Fruit Retention, Yield and Postharvest Fruit Quality of Mango in Relation to: I. Putrescine, GA_3, NAA and Urea Foliar Sprays

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ABSTRACT

The present study was conducted in 2002 and 2003 growing seasons on mature Zebda mango trees with the aim of enhancing fruit retention, yield and postharvest fruit quality. Except of spraying urea alone, the percent of fruit retained on the tree, yield, V C, TSS and sugars contents were increased by all treatments. However, fruit length, diameter and weight were decreased. Spraying urea alone was the least effecting treatments on the different parameters studied. Commonly applying putrescine at full bloom alone or in combinations with the other substances at pea stage was the most effective in enhancing the studied parameters than NAA, GA_3 and urea applied alone or in combination with each other.

INTRODUCTION

Polyembryonic mango varieties such as Zebda are known to drop a great number of fruitlets after the initial fruit set. Because of its reasonable price and mediate quality it is required by the Egyptian consumer. Increasing fruit retention and fruit set as well as reaching a high yield and fruit quality of mango trees is an important aim for all mango producers. Growth regulators (GA_3 and NAA) and other materials like urea and the polyamines which are recently considered as plant hormones (Davies, 1995) were used as exogenous applications at different dates in order to increase fruit set, yield and fruit quality of different fruit species (Coggins, 1995 and Davies, 1995). Preharvest foliar sprays of GA_3 were found to have an effect on Tommy Atkins mango fruits (Mendez, 1994). Fruit retention of mango trees was increased by foliar application of the polyamine putrescine at full bloom (Zor and Singh, 1995 and Singh and Jones, 2000). The aim of the work is controlling fruit retention and enhancing set, yield and quality characters of Zebda mangoes by the substances used and the time of application.

MATERIALS AND METHODS

The research was conducted in a private mango orchard at Abo El-Matameer region, near Alexandria during the growing seasons 2002 and 2003 on mature (22 year old) Zebda mango trees (*Mangifera indica*, L.) budded on seedling rootstock. The soil was calcareous sandy clay with pH ranging between 7.76 and 7.85, $CaCO_3$ of 31% and water table level of about 130 to 150 cm from the ground surface. Trees were planted at 7x8 m apart and irrigated with Nile water every 15 days. The orchard was fertilized with organic manure and calcium superphosphate at the rate of 20 cubic meters and 150 kg

per feddan, respectively, in December every year. Orchard was also fertilized by ammonium nitrate at the rate of 350 kg/fed. at two equal doses (mid-March and Mid-June). Trees were sprayed with putrescine (10^{-4}) at full bloom and NAA (30 ppm), GA_3 (50 ppm) and urea (1%) at pea stage either alone or in combinations and eleven treatments with a group of 33 trees were established as follow:

1) Water spray only (control)
2) Putrescine (put)
3) NAA
4) GA_3
5) Urea
6) Put + NAA
7) Put + GA_3
8) Put + urea
9) NAA + GA_3
10) NAA + urea
11) GA_3 + urea

The surfactant Biofilm (30cm/100L water) produced by Biotechegypt was added to all spray materials in order to obtain best spraying results.

To study the effect of the different treatments on fruit drop and retention, three branches were tagged on the different sides of each tree in February of both seasons and the number of fruits on each branch was counted and recorded after fruit set (May), after June drop (July) and at harvest (September) of both seasons. The percentages of fruit drop and retention were calculated as follow:

- % fruit retention after June drop =
No. of remained fruits after June drop / No. of fruit after set

- % fruit drop = 100 - % fruit retention

The yield was recorded at harvest in September of 2002 and 3003 expressed as weight (Kg/tree) and number of fruit per tree. Seven fruits were sampled once at harvest from each tree to determine fruit quality. Fruit weight (gm), diameter and length (cm), were measured. In the fruit juice, total soluble solids percent (TSS) was determined with a hand refractometer, acidity and vitamin C (mg/100gm pulp) contents were determined by titration. In addition, pulp reducing sugars were determined by Nelson method as illustrated by Malik and Singh (1980). The total soluble sugars were also determined after hydrolysis with hydrochloric acid and the non-reducing sugars were calculated from the difference between total and reducing sugars.

The data were statistically analyzed using randomized complete block design according to the method of Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

Fruit retention

The data in Tables 1 and 2 showed that, in both seasons, all spraying treatments, except for urea in the first season, significantly increased fruit retention when compared with the water sprayed control. In addition, in both seasons spraying putrescine alone retained more fruits when compared with NAA, GA_3, urea, either alone or in combinations with each other. Moreover, the putrescine plus GA_3 or NAA gave higher fruit retention than GA_3 and NAA, respectively. In the first season only, the fruit retention percentage was higher under NAA spray followed by GA_3 and then urea. However, no significant differences were observed when putrescine was sprayed alone or in combinations with NAA, GA_3 or urea. Also no differences were obtained by spraying NAA alone or in combinations with urea, GA_3 and GA_3 + urea, in both seasons (Tables 1 and 2).

