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## Improving Pollination Efficiency, Yield and Fruit Quality of Two Date Palm Cultivars using Growth Activator

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### ABSTRACT

This study was carried out during two successive seasons 2011 and 2012 on Zaghloul and Samany date palm cultivars grown in a private orchard at Abo-Rawash region, Giza Governorate, Egypt. This investigation included treatments for three periods to activate pollen grains using in small amounts by mixing with the natural growth activator (Milagro) and evaluate its impact on the efficiency of pollination process, yield and fruit quality. The first one was carried out by dusting female inflorescence as soon as it opened using (pollen grain at 2 g, Milagro at 1 g and mixture of pollen grains at 1 g+Milagro 1 g). After one month and two months from initial treatment the 2nd and the 3rd treatments were carried out with the same rates, in order to increase yield and improve fruit quality. Results showed that all treatments markedly improved pollination, yield and fruit quality. The best results were achieved from the combined treatment (pollen grains at 1 g+Milagro 1 g) which recorded the highest significant percentages for fruit set and retained fruits. Physical and chemical characteristics of fruits expressed by fruit shape, weight, volume, pulp value, bunch weight and yield/palm as well as TSS%, reducing sugars and total sugars were markedly enhanced. It is concluded that the growth activator Milagro has potential strategy for improving pollination, yield and fruit quality of date palm cultivars under study, besides its environmentally safe effect as non-chemical tool.

**Key words:** Date palm, fruit quality, milagro, pollination, yield

### INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruit crops grown in arid regions of the Arabian Peninsula, North Africa and Middle East. Dates are a major food source where its tree parts used for various purposes as well as resembling income source for local populations in Middle East and North Africa. Also, date palm plays a significant role in economy, society and environment of these areas (Botes and Zaid, 1999; Chao and Krueger, 2007).

Zaghloul and Samany are considered the most important soft cultivar date fruits in Egypt. The successful in horticultural management practices are directed toward obtaining a high yield with good fruit quality. Pollination is one of the most important cultural practices for date palm orchards where it classified as a dioecious species with male and female flowers produced on separate trees (Ashour *et al.*, 2008). Dates are naturally wind pollinated but humans have assisted in this pollen transfer since great antiquity by limiting quantity of pollen grains as basis to justify the use of mechanical pollination using dusters and sprayers. Therefore, artificial hand pollination becomes

a necessary operation as a mean to ensure good yield (Chabana and Shafaat, 1982; Ashour *et al.*, 2004). Bio-regulators were used to improve tree productivity and fruit quality (Aljuburi *et al.*, 2001). Milagro is a natural growth activator that extracted from pollen flowers of cabbage has a broad effect on different crops. This product is reflecting the effect of Auxins, Cytokinins, Gibberellins, Ethylene, Hydrogen Sinamed and Humic, where its impact depends on the time of trans-action. It improve plant growth in all parts as a tonic for physiological processes in particular, enhance photosynthesis, increases the yield by 20-25% and improves quality characteristics (Abd El-Zaher, 2008; Ebeed *et al.*, 2008; Ramezani and Shekafandeh, 2009).

Thus, the objective of the present work was to evaluate the possibility of using the natural growth activator Milagro as a safe way with or without pollen grains to enhance pollination process, increase yield and improve fruit quality of Zaghloul and Samany date palm cultivars.

## **MATERIALS AND METHODS**

**Date palm orchard:** Tested Zaghloul and Samany date palm Cvs. cultivated in a private orchard at Abo-Rawash region, El-Giza Governorate were twenty years old, grown in sandy soil, spaced 8×8 m, under drip irrigation system, similar in growth and received common horticultural practices. Fruits were picked during 2nd week of September at mature stage (Bisir or Khalaal) during 2011 and 2012 seasons.

