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Effect of putrescine and whey on improving productivity and fruit quality of Ewais mango

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ABSTRACT

This experiment was carried out during 2014 and 2015 seasons to study the effect of foliar application of whey and putrescine on improving fruiting and fruit quality of Ewais mango cultivar. Trees were sprayed with whey at 10, 20, and 30%, Putrescine at 5, 15, 30 ppm comparing with control (sprayed with water). Trees were sprayed four times, the first time at the beginning of flowering (first week of March), the second at full bloom stage (last week of March), the third after three weeks of the setting (third week of April) and the fourth was at third week of May. Results showed that foliar application of whey and putrescine enhanced initial and final fruit set. Putrescine at 5ppm and whey at 30% recorded the highest initial fruit set in the first and second seasons, respectively. Putrescine at 5ppm recorded the highest value of final fruit set followed by putrescine at 15ppm and whey at 20% in both seasons. The lowest fruit drop% and the highest fruit retention% were obtained from putrescine at 5ppm in both seasons. The highest number of fruits per tree was achieved by whey treatment at 20% followed by putrescine at 5ppm in both seasons. Trees treated with whey at 20% or putrescine at 5ppm produced the highest yield (as number of fruits per tree or Kg/tree). Whey treatments were more effective in increasing fruit weight than putrescine where the highest values were detected with whey at 20%. The highest value of fruit TSS was recorded by putrescine at 5ppm in both seasons. The lowest fruit acidity was recorded by control meanwhile, the highest fruit acidity was recorded with putrescine at 30 ppm and whey at 20% in the first and second seasons, respectively. The highest significant values of TSS/ acid ratio were detected with putrescine at 5 ppm in the first season and whey at 10% in the second one.

Key words: Mango (*Mangifera indica* L.), Putrescine, Whey, Fruit set, Fruit drop, Fruit retention, Yield, TSS, Acidity.

Introduction

Mango (*Mangifera indica* L.) is one of the oldest and choicest tropical fruits of the world and it is considered one of the major fruit crops in Egypt. Mangoes cultivation extended rapidly in Egypt while production average is rather low and even it is not consistent due to several reasons as biennial bearing, low fruit set and high abscission rates (Wafaa Haggag, 2010). There are many cultivars grown in Egypt such as Zebda, Ewais, Fagriklan and Sedik. Ewais one of the most important mango cultivars grown in Egypt and face many problems i.e. poor fruit set, high fruit drop, irregular bearing, lower productivity (Syed *et al.,* 2009).

Whey is a by-product of the dairy industry, which for years was thought to be insignificant and was either used as an animal feed or it was disposed of as waste. Over the last few years, several studies were carried out concerning the beneficial properties of whey i.e. its nutritional value and pharmacological properties like as antimicrobial, antiviral and anti-oxidant properties. It can offer a kind of protection against cancer and heart diseases and assists at the enhancement of immune defence (Charu *et al*., 2012). One ton of cheese resulted in the production of about 8 tons of liquid whey, (Abdel-Rahman and Abo-Hamed, 1992). A few number of investigators mentioned that whey was used on some crops as nutritive or resistance to some diseases. In this regard, when whey was sprayed at different concentrations (25-100%) with nutrient elements on tomato and okra caused significant

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increases of vegetative growth, yield and fruit quality, (Fakir and Abed AL-Hussain (2009); Abed AL-Hussain and Muhammed, (2016). Moreover, whey had a positive effect on controlling powdery mildew on grapes, Crisp *et al*., (2006) and cucumber, Wagner *et al.,* (2008).