Similarly, Singh *et al.* (1994) found that interacted treatments of urea and NAA at pea stage were effective in increasing fruit retention of mango trees. Also, Zora and Singh (1995) stated that spraying mango trees with the polyamines such as putrescine at full bloom increased fruit retention. Also, Costa *et al.* (1984) reported that spraying apple trees with putrescine at full bloom induced the best fruit set. However, Singh and Janes (2000) reported that the polyamine spermine was more effective in increasing fruit retention than putrescine.

Fruit drop

The percentage of fruit drop was significantly decreased by all spraying treatments as compared with the control in both seasons (Tables 1and 2). In addition, in both seasons spraying urea alone had the lowest effect on decreasing fruit drop when compared with the other treatments. However, in both seasons spraying putrscine alone or +NAA gave a significant lower fruit drop percent than other treatments (Tables 1 and 2). Khan *et al.* (1993) reported that fruit drop was decreased when Malda mango trees were sprayed with 2,4-D and NAA at pea size. Also the data are in line with those of Rajput and Singh (1988) spraying urea and GA_3 to mango trees.

Yield

The yield expressed as Kg and number of fruits per tree was significantly increased by all spraying treatments when compared with the control in both seasons (Tables 1 and 2). In addition, all spraying materials had a significant higher effect on yield than urea sprayed alone in both seasons. Moreover, the

data presented in Tables 1 and 2 also showed that spraying putrescine alone or in combination with NAA, GA_3 or urea had a significant higher yield than NAA, GA_3 and urea, either alone or in combination with each other. No significant differences were obtained by spraying putrescine alone, putrescine + GA_3 or putrescine + NAA and between NAA + GA_3, NAA + urea and GA_3 + urea during both seasons. Similarly, Sharma *et al.* (1993) found that spraying Langra mango with 4% urea and 40 ppm NAA increased the number of fruits per plant. Abou-Rawash *et al.* (1998) reported that the yield of Taimour mango trees was increased by NAA foliar spray after full bloom. In contrast, Oosthuyse (1995) found that spraying Tommy Atkins mango trees at pea size with GA_3 and or NAA did not affect the yield.

Fruit length, diameter and weight

In both seasons, fruit length was significantly decreased by all treatments (except for putrescine, urea alone and NAA + GA_3 in the first season and put + urea in the second season) as compared with the control (Tables 1 and 2). The above mentioned results are in line with those of Oosthuyse (1995). He stated that fruit size was reduced by spraying NAA and GA_3 at pea stage. However, the data disagree with those of Rajput and Singh (1988) and Abou-Rawash *et al.* (1998). Moreover, no significant differences in the first season only were obtained between the treatments (put, GA_3, NAA, put + urea and put + GA_3). In the second season (Table 2), no significant differences were obtained between the treatments (GA_3, put and GA_3 + urea). Fruit diameter was significantly decreased in both seasons by spraying NAA + put, NAA + GA_3 and GA_3 + urea when compared with the control (Tables 1 and 2). Moreover, no significant differences among the above mentioned treatments were obtained. In addition, the data in Table 1 showed that comparing with the control, fruit weight was significantly decreased by all spraying treatments in the first season. However, in the second season fruit weight was significantly decreased by spraying putrescine alone, put+ NAA, put + GA_3 and put + urea (Table 2). This could be due to the effect of these spraying treatments on increasing the yield. On the contrary, Singh et al (1994) reported that fruit diameter, length and weight were increased when Langra mango trees were sprayed with urea and or NAA at pea stage. Also, Costa *et al.* (1984) working on apple found that foliar application of putrescine at full bloom induced fruit weight and growth.

Acidity

The results obtained showed that fruit acidity was not affected in the first season by spraying put, GA_3, put + GA_3 or NAA + urea (Table 3) and in the second season by spraying put, put + GA_3 when compared with the water sprayed control. However, in both seasons acidity was significantly decreased by all other treatments as compared with the control (Tables 3 and 4).

In addition, spraying put + NAA, GA_3 + NAA, NAA alone and urea gave a significantly lower acidity content than put + urea and GA_3 + urea in the first season. In the second season, spraying GA_3, NAA, put + NAA and NAA + urea significantly decreased acidity content when compared with put + urea, urea alone, GA_3 + urea and NAA + GA_3 (Table 4). These results are in line with those of Sharma et al (1993) and Singh *et al.* (1994) working on mango.

Vitamin C, TSS and sugars contents

In the first season (Table 3) vitamin C content was significantly increased by spraying NAA, GA_3, urea, put +NAA, put + GA_3 and GA_3 + urea. On the other hand, all treatments (except putrescine alone) increased V. C. content in the second season comparing with the control (Table 4). Moreover, the treatments urea alone, urea + NAA and GA_3 + put gave a significantly higher V.C. content than spraying NAA alone, NAA + put, GA_3 alone, GA_3 + urea and urea + put in the second season only (Table 4). Additionally, the data in Table 3 showed that spraying NAA, GA_3, urea, put + GA_3 and urea + GA_3 significantly increased the TSS content when compared with the control in the first season. However, in the second season all spraying treatments (except put alone) significantly increased TSS content as compared with the water sprayed control (Table 4). In addition, no significant differences among the above mentioned treatments were obtained in the second season. Similarly, Abou-Rawash *et al.* (1998) stated that NAA foliar sprays after full bloom increased TSS of Taimour mango fruit juice. As for sugars content, the treatments NAA, GA_3, urea, put + GA_3, put + urea, GA_3 + urea gave a higher reducing sugar content than the control in the first season (Table 3). However, in the second season all treatments (except put alone and put + NAA) increased reducing sugars content as compared with the control (Table 4).