**Treatments:** Nine tested female uniform date palm trees of both cultivars were pollinated during 1st week of April as soon as it opened by dusting female inflorescence using (2 g pollen grains+3 g filler material) or (1 g Milagro+4 g filler material) or (1 g pollen grains+1 g Milagro+3 g filler material) to be at equal volume 5 g. These treatments were re-conducted after one month and two months from initial treatment, in order to increase yield and improve fruit quality. Each tested cultivar was resembled with 3 trees/either treatment in a randomized complete block design and grouped under 3 treatments.

### **Studied parameters**

**Fruit set percentage:** The number of fruit set was recorded and fruit set percentages calculated according to El-Mkhtoun (1981).

**Fruit retention percentage:** It was determined according to Soliman and El-Kosary (2002) using the following equation: Total No. of the retained fruits per bunch total No. of the nodes per bunch.

**Total yield/palm:** Bunches were harvested during the 2nd week of September at the peak of color development to determine No. of bunches per palm and average of bunch weight (kg).

**Fruit quality:** Twenty fruits were randomly selected from each bunch, for determination physical and chemical fruit properties.

**Physical characteristics:** Fruit length (L) and diameter (D) (cm), shape (L/D), volume (cm<sup>3</sup>), weight (g), flesh%, seed% and specific weight as weight/volume were assessed.

### **Chemical characteristics**

**Total soluble solids (TSS%):** Was determined in fruit juice using hand refractometer.

**Total acidity percentage (TA%):** Estimated as malic acid/100 mL juice according to AOAC (1995).

**Total sugars (g/100 g fresh weight):** Was determined as described by Smith *et al.* (1956).

**Reducing sugars:** Determined in the methanolic extract according to AOAC (1995).

**Non-reducing sugars:** By differentiate between total and reducing sugars.

**Total soluble tannins (g/100 g fresh weight):** Was determined in fruit tissue (including skin and flesh) using Folin-Ciocalteu and sodium carbonate reagent and measured for absorbance using a UV-V Spectrophotometer at 750 nm according to Taira (1996).

**Statistical analysis:** Data subjected to Analysis of Variance and mean values were compared by the Least Significant Difference (LSD) test at significance  $p = 0.05$  (Snedecor and Cochran, 1980).

## RESULTS AND DISCUSSION

### Fruit set, fruit retention and yield/palm

**Fruit set (%):** It is clear that Samany cv. treatments had reflected significant increase in fruit set (60.9%) as compared with Zaghloul cv. dates which recorded (58.7%) as shown in Table 1. The best values were obtained by the combined treatment Milagro+pollen grains (65.1%) followed by sole treatment of Milagro (59.2%) as compared with the sole treatment of pollen grains. As for interactions, data showed that pollen grain+Milagro treatment gave the highest significant fruit set percentages for Zaghloul and Samany dates (65.4 and 64.9%), respectively, with no significant difference among them.

**Fruit retention (%):** Data in Table 1 showed that Samany cv. gave significant increment in fruit retention (46.3%) as compared with Zaghloul cv. (42.7%). The best treatments that gave highest significant values were obtained in dates pollinated by Milagro alone (50.3%), followed by the combined treatment of Milagro+pollen grains (48.2%). Regarding interactions, Samany cv. showed the highest significant percentage as pollinated by Milagro alone (57.0%) than Zaghloul cv.

**Total yield/palm (kg):** Data in Table 1 revealed that Samany cv. recorded superior increase in total yield (124.0 kg) as compared with Zaghloul cv. (71.6 kg). Different treatments reflected higher values of total yield/palm while the best results were obtained as Milagro combined with pollen

