. The leaf / bunch ratio was maintained at 7:1.

Measuring growth characters of Aerjon (bunch)

The growth characters of Aerjon (Curved stem of female inflorescence which originates from the axilla of palm leaves and carries floral stalks on its terminal part) at harvesting were measured in cm. Such characters included Aerjon length and perimeter (directly before branching) and strand length.

Fruit set and drop percentages and yield/palm

Twelve female strands were randomly selected from each bunch. On these strands, number of normal setting fruits (NNSF), number of abnormal setting fruits (NASF) and number of flower scars (NFS) were counted after 3 weeks from pollination. At harvest time, number of remaining fruits on strand (NRFS), number of strands/bunch (NSB) and number of bunches/palm (NBP) as well as average fruit weight (g) of 20 date fruits (Av. FW) were also counted. Then fruit set percentage, fruit drop percentage and yield/palm (kg) were calculated for each treatment by using the following equations:

$$\text{Fruit set \%} = [(NNSF) / (NNSF + NASF + NFS)] \times 100$$

$$\text{Fruit drop \%} = [(NNSF - NRFS) / (NNSF)] \times 100$$

$$\text{Yield/palm (kg)} = [(NRFS) \times (\text{Av. FW}) \times (\text{NSB}) \times (\text{NBP})] / 1000$$

Physical and chemical characteristics of fruit

Fifty completed red color date fruits from each replicate were randomly harvested at the end of khalal (bisir) stage (during the second week of October in both seasons) and used for determination of the following physical and chemical parameters of their fruits. The harvested samples fruits were immediately packed in plastic bags and kept on ice during transporting to the laboratory, and then kept in a refrigerator at $5 \pm 1^\circ C$ for the determination of physical and chemical properties, i.e., fruit weight (g), fruit number/kg, fruit size (cm^3), fruit length (cm), fruit diameter (cm), flesh/seed ratio (w/w). The total sugars content was analyzed in flesh

according to AOAC (2014) and the results were computed on a dry weight basis. The titratable acidity (citric acid), soluble solid content (SSC %) and vitamin C content (mg/100ml) were determined in date juice according to Ranganna (1979).

Statistical analysis

Data were statistically analyzed as a factorial experiment on design of randomized complete block by analysis of variance (ANOVA) using the statistical package software SAS (SAS, 2000). Comparisons between means were made by F-test and Duncan's new multiple range tests at $P \leq 5\%$.

RESULTS AND DISCUSSION

Growth characteristics of Aerjon (bunch)

The vegetative growth characteristics of Aerjon were involved the total length and perimeter as well as strand length in cm. Data in Table 1 show that the combinations of the three pollen mixtures (PM) "5%, 10% and 20%" and spraying SSPG (T₄, T₆ & T₈, respectively) resulted in significantly higher growth characteristics of Aerjon than those of the corresponding PM solely (T₃, T₅ & T₇, respectively). The treatment of SSPG spraying followed with TP (T₂) had similar trend in this respect. No considered differences in length of both Aerjon and strand were observed between the tested PM alone and TP (the control technique). Spraying SSPG on the female inflorescences immediately before applying PM

exhibited highly significant increase of Aerjon total length and perimeter as well as strand length (175, 95.1 and 10.3 cm, respectively) compared with no spraying SSPG (159.7, 87.7 and 9.43 cm, respectively). The stimulatory effect of SSPG on growth characteristics of Aerjon could be attributed to its contents of B, Ca, K and vitamin B complex which may be stimulated cell division and elongation. Such increases are necessary for providing the best growth distances of setting fruits and thus reduce dropping of fruits and improve their qualities. Also, increasing the length of Aerjon makes its bending process easier and thus facilitates the collection of rutab fruits. With respect to the physiological roles of B, Ca, K and vitamin B complex on the plant vegetative growth characteristics, it has been shown that calcium is required for cell wall structure and for maintenance of membrane integrity and is involved nearly all aspects of plant development (Hanson, 1984 and Harper *et al.*, 2004), and increasing evidence suggests that boron may affect metabolic pathways which play important roles in the growth and development of vascular plants by binding apoplastic proteins to cis-hydroxyl groups of membranes and cell walls, and by interfering with manganese-dependent enzymatic reactions (Blevins and Lukaszewski, 1998). In the same line, K (potassium) acts in a complementary manner with reducing sugars to induce the turgor potential required for cell extension (Guardia and Benlloch, 1980).