Aliphatic polyamines i.e., spermidine, spermine, and their obligate di-amine precursor putrescine are polycationic compounds of low molecular weight that have been proposed to be a new category of plant growth regulators or secondary hormonal messenger, They are implicated in a wide range of plant physiological processes such as morphogenesis, flower differentiation and initiation, pollen viability, root growth, somatic embryogenesis, anti-senescence, and biotic/a biotic stress responses, (Galston and Sawhney, (1990); Bouchereau *et al*. (1999) and Childs, *et al.* (2003). Polyamines have been suggested to be associated with cell division. Therefore, they can be utilized to regulate fruit development. Accumulating evidences showed that endogenous polyamine is important for pollen germination and pollen tube growth, (Song *et al.* (1999) and Wolukau *et al*. (2004). Also, the effect of polyamines has been ascribed to increase viability of ovule and prolonged pollination period, inhibition of enzymes involved on ripening or inhibition of ethylene synthesis (Kitashiba *et al.,* 2005). Putrescine enhanced pollen tube ovule penetration and delayed ovule senescence without effect on flower ethylene production, (Crisosto *et al*., 1988 and 1992), Singh and Singh (1995), Boniel and Protacio (2002), Malik and Singh (2006) worked on mango, and found that spraying polyamine (putrescine) at full bloom stage markedly increased fruit set, fruit retention and size of fruits. On olive, Ayad *et al.* (2011) mentioned that foliar application of putrescine significantly increased fruit growth characters i.e., size, weight, length and diameter and fruit quality characters i.e. pulp weight and thickness, moisture content, soluble solid content.

Therefore, this research aims to study and compare the effect of foliar application of whey and putrescine on improving fruiting and fruit quality of Ewais mango cultivar.

Materials and Methods

This study was carried out during the two successive seasons of 2014 and 2015 in a Farm of Agricultural Production and Research Station (APRS), National Research Centre (NRC), El Nubaria Province, El-Behaira Governorate, Egypt (latitude 30.8667 N, and longitude 30.1667 E).

The study was conducted on 10 years old Ewais mango cv., planted at 5 X 3 m apart grown in sandy soil, under drip irrigation system. The trees were harmony in shape and received the common horticultural practices.

Treatments:

Twenty one trees were assigned from Ewais mango cultivar for this investigation. The selected trees were arranged in seven treatments with three trees for each, and each tree was treated as a replicate.

Different treatments in the two seasons were as follows:

Spraying with whey at 10, 20, and 30%, spraying with putrescine at 5, 15, 30 ppm comparing with control (sprayed with water).

Trees were sprayed four times, the first time at the beginning of flowering (first week of March), the second at full bloom stage (last week of March), the third after three weeks of setting (third week of April) and the fourth was at third week of May. Each treatment was repeated three times on a different tree acting as replicate.

The following estimations were carried out:

On each tree 10 terminal shoots were tagged before flowering for determining the following parameters:

Initial fruit set (Number of fruitlets/ panicle): Was determined as number of settled fruits per panicle (two weeks after petal fall).

Final fruit set (Number of retained fruits/ panicle): Was determined by counting number of retained fruits per panicle at harvest (First week of August).

Fruit retention (%): Was determined at harvest using the following equation:

Final fruit set/ Initial fruit set X 100
Fruit drop (%): Was determined at harvest using the following equation:
(Initial fruit set – Final fruit set) ÷ Initial fruit set x 100.
Number of fruits per tree: was estimated by counting number of fruits each tree at harvest time.
Yield (Kg) per tree: was estimated by multiplying number of fruits per tree X the average of fruit weight.

Fruit characteristics

A sample of 10 mature fruits from each replicate tree was taken at the harvest time according to Abd El-Razek *et al.* (2013) for determining the following fruits properties.
Fruit weight: was measured by ordinary balance with 0.01 g sensitivity.
Fruit total soluble solids (TSS%): total soluble solids of mango fruit juice were measured using a hand refractometer, according to A.O.A.C., (1990). The total soluble solids were expressed as a percent.

Fruit titratable acidity:

Mango fruit juice samples (5 ml) were used and titrated against 0.1 N sodium hydroxide in the presence of phenolphthalein as an indicator, according to A.O.A.C., (1990). The titratable acidity was expressed as grams of citric acid percent.
TSS/ Acid ratio: was determined by dividing TSS on Acidity.