Table 1: Fruit set, fruit retention and yield/palm of Samany and Zaghloul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Fruit set (%)			Fruit retention (%)			Yield/palm (kg)		
	Samany	Zaghloul	Means	Samany	Zaghloul	Means	Samany	Zaghloul	Means
Pollen grains (P)	57.2	52.2	54.7 <sup>c</sup>	34.0	36.0	35.0 <sup>c</sup>	115.5	68.0	91.8 <sup>c</sup>
Milagro (M)	59.9	58.4	59.2 <sup>b</sup>	57.0	43.5	50.3 <sup>a</sup>	122.2	68.5	95.4 <sup>b</sup>
P+M	64.9	65.4	65.1 <sup>a</sup>	47.8	48.5	48.2 <sup>b</sup>	134.2	78.2	106.2 <sup>a</sup>
Means	60.9 <sup>a</sup>	58.7 <sup>b</sup>		46.3 <sup>a</sup>	42.7 <sup>b</sup>		124.0 <sup>a</sup>	71.6 <sup>b</sup>	
LSD <sub>0.05</sub> (P+M) =		0.98			1.7			22.8	

Table 2: Bunch weight, fruit weight and fruit volume of Samany and Zaghoul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Bunch weight (kg)			Fruit weight (g)			Fruit volume (cm <sup>3</sup> )		
	Samany	Zaghoul	Means	Samany	Zaghoul	Means	Samany	Zaghoul	Means
Pollen (P)	21.5	24.0	22.8 <sup>c</sup>	28.30	20.9	24.6 <sup>c</sup>	28.60	22.2	25.4 <sup>c</sup>
Milagro (M)	23.5	27.1	25.2 <sup>b</sup>	30.60	23.3	27.0 <sup>b</sup>	31.00	22.5	26.8 <sup>b</sup>
P+M	26.0	28.4	27.2 <sup>a</sup>	33.50	23.1	28.3 <sup>a</sup>	33.70	23.2	28.5 <sup>a</sup>
Means	23.7 <sup>b</sup>	26.5 <sup>a</sup>		30.80 <sup>a</sup>	22.4 <sup>b</sup>		31.10 <sup>a</sup>	22.6 <sup>b</sup>	
LSD <sub>0.05</sub> (P+M) =		1.1			0.41			0.11	

grains (106.2 kg). Followed by sole treatment of Milagro (95.4 kg) and the pollen grain treatment (91.8 kg), consecutively with high significant differences. Concerning interactions, results indicated that Samany cv. pollinated with Milagro+pollen grains gave the highest significant yield value (134.2 kg) as compared with other interaction values.

The enhancement in fruit set, fruit retention and yield/palm Cvs. of Samany and Zaghoul by pollination with either Milagro alone or combined with pollen grains may be attributed to its effects in the processes of photosynthesis, Auxin, Cytokinin, Gibberellins, Ethylene, Hydrogen Sinamed and Humic that progress the formation and movement of natural hormones which are vital to improvement of cell division, especially in the meristematic tissues. These findings are in accordance with reports by Abou Aziz *et al.* (1982), Soliman and El-Kosary (2002), Kassem and Marzouk (2002), Abo-El-Ez *et al.* (2002), El-Kosary (2009) and Al-Qurash *et al.* (2012).

### Physical characteristics

**Bunch weight (kg):** Results in Table 2 indicated that the highest bunch weight was significantly obtained by Zaghoul cv. treatments (26.5 kg) as compared with Samany date cv. (23.7 kg). Moreover, bunch weight recorded highest significant values as dates pollinated with pollen grains+Milagro (27.2 kg) followed in descending order by sole Milagro treatment (25.2 kg) and pollen grain treatment (22.8 kg) with highly significant differences between them.

Regarding interactions, Zaghoul cv. pollinated with Milagro+pollen grains followed by Milagro treatment, recorded highest significant values (28.4 and 27.1 kg, respectively).

**Fruit weight (g):** Data indicated that Samany cv. gave higher fruit weight (30.8 g) than Zaghoul cv. Also, palm dates treated with (Milagro+pollen grains) showed highest statistical values (28.3 g) than other treatments. Regarding interactions, data cleared that Milagro+pollen grain induced high significant increment in fruit weight of Samany cv. (33.5 g) as compared with other interaction values.