Table 1. Growth characters of Aerjon (bunch) affected by various pollination techniques (average values of 2013 and 2014 seasons).

Pollination techniques		Growth characteristics of Arjon		
Pollen source * SSPG [®]		Length (cm)	Perimeter (cm)	Strand length (cm)
T1	TP	160.5c	9.09c	86.5d
T2	TP + SSPG	171.5b	9.93b	94.5b
T3	5% PM	161.4c	9.73b	89.8c
T4	5% PM + SSPG	180.6a	10.35a	94.4b
T5	10% PM	158.4c	8.98c	86.9d
T6	10% PM + SSPG	176.1a	9.73b	90.3c
T7	20% PM	158.6c	9.95b	87.5cd
T8	20% PM + SSPG	181.3a	10.35a	101.1a
	F-test	**	**	**
	<u>Pollen source</u>			
	TP	166.0a	9.50b	90.5ab
	5% PM	171.0a	10.04a	92.1ab
	10% PM	167.3a	9.35b	88.6b
	20% PM	169.9a	10.15a	94.3a
	F-test	NS	**	*
	<u>SSPG spray</u>			
	Water	159.7	9.43	87.7
	SSPG	175.0	10.30	95.1
	T-test	**	**	**

SSPG[®], Stimulative solution of pollen germination. TP, Traditional pollination with male strand pollen. PM, Pollen mixture. Values within each column followed with the same letter are not statistically different at 5% level. **, Significant at level $p = 0.01$ *, Significant at level $p = 0.05$. NS, Non-significant.

Fruit setting and drop and palm yield

The obtained results in Table 2 indicate that the method of TP preceded by spraying SSPG (T₂) produced the highest fruit set percentage (36.21%) and yield/palm (169.2 kg) while, the lowest fruit set (26.99 & 26.71%) and yield per palm (105.8 & 111.9 kg) were obtained with the pollination of 5% PM and TP alone

(control), respectively. This result is strengthened by the findings of Iqbal *et al.*, (2010) which revealed that different pollination techniques had significantly affected the fruit setting and other quality parameters. Similar tendency was obtained by Hamood *et al.*, (1986). Moreover, both fruit set% and palm yield were increased significantly by increasing pollen ratio in PM

of T₃, T₅ and T₇. Such findings could be referred to the reduction of fruit set as the pollen grains concentration is reduced in turn this leads to reduce the remaining fruits, hence the fruits weight/bunch and thus palm yield was reduced. The above results are in agreement with those obtained by El-Kassas *et al.*, (1996); El-Salhy, *et al.*, (1997) and El-Salhy, *et al.*, (2010). They indicated that there was a positive correlation between fruit set% and the obtained weight of bunch at harvest. In addition,

the enhancement in fruit set and yield / date palm of Hayany cv. by pollination with either PM alone or combined with SSPG may be ascribed to its effects on the physiological activities that progress the formation and movement of natural hormones which are essential to ameliorate of cell division, especially in the meristematic tissues (El-Salhy *et al.*, 2007 and Al-Qurash *et al.*, 2012).

Table 2. Effect of various pollination techniques on fruit setting and drop and palm yield (average values of 2013 and 2014 seasons).