Statistical Analyses:

All obtained data during both 2014 and 2015 experimental seasons were conducted using a randomized complete block design, each treatment was replicated three times with one tree per replicate. Data from the analytical determinations were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran, (1980) using MSTAT program. The least significant ranges (LSD) were used to compare between means of treatments according to Duncan, (1955) at probability of 5 %.

Results and Discussion

Initial and final fruit set:

Results in Table (1) show the effect of foliar application of whey and putrescine on initial fruit set and final fruit set of Ewais mango cultivar. For initial fruit set, generally there is no significant differences between whey and putrescine treatments compared to the control in the first season. Meanwhile, in the second season whey and putrescine treatments increased initial fruit set significantly compared to the control. Putrescine at 5ppm recorded the highest initial fruit set followed by whey at 20% in the first season. Concerning the second season whey at 30% recorded the highest initial fruit set followed by whey at 20% and putrescine at 5ppm. On the other hand, whey at 10% and the control gave the lowest values of initial fruit set in the first and second seasons, respectively. Concerning final fruit set, putrescine treatments recorded the highest values followed by whey then the control which recorded the lowest value in the first season. Whey and putrescine treatments increased final fruit set than the control in the second season. Putrescine at 5ppm recorded the highest value of final fruit set followed by putrescine at 15ppm and whey at 20% in both seasons. On the contrary the control treatment recorded the lowest value of final fruit set in both seasons. These findings are in accordance with Ali *et al*. (2017) on mango as they showed that, spraying putrescine at three times at 20%, 40% and 80% of flowering increased fruit set, fruit retention and yield and decreased fruit drop. Moreover, Raphael and Shmuel, (2000) found that the application of the putrescine on 'Mauritius' litchi at the beginning of female bloom significantly increased the number of fruits per panicle as well as yield. Also, Singh and Singh, (1995) found that, spraying putrescine at 10-4 M stimulated fruit set and retention of Dashehari and Langra mango varieties when applied at

full bloom. Abed AL-Hussain and Muhammed (2016) found that spraying whey with or without growing point pinching on okra increased significantly number of fruits per plant and yield.

Table 1: Effect of whey and putrescine sprays on initial and final fruit set of Ewais mango trees in 2014-2015 seasons.

Treatment		Initial fruit set (No.)				Final fruit set (No.)			
		1st Season	Mean	2nd Season	Mean	1st Season	Mean	2nd Season	Mean
Sub.	Conc.								
Whey	10%	4.33 c	5.74 A	4.78 ab	5.50 A	0.65 c	0.66 B	0.33 cd	0.38 A
	20%	6.47 a		5.48 ab		0.76 c		0.43 ab	
	30%	6.43 a		6.23 a		0.58 c		0.40 bc	
Putrescine	5ppm	6.53 a	6.14 A	5.32 ab	4.77 A	1.22 a	0.97 A	0.49 a	0.44 A
	15ppm	6.33 a		3.83 bc		1.00 b		0.43 ab	
	30ppm	5.57 b		5.14 ab		0.68 c		0.41 b	
Control		5.47 b	5.47 A	2.52 c	2.52 B	0.60 c	0.60 B	0.29 d	0.29 B

Values followed by the same letter (S) in each col. are not significantly differed at 5% level of probability.

Fruit drop and fruit retention:

Results in Table (2) show the effect of the foliar application of whey and putrescine on fruit drop and retention percentage of Ewais mango cultivar. Concerning fruit drop, the results indicated that putrescine decreased it significantly compared to whey and control treatments in both seasons. The lowest fruit drop was obtained from putrescine at 5ppm in both seasons. On the contrary, the highest fruit drop percentage recorded by whey at 30% and control treatment in the first and second seasons, respectively. As for fruit retention, results reveal that putrescine treatments significantly improved fruit retention percentage compared to the control in both seasons. Also, whey increased fruit retention percentage compared to the control and the differences were significant in the second season only. Putrescine at 5ppm gave the highest fruit retention compared to other treatments in both seasons. On the other hand, the lowest fruit retention was recorded by whey at 30% and control treatment in the first and second seasons respectively. In this respect, Babu *et al.* (2016) investigated the effect of polyamines on Kesar mango cv. at pea stage and 20 days later, they found a significant increase in fruit retention and yield compared to the control. Also, foliar spray of putrescine increased significantly fruit set %, fruit retention % and significantly reduced fruit drop percentage of Washington navel orange, (Ataweia *et al*., 2012).