**Fruit volume (cm<sup>3</sup>):** Data in Table 2 cleared that trend of fruit volume was similar to those of fruit weight.

**Fruit length (cm):** It is noticed from Table 3 that Zaghoul cv. had significant increase in fruit length (6.02 cm) as compared with Samany cv. fruit (5.72 cm). The best values were obtained as dates pollinated with Milagro+pollen grains (6.09 cm) followed by Milagro treatment (5.88 cm). As for the interaction, data showed that fruit length of Zaghoul cv. was dominated as treated with Milagro+pollen grains(6.45 cm) followed by single treatment of Milagro (5.90 cm).

Table 3: Fruit length, fruit diameter and fruit shape of Samany and Zaghoul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Fruit length (cm)			Fruit diameter (cm)			Fruit shape		
	Samany	Zaghoul	Means	Samany	Zaghoul	Means	Samany	Zaghoul	Means
Pollen (P)	5.57	5.72	<b>5.65<sup>c</sup></b>	3.25	2.70	<b>2.98<sup>b</sup></b>	1.74	2.10	<b>1.92<sup>b</sup></b>
Milagro (M)	5.85	5.90	<b>5.88<sup>b</sup></b>	3.30	2.65	<b>2.98<sup>b</sup></b>	1.79	2.20	<b>2.00<sup>a</sup></b>
P+M	5.73	6.45	<b>6.09<sup>a</sup></b>	3.40	2.85	<b>3.13<sup>a</sup></b>	1.68	2.25	<b>1.97<sup>a</sup></b>
Means	<b>5.72<sup>b</sup></b>	<b>6.02<sup>a</sup></b>		<b>3.32<sup>a</sup></b>	<b>2.73<sup>b</sup></b>		<b>1.74<sup>b</sup></b>	<b>2.18<sup>a</sup></b>	
LSD <sub>0.05</sub> (P+M) =		0.14			0.11			0.37	

Table 4: Flesh%, seed% and specific weight of Samany and Zaghoul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Flesh%			Seed%			Specific fruit weight		
	Samany	Zaghoul	Means	Samany	Zaghoul	Means	Samany	Zaghoul	Means
Pollen (P)	90.3	88.8	<b>89.6<sup>a</sup></b>	10.00	11.2	<b>10.6<sup>a</sup></b>	0.89	0.94	<b>0.96<sup>b</sup></b>
Milagro (M)	90.4	89.5	<b>89.5<sup>ab</sup></b>	9.60	10.6	<b>10.1<sup>b</sup></b>	0.99	1.10	<b>1.10<sup>a</sup></b>
P+M	90.0	89.1	<b>89.7<sup>a</sup></b>	10.60	10.7	<b>10.7<sup>a</sup></b>	0.99	1.00	<b>0.99<sup>a</sup></b>
Means	<b>90.2<sup>a</sup></b>	<b>89.0<sup>b</sup></b>		<b>10.10<sup>b</sup></b>	<b>10.8<sup>a</sup></b>		<b>0.99<sup>a</sup></b>	<b>1.01<sup>a</sup></b>	
LSD <sub>0.05</sub> (P+M) =		0.65			0.96			0.30	

**Fruit diameter (cm):** Obtained data illustrated that Samany cv. was superior to Zaghoul in this character and registered highest statistical value (3.32 cm) as compared with Zaghoul cv. (2.73 cm). Concerning treatments, combined pollination with Milagro+pollen grains recorded highest increment in fruit diameter (3.13 cm) followed by either Milagro or pollen grains treatment with the same value (2.98 cm). As for interactions, Samany cv. resulted in highest significant fruit diameter when pollinated with the Milagro+pollen grain or Milagro alone as compared with pollen grains only.