Pollination techniques		Fruit setting (%)	Fruit drop (%)	Palm yield (kg)
Pollen source * SSPG [®]				
T1	TP	26.71e	42.61b	111.9f
T2	TP + SSPG	36.21a	33.27c	169.2a
T3	5% PM	26.99e	49.10a	105.8g
T4	5% PM + SSPG	30.63c	41.33b	123.8e
T5	10% PM	28.95c	35.10c	134.8d
T6	10% PM+ SSPG	31.59bc	35.09c	146.74c
T7	20% PM	32.30b	33.75c	160.0b
T8	20% PM+ SSPG	30.71bc	21.98d	156.3b
F-test		***	***	***
Pollen source				
TP		31.46a	37.94b	140.6a
5% PM		28.80b	45.22a	114.8b
10% PM		30.27a	34.10b	140.8a
20% PM		31.50a	27.86c	158.2a
F-test		*	***	***
SSPG spray				
Water		28.37	40.03	128.8
SSPG		32.29	32.42	149.1
T-test		**	**	**

SSPG[®], Stimulative solution of pollen germination. TP, Traditional pollination with male strand pollen. PM, Pollen mixture. Values within each column followed with the same letter are not statistically different at 5% level. ***, Significant at level $p = 0.001$. **, Significant at level $p = 0.01$. *, Significant at level $p = 0.05$.

In the same Table 2, the treatments included SSPG-spraying on the female inflorescences immediately before applying TP and PM at 5% or 10% (T₂, T₄ and T₆, respectively) significantly surpassed in fruit set% and palm yield (kg) compared to the corresponding treatments without SSPG-spraying (T₁, T₃ and T₅, respectively). These results are in parallel with those by Rosell *et al.*, (1999) who found that pollen requires prehydration prior to in vitro germination and it only germinates when the anthers are also added to the medium contained enough boron and calcium as well as sucrose at 5-10%. Such result was confirmed by Kavand *et al.*, (2014) who proved that existence of boron and calcium in medium are necessary for germination and pollen tube growth. The beneficial effect of boron on pollen germination and thus on improving fruit set were supported by results of Wang *et al.*, (2003) who evidenced that pollen germination in boron-efficient medium was 3 fold higher than it in boron-deficient medium. This regulatory positive role of boron in pollen germination and pollen tube growth could be attributed to involving boron in several physiological processes that include cell wall synthesis and maintenance, sugar transport, membrane integrity, and metabolism of RNA, indole acetic acid (IAA) and phenol (Loomis and Durst 1992, Dordas and Brown 2000). Moreover, pollen germination and pollen tube growth are also regulated by transferring inorganic Ca²⁺ and K⁺ ions across the plasma membrane (Taylor and Hepler, 1997). Such conclusion is in line with the findings of Kavand *et al.*,

(2014) who reported that application of certain concentration of calcium nitrate in culture media increased the date palm pollen germination rates. Calcium establishes polarity of the pollen tube during the elongation and forms a basis for pulsatory growth. The gametes fusion of male and female together requires calcium (Ge *et al.*, 2007).

Fruit drop was decreased significantly by increasing pollen ratio in PM of 5, 10 and 20% (Table 2). These pollination mixtures recorded 45.22, 34.10 and 27.86%, respectively as an average of the two tested seasons. The highest fruit drop percentages (49.10% and 42.61%) were obtained with the technique of 5% PM and TP (control) while, the lowest fruit drop (21.98%) was obtained with the technique of 20% PM. Spraying SSPG on the female inflorescences immediately before applying PM at three different concentrations (5%, 10% and 20%) and TP (T₄, T₆, T₈ and T₂, respectively) resulted in significantly reduction of fruit dropping compared with non SSPG treatments (T₃, T₅, T₇ and T₁, respectively). These findings confirmed those of Ali *et al.*, (2017) which indicated the beneficial effect of high concentration of boron (0.3%) and putrescine (0.45 mM) in decreasing the percentage of fruit drop and improving fruit quality. Also, calcium through cross-linking pectates and cementing cell wall materials will directly inhibit or retards the abscission of the fruits (Poovaiah and Leopold, 1976). In addition, the flowers and fruits abscission is primary responsible for low percentage of fruits retained to maturity (Rallo and