Table 2: Effect of whey and putrescine sprays on fruit drop and retention percentage of Ewais mango trees in 2014 and 2015 seasons.

Treatment		Fruit drop (%)				Fruit retention (%)			
		1st Season	Mean	2nd Season	Mean	1st Season	Mean	2nd Season	Mean
Sub.	Conc.								
Whey	10%	84.52 c	88.04 A	93.55 a	92.64 B	16.99 b	12.58 AB	6.45 c	7.36 B
	20%	88.61ab		90.62 b		11.19de		9.38 b	
	30%	90.98 a		93.74 a		9.54 e		6.26 c	
Putrescine	5ppm	81.01 d	84.77 B	87.62 c	89.81 C	19.79 a	15.50 A	12.38 a	10.19 A
	15ppm	85.44bc		91.17 b		14.56 c		8.83 b	
	30ppm	87.86ab		90.65 b		12.14 d		9.35 b	
Control		88.02ab	88.02 A	94.47 a	94.47 A	11.98 d	11.98 B	5.53 c	5.53 C

Values followed by the same letter (S) in each col. are not significantly differed at 5% level of probability.

Yield:

Results in Table (3) indicate the effect of foliar treatments of whey and putrescine on number of fruits and yield of Ewais mango cultivar. The highest number of fruits per tree was significantly in closed relationship to whey treatments in both seasons. Moreover, putrescine ranked statistically second pertaining its efficiency followed by control which came statistically the third in this concern. The highest number of fruits per tree was achieved by whey treatment at 20% followed by putrescine at 5ppm in both seasons. On the other hand, the lowest number of fruits per tree was obtained from whey at 30% in first season and the control in the second season. With regard to the effect of treatments on yield, whey and putrescine treatments increased yield compared to the control in the two studied seasons. Moreover, trees treated with whey at 20% produced the highest yield followed by putrescine at 5ppm in both seasons. On the contrary, the lowest values of yield were obtained from putrescine at 30ppm and control in the first and second seasons, respectively. These results are in harmony with those obtained by Buronkar (2005) who found that application with putrescine at full bloom, marble and egg stages significantly increased yield of Alphonso mango trees. Also, Naser *et al.* (2016) showed that treated date palm trees with putrescine and biofertilizers recorded significant increase in total palm yield. Fakir and Abed AL-Hussain (2009) on tomato plant studied the effect of whey and mineral nutrition. They found a significant increase in number of fruits and yield compared to the control.

Table 3: Effect of whey and putrescine sprays on number of fruits/tree and yield (kg/tree) of Ewais mango trees in 2014 and 2015 seasons.

Treatments		Number of fruits/tree				Yield (Kg/tree)			
		1st Season	Mean	2nd Season	Mean	1st Season	Mean	2nd Season	Mean
Sub.	Conc.								
Whey	10%	41.00c	46.25 A	25.22c	25.57 A	9.50c	10.97 A	5.48c	6.10 A
	20%	76.50a		34.00a		18.44a		8.74a	
	30%	21.25e		17.50d		4.96e		4.10d	
Putrescine	5ppm	62.17b	36.65 A	26.84b	20.50 B	13.88b	8.12 AB	6.83b	5.05 A
	15ppm	34.00d		17.67d		7.48d		4.26d	
	30ppm	13.78f		17.00d		3f		4.06d	
Control		31.61d	31.61 A	12.33e	12.33 C	6.72d	6.72 B	2.61e	2.61 B

Values followed by the same letter (S) in each col. are not significantly differed at 5% level of probability.

Fruit weight and TSS:

Putrescine and whey significantly increased fruit weight compared to the control (Table, 4). Whey treatments were more effective in increasing fruit weight than putrescine where the highest value was detected with whey at 20% followed by 30% then 10% this was noticed in the first season. Meanwhile, in the second season the highest value was recorded with whey at 20% followed by putrescine at 5 ppm then putrescine at 15% ppm. Control trees produced the lowest fruit weight in both seasons.