**Fruit shape:** Data in Table 3 revealed that Zaghoul cv. was more shaped (2.18) as compared with Samany dates. The best treatments were significantly obtained as Milagro applied alone (2.00) or combined with pollen grains (1.97) with non significant differences. Results for interactions indicated that Zaghoul cv. pollinated with Milagro alone or combined with pollen grains reflected highest significant values of fruit shape (2.25 and 2.20) as compared with pollen grains only.

**Flesh of fruit (%):** Data in Table 4 clearly indicated that Flesh% in Samany cv. (90.2%) was superior to Zaghoul cv. (89.0%). Best treatment results were obtained from pollinated dates with either Milagro (89.5%) or pollen grains (89.6%) or in combination (89.7%), with no significant differences. Regarding interaction, results revealed that pollination with sole treatment of either Milagro or pollen grains induced highest significant increase in flesh of Samany cv. (90.4 and 90.3%), consecutively.

But, Milagro+pollen grain treatment recorded the next in this respect (90.0%) with non statistical differences.

**Fruit seed (%):** Data indicated that the seed% of Zaghoul cv. contained high (10.8%) as compared with Samany cv. (10.1%). Palms treated with either sole application of pollen grains or in

combination with Milagro gave highest statistical increase in seed% (10.6 and 10.7%) than Milagro alone (10.1%). Results concerning interactions cleared that Zaghoul cv. pollinated by Pollen grains recorded the highest values of seed% (11.2%).

**Specific fruit weight:** From data in Table 4, it is noticed that trend of specific fruit weight was similar to those of Samany and Zaghoul dates Cvs. Moreover, results showed no significant differences between sole pollination with Milagro or when combined with pollen grains in this respect.

The improvement in all aspects of physical characteristics for pollinated date Cvs. by growth activator Milagro alone or combined with pollen grains may be attributed to its effects in stimulating biosynthesis of organic materials especially carbohydrates and proteins and enhancement the formation and movement of natural hormones which are vital to improvement of cell division and cell enlargement, especially in the meristematic tissues (Abo-El-Ez *et al.*, 2002). These results are in harmony with those obtained by Ragab (2004), Al-Hammadi (2006) and El-Khawaga (2013).

**Chemical characteristics**

**Total soluble solids (%):** It is clear from Table 5 that fruits of Samany cv. gave highest significant increase in TSS content (25.2%) than those of Zaghoul cv. which showed (21.4%). Best results were obtained as Milagro combined with pollen grains (23.8%) followed by the single pollinated of Milagro (23.2%), with significant differences among them. Concerning interactions, the highest statistical increase in TSS% showed by Samany cv. pollinated by Milagro+pollen grains being (25.5%).

**Total acidity (TA%):** Data indicated that Samany cv. gave the lowest TA% values (0.25%) than those of Zaghoul cv. (0.32%). No statistical differences in TA% content for tested pollinated date Cvs. were showed (Table 5). Regarding interactions, data cleared that Zaghoul cv. treated with tested pollinators and its combination, induced similar effect with non significant differences among them.

**Total soluble tannins:** It could be noticed that Zaghoul cv. recorded lower values of total soluble tannins (0.47 mg/g FW) than Samany cv. The best treatments that induced lowest significant values were equally obtained with either single Milagro or as combined with pollen grains being (0.49 mg/g FW). Concerning interactions, Zaghoul cv. recorded the lowest total soluble tannins values as pollinated with either Milagro alone or added to pollen grains without statistical differences among them (0.47 mg/g FW).