Fernandez-Escobar, 1985). This phenomenon has been observed in several fruit species and has been attributed to many factors specially calcium (Poovaiah and Leopold, 1976) and boron (Stanly and Lichtenberg, 1963) deficiency. In a study on leaf abscission, Poovaiah and Leopold (1976) reported that Ca²⁺ inhibited or slowed this process. However, significantly higher pollen germination was obtained with boric acid when compared to GA, IAA and IBA treatments and control (Bamzai and Randhawa, 1967; Acar *et al.*, 2010). Pollen of Japanese pear germinated well on agar medium containing 10% sucrose or glucose, but not on fructose medium (Okusaka and Hiratsuka, 2009). They also added that sucrose enhanced pollen tube growth much more effectively than glucose. The pollen respire 10 times faster than vegetative tissue and the rate of pollen tube growth can reach 1.0 cmh⁻¹ (Taylor and Hepler, 1997). To enable the pollen tube to grow at this rate, high supply of energy and rapid synthesis of cell wall materials such as pectins and cellulose are necessary+9 sucrose is generally used as an energy source during pollen tube elongation in many plant species (Derksen *et al.*, 1995), because it usually

stimulates pollen germination and subsequent tube growth. Moreover, the growth of pollen tube may be influenced by additions of vitamin B to the SSPG (Bonner and Greene, 1939 and Minarik, 1942).

Physical characteristics of fruit quality

The obtained results in Table 3 show that dusting pollen mixture (PM) on female palm inflorescence at rates of 5, 10 and 20% showed an increase in most measured physical characteristics that include fruit weight (g), size (cm³), length (cm), diameter (cm) and flesh/seed ratio compared to the traditional pollination (TP). The application of SSPG followed by TP (T₂) led to a significant increase in the fruit physical quality included weight, size and flesh/seed ratio compared with traditional pollination technique (T₁, only male strands). Pollinating the female inflorescences by dusting 10% PM alone (T₅) or preceded by spraying SSPG (T₆) were the best treatments to increase flesh/seed ratios. All pollination techniques decreased significantly fruits number/ kg comparing with the TP techniques (Table 3). Such result greatly confirmed the positive effect of PM alone or in combination with SSPG on weight and size of the resulting fruits.

Table 3. Effect of various pollination techniques on physical characteristics of date fruit quality at end of khalal stage (average values of 2013 and 2014 seasons).

Pollination techniques		Physical characteristics of date fruit					Flesh/seed ratio(w/w)
Pollen source	* SSPG [®]	Weight (g)	No./kg	Size (cm ³)	Length (cm)	Diameter (cm)	
T1	TP	22.33e	44.8a	22.99d	5.25d	2.58b	8.15e
T2	TP + SSPG	23.46d	42.7b	25.11c	5.32cd	2.59b	8.96d
T3	5% PM	24.84c	40.3c	26.59abc	5.44bc	2.74a	8.86d
T4	5% PM + SSPG	26.02ab	38.5de	25.57bc	5.43bc	2.71a	9.21cd
T5	10% PM	25.42bc	39.5cd	27.02ab	5.50b	2.70a	10.84a
T6	10% PM + SSPG	26.37a	38.0e	27.09ab	5.66a	2.75a	9.79b
T7	20% PM	25.42bc	39.5cd	27.59a	5.56ab	2.73a	10.00b
T8	20% PM + SSPG	26.10ab	38.4de	26.72abc	5.52ab	2.71a	8.82d
F-test		***	***	***	**	**	***
	<u>Pollen source</u>						
	TP	22.90b	43.8a	24.05b	5.29c	2.40b	8.55c
	5% PM	25.43a	39.4b	26.08a	5.44b	2.61a	9.03bc
	10% PM	25.90a	38.8b	27.06a	5.58a	2.71a	10.31a
	20% PM	25.76a	38.9b	27.15a	5.54ab	2.72a	9.41b
F-test		***	***	***	**	**	***
	<u>SSPG spray</u>						
	Water	24.50	41.0	26.05	5.44	2.69	9.46
	SSPG	25.49	39.4	26.12	5.48	2.69	9.19
T-test		**	NS	NS	NS	NS	NS

SSPG[®], Stimulative solution of pollen germination. TP, Traditional pollination with male strand pollen. PM, Pollen mixture. Values within each column followed with the same letter are not statistically different at 5% level. ***, Significant at level *p* = 0.001. **, Significant at level *p* = 0.01. NS, Non-significant.