As for fruit TSS results in Table (4) reveal that whey and putrescine increased fruit TSS significantly compared to the control. Moreover, putrescine recorded higher values than whey and the differences between them were significant in the first season only. The highest value of fruit TSS was recorded by putrescine at 5ppm in both seasons. On the other hand, the control treatment gave the lowest value of fruit TSS in both seasons. These results are in agreement with the findings by Ali *et al*. (2017) on mango, Naser *et al.* (2016) on date palm and Ataweia *et al*. (2012) on Washington navel orange as they increased fruit weight and TSS with application of putrescine.

Fruit acidity and TSS/ Acid ratio:

Concerning the fruit acidity, the results in Table 5 show that, there is no significant effect between whey and putrescine treatments in both seasons. Although, control treatment decreased it

significantly compared to putrescine in the first season. Moreover, the lowest acidity values were recorded by control in both seasons. Meanwhile, the highest acidity% was recorded with putrescine at 30ppm and whey at 20% in the first and second seasons, respectively.

For TSS/Acid ratio, results clear that putrescine increased TSS/acid ratio in both seasons, however the differences were insignificant compared to the control. The highest significant values of TSS/ acid ratio were detected with putrescine at 5 ppm in the first season and whey at 10% in the second one. On the other hand, the lowest TSS/acid ratio was recorded with whey at 10 and 20% in the first and second seasons respectively. These results are in agreement with those reported by Ayad *et al*. (2011) on Olive, Abd El-Migeed *et al*. (2013) on Date palm and Ali *et al*. (2017) on mango.

Table 4: Effect of whey and putrescine sprays on fruit weight (g) and fruit TSS (%) of Ewais mango trees in 2014-2015, seasons.

Treatment		Fruit weight (g)				T.S.S (%)			
		1st Season	Mean	2nd Season	Mean	1st Season	Mean	2nd Season	Mean
Sub.	Conc.								
Whey	10%	231.69bc	235.49 A	217.21d	236.09 A	8.60 bc	9.87 AB	10.30 bc	10.10 A
	20%	241.02a		256.93a		10.00abc		9.80 c	
	30%	233.77b		234.14c		11.00 ab		10.20 bc	
Putrescine	5ppm	223.34de	223.71 B	254.52a	244.78 A	12.00 a	10.43 A	11.30 a	10.60 A
	15ppm	219.70e		241.01b		10.00abc		9.60 c	
	30ppm	228.08cd		238.80b		9.30 bc		10.90 ab	
Control		212.62f	212.62 C	211.88e	211.88 B	8.30c	8.30 B	8.10 d	8.10 B

Values followed by the same letter (S) in each col. are not significantly differed at 5% level of probability.

Table 5: Effect of whey and putrescine sprays on acidity and TSS/ acid ratio of Ewais mango fruits in 2014-2015, seasons.

Treatment		Acidity %				TSS/ Acid ratio			
		1st Season	Mean	2nd Season	Mean	1st Season	Mean	2nd Season	Mean
Sub.	Conc.								
Whey	10%	1.40ab	1.43 AB	1.30 b	1.50 A	6.26b	7.10 A	8.17 a	6.99 A
	20%	1.30b		1.70 a		7.98ab		5.92 b	
	30%	1.60 ab		1.50 ab		7.05ab		6.89 ab	
Putrescine	5ppm	1.20b	1.53 A	1.40 ab	1.50 A	10.00 a	7.30 A	8.15 a	7.22 A
	15ppm	1.60 ab		1.50 ab		6.64ab		6.50 ab	
	30ppm	1.80 a		1.60 ab		5.26b		7.02 ab	
Control		1.20b	1.20B	1.30 b	1.30A	7.11ab	7.11A	6.32 ab	6.32A

Values followed by the same letter (S) in each col. are not significantly differed at 5% level of probability.

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