Table 5: Total soluble solids, total acidity and total tannins of Samany and Zaghoul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Total soluble solids (%)			Total acidity (%)			Total tannins (mg g <sup>-1</sup> FW)		
	Samany	Zaghoul	Means	Samany	Zaghoul	Means	Samany	Zaghoul	Means
Pollen (P)	24.8	21.0	22.9 <sup>a</sup>	0.26	0.33	0.30 <sup>a</sup>	0.51	0.48	0.50 <sup>a</sup>
Milagro (M)	25.2	21.2	23.2 <sup>b</sup>	0.25	0.32	0.29 <sup>a</sup>	0.51	0.47	0.49 <sup>b</sup>
P+M	25.5	22.0	23.8 <sup>a</sup>	0.25	0.32	0.29 <sup>a</sup>	0.51	0.47	0.49 <sup>b</sup>
Means	25.2 <sup>a</sup>	21.4 <sup>b</sup>		0.25 <sup>b</sup>	0.32 <sup>a</sup>		0.51 <sup>a</sup>	0.47 <sup>b</sup>	
LSD <sub>0.05</sub> (P+M) =		0.94			0.02			0.01	

Table 6: Non reducing, reducing and total sugars of Samany and Zaghloul dates as affected by the growth activator Milagro (Mean of the two seasons)

Treatments	Non reducing sugars (%)			Reducing sugars (%)			Total sugars (%)		
	Samany	Zaghloul	Means	Samany	Zaghloul	Means	Samany	Zaghloul	Means
Pollen (P)	7.6	5.1	<b>6.4<sup>b</sup></b>	66.0	61.5	<b>63.8<sup>b</sup></b>	73.6	66.6	<b>70.1<sup>b</sup></b>
Milagro (M)	7.6	5.5	<b>6.6<sup>b</sup></b>	66.8	61.5	<b>64.2<sup>b</sup></b>	74.4	67.0	<b>70.7<sup>b</sup></b>
P+M	8.1	5.6	<b>6.9<sup>a</sup></b>	67.4	63.5	<b>65.5<sup>a</sup></b>	75.5	69.1	<b>72.3<sup>a</sup></b>
Means	<b>7.8<sup>a</sup></b>	<b>5.4<sup>b</sup></b>		<b>66.7<sup>a</sup></b>	<b>62.2<sup>b</sup></b>		<b>74.5<sup>a</sup></b>	<b>67.6<sup>b</sup></b>	
LSD <sub>0.05</sub> (P+M) =		0.14			1.2			1.12	

**Non reducing sugars (%):** Obtained data indicated that fruits of Zaghloul cv. contained less non reducing sugar values than Samany cv. The lowest values were obtained as dates pollinated with either pollen grains or Milagro (6.4 and 6.6%), with no significant different among them (Table 6). Regarding interactions, results revealed that pollinated Zaghloul cv. with pollen grains induced lowest significant decrease in reducing sugars values (5.1%) than other interactions.

**Reducing sugars (%):** Data indicated that fruits of Samany cv. contained high reducing sugars% as compared with Zaghloul cv. Best results were statistically obtained as tested Cvs. pollinated with Milagro+pollen grains(65.5%), followed by either Milagro or pollen grain treatments, with no differ among them. Results concerning interactions revealed that pollinating Samany cv. with Milagro+pollen grains induced highest significant values of reducing sugars (67.4%) than other interactions.

**Total sugars (%):** From data in Table 6, it is noticed that trend of total sugars was similar to those of reducing sugars one.

The progress in contents of reducing, total sugars and total soluble solids as well as reduction in total acidity, tannins and non reducing sugars in juice of both date palm cultivars as pollinated with the growth activator Milagro alone or combined with pollen grains, may be attributed to the effect of Auxins, Cytokinins, Gibberellins, Ethylene, Hydrogen Sinamed and Humic. It improved growth in all parts of the plant as a tonic for physiological processes in particular to enhance the process of photosynthesis and increases the yield moreover improves the quality characteristics. Similar results were reported by many authors such as Abou Aziz *et al.* (1982), Abo-El-Ez *et al.* (2002) and Al-Qurash *et al.* (2012).

## CONCLUSION

It is concluded that the growth activator Milagro as non-chemical tool has potential strategy for improving pollination, yield and fruit quality of date palm cultivars under study as combined with pollen grains, besides its environmentally safe effect.

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