The present results are disagree with findings of Hamood *et al.*, (1986) with date palm Zahidi cultivar and Iqbal *et al.*, (2010) with Dhakki date palm. They reported no significant differences in fruit weight and length. This mismatch between our results and the findings of other mentioned researches attributed to the difference in the tested cultivars, as well as the use of stimulative solution of pollen germination (SSPG) before dusting PM in the our present research. Applying SSPG increased strand length of female inflorescence which is necessary for providing the best growth

distances of setting fruits and consequently improving their physical qualities.

3.4. Chemical characteristics of fruit quality

Data presented in Table 4 show that dusting 5% PM on the female inflorescences gave fruits have the lowest content of total sugars (21.55%) comparing to the other pollination techniques studied (24.52, 25.54 and 26.57% for TP, 10% PM & 20% PM, respectively). Regarding the effect of pollination techniques tested on SSC% of the obtained fruits, the same trend was true.

Table 4. Effect of various pollination techniques on chemical characteristics of date quality at end of khalal stage (average values of 2013 and 2014 seasons).

Pollination techniques		Total sugars (%)	Titrateable acidity (%)	SSC (%)	Vit.C (mg/100 ml juice)
Pollen source * SSPG [®]					
T1	TP	23.39d	0.73c	31.6ab	07.79f
T2	TP + SSPG	25.64c	0.74c	31.6ab	11.65c
T3	5% PM	21.15f	0.75c	32.0ab	12.28b
T4	5% PM + SSPG	21.96ef	0.78bc	27.6c	10.90d
T5	10% PM	22.68de	0.84ab	32.8a	09.42e
T6	10% PM+ SSPG	28.40b	0.71cd	31.9ab	12.87a
T7	20% PM	23.49d	0.87a	32.2ab	11.29c
T8	20% PM + SSPG	29.65a	0.67d	30.6b	12.30b
F-test		***	***	**	***
Pollen source					
TP		24.52ab	0.74a	31.6ab	09.72b
5% PM		21.55b	0.76a	29.8b	11.59a
10% PM		25.54a	0.77a	32.4a	11.14a
20% PM		26.57a	0.76a	31.4ab	11.79a
F-test		*	NS	*	*
SSPG spray					
Water		22.68	0.80	32.2	10.20
SSPG		26.41	0.73	30.4	12.00
T-test		***	*	**	**

SSPG[®], Stimulative solution of pollen germination. TP, Traditional pollination with male strand pollen. PM, Pollen mixture. Values within each column followed with the same letter are not statistically different at 5% level. ***, Significant at level $p = 0.001$. **, Significant at level $p = 0.01$. *, Significant at level $p = 0.05$. NS, Non-significant.

In general, spraying SSPG on the female inflorescences before dusting PM resulted in significantly increases of fruit total sugars (26.41%) and Vit C (12 mg/100ml juice) contents and significantly decreases of fruit SSC (30.40%) and acidity (0.73%) contents compared with those of pollination treatments without spraying SSPG which recorded 22.68%, 10.2 mg/100ml juice, 32.16% and 0.80% for total sugars, Vit C, SSC and acidity, respectively. This trend was more pronounced for fruits of the combinations between SSPG and PM at 10% or 20% (T6 & T8) compared with those from applying PM only (T5 & T7). These results are in line with the findings of Saleh *et al.*, (2014) who stated that fruits from palms treated with pollen grains or bio-activator contained less non reducing sugar values than those treated with its combination. Such finding might be due to reduction of compactness and the better supply of carbohydrates which are synthesized in the leaves. On the other hand, no significant difference was observed in fruit acidity% between the tested pollination techniques (Table 4). This result is strengthened by El-Mardi *et al.*, (1998) who reported that the differences in the chemical properties of date fruits produced by hand pollination were nonsignificant compared to those of the hand and motorized dusters at different pollen concentrations.

CONCLUSION

Considering the aforementioned results, it could be concluded that applying SSPG on female inflorescences before TP and dusting PM at 5, 10 or 20% stimulates and accelerates germination pollen grain of date palm. Therefore, it improves the fruit set percentage, reduces fruit drop and consequently increases yield/date palm. Moreover, these pollination techniques greatly succeeded to enhance the physical and chemical characteristics of fruit qualities that include increasing weight, size, flesh/seed ratio and

contents of total sugars and vitamin C as well as reducing acidity percentage.

From the previous present data, it could be recommended with using the combination of spraying SSPG and dusting 10% PM as an improved pollination technique. It saved the required pollen grains comparing with applying 20% PM and also produced high yield/date palm has the high physical and chemical qualities. The combination of mixing pollen grains with carrier and SSPG is useful for establishing mechanical pollination and getting an economical yield with good quality of fruits. Also, it is surely responsible for enhancing pollination efficacy. Mechanization of date production is becoming more important due to the rise of production cost and shortage of human power, particularly the difficult to find skilled labors to work during the period of peak pollination.

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تحسين تكنيك التلقيح في نخيل البلح

الرفاعي فؤاد أحمد الذنجاوي

قسم الفاكهة – كلية الزراعة – جامعة دمياط – مصر

أجريت هذه الدراسة خلال موسمين متعاقبين هما ٢٠١٣ و ٢٠١٤م بهدف تحسين تكنيك التلقيح في نخيل البلح . وقد استخدم لهذا الغرض ٣٢ نخلة بلح صنف حياني متماثلة النمو تقريبا ، نامية في أرض رملية طينية في بستان خاص في منطقة أم الرضا بمحافظة دمياط – مصر. وقسمت أشجار النخيل إلى ٨ مجموعات بكل منها ٤ نخلات (٤ مكررات) وأخضعت كل مجموعة لتكنيك تلقيح معين. وقد أجريت عملية التلقيح في شهر إبريل من كل موسم باستخدام شماريخ لقاح مذكرة (كنترول) أو التعفير بخليط لقاح مع دقيق قمح بنسب ٥% أو ١٠% أو ٢٠% إما منفردة أو مسبوقا مباشرة برش النورات المؤنثة بمحلول منشط لانبات حبوب اللقاح (SSPG). وقد درس تأثير تكنيك التلقيح المستخدم على صفات نمو العرجون والنسبة المئوية لعقد وتساقط الثمار وكمية المحصول الناتجة لكل نخلة وجودة الثمار التي تتمثل في وزن وحجم الثمار ونسبة اللحم/النواة ومحتوى الثمرة من فيتامين ج والسكريات الكلية والحموضة والمواد الصلبة الذائبة. وأوضحت النتائج أن معظم معاملات التلقيح المدروسة حسنت كثيرا من صفات نمو العرجون والنسبة المئوية لعقد الثمار وأنقصت تساقط الثمار ونتج عن ذلك زيادة محصول النخلة بدرجة معنوية مقارنة بطريقة التلقيح التقليدية (الكنترول). وأيضا نجحت طرق التلقيح المستخدمة في تعزيز صفات جودة الثمار الطبيعية والكيميائية ، وكانت أفضل المعاملات في ذلك الرش بمحلول منشط لانبات حبوب اللقاح (SSPG) متبوعا مباشرة بالتعفير بخليط اللقاح بتركيز ٢٠% أو ١٠%. بناء على ماسبق يمكن التوصية باستخدام تكنيك التلقيح بخليط لقاح ١٠% مسبوقا بالرش بمحلول منشط لانبات حبوب اللقاح (SSPG). حيث يوفر ١٠% من كمية اللقاح المستخدمة وينتج محصولا جيدا عالي الجودة مقارنة بخليط اللقاح ٢٠%. وهذا التكنيك يفيد مستقبلا في تأسيس تلقيح ميكانيكي يعطى محصولا اقتصاديا بجودة عالية مع تقليل التكلفة.