In addition, spraying urea alone gave a higher reducing sugars content than all other treatments (except GA_3 + urea) in the second season (Table 4). Moreover, the data in table 3 showed that in the first season the only treatments that significantly increased non reducing sugars content than the control were NAA, GA_3, urea and put + NAA. However, no significant differences among the above mentioned treatments were obtained. In the second season all treatments (except put alone) increased non reducing sugars content as compared with the control (Table 4). Additionally no significant differences among the treatments NAA + GA_3, put +NAA, put + GA_3, GA_3 + urea and NAA alone were obtained. On the other hand spraying NAA + GA_3 gave a higher non reducing sugars content than put + urea, GA_3, urea and NAA + urea (Table 4). Moreover, in the first season only spraying NAA, GA_3 or urea alone and GA_3 + urea increased total sugars content as compared with the control (Table 3). Additionally, no differences were obtained among the above mentioned treatments. In contrast, in the second season all treatments (except put alone) gave higher total sugars content than the control (Table 4). However, the

treatments did not significantly differ from each other. Malik *et al.* (2003) working on mango reported that pre-harvest sprays of putrescine exhibit a high TSS percent, whereas the total and non reducing sugars were reduced.

From the above mentioned results it is concluded that all spraying treatments (except urea alone) affected fruit retention, fruit set, crop and fruit length. Fruit diameter was also affected with sprays including NAA. Also, putrescine was more effective when applied in combinations with the other materials than alone. Moreover, spraying NAA, GA_3, urea alone or urea+ GA_3 had a great effect in increasing V C, TSS and sugars contents in the first season, whereas in the second season most treatments had a significant effect. Finally spraying urea alone was the least effective treatment on the studied characters.

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Table 1. Effect of putrescine, NAA, GA_3 and urea spray on fruit retention, yield and fruit physical quality of Zebda mango, during 2002 season.

Treatment	Fruit retention (%)	Fruit drop (%)	Yield/tree (kg)	Yield/tree (No.)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
Control	19.8	80.2	113	202	17.3	12.1	560
Putrescine	33.7	66.3	245	484	16.7	11.7	508
NAA	29.9	70.1	200	400	16.2	11.3	501
GA_3	25.8	74.2	220	452	16.6	11.7	487
Urea	22.7	77.3	140	262	16.8	11.7	538
put+NAA	32.7	67.3	253	513	15.6	10.7	491
put+GA_3	30.8	69.2	244	498	16.2	11.1	490
put+urea	31.2	68.8	240	476	16.3	11.3	503
NAA+GA_3	30.0	70.0	179	358	17.0	10.8	500
NAA+urea	29.5	70.5	189	390	15.8	10.6	485
GA_3+urea	27.8	72.2	196	404	15.6	10.4	488
$L.S.D_{0.05}$	3.3	2.1	18	50	0.6	1.2	21

Table 2. Effect of putrescine, NAA, GA_3 and urea spray on fruit retention, yield and fruit physical quality of Zebda mango, during 2003 season.

Treatment	Fruit retention (%)	Fruit drop (%)	Yield/tree (kg)	Yield/tree (No.)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
Control	21.8	78.2	91	156	17.4	11.8	582
Putrescine	36.5	66.7	253	400	16.2	11.3	516
NAA	30.2	69.8	203	386	16.7	11.6	527
GA_3	27.9	72.1	225	420	16.2	11.4	532
Urea	25.7	74.3	136	240	17.0	12.1	563
put+NAA	35.4	64.6	245	492	16.6	10.6	498
put+GA_3	34.8	65.2	250	498	17.0	10.6	501
put+urea	32.6	67.4	224	433	17.2	11.2	518
NAA+GA_3	30.7	69.3	216	410	17.0	10.8	527
NAA+urea	29.8	70.2	214	398	16.7	11.0	536
GA_3+urea	28.7	71.3	215	416	16.3	10.7	520
$L.S.D_{0.05}$	5.2	1.8	21	55	0.3	0.9	63

Table 3. Effect of putrescine, NAA, GA_3 and urea spray on fruit chemical quality of Zebda mango, during 2002 season.

Treatment	Acidity (%)	V.C. (mg/100 g juice)	T.S.S (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
Control	0.38	26	13.36	3.78	7.43	11.21
Putrescine	0.40	31	14.06	4.06	7.94	12.00
NAA	0.29	36	15.31	4.71	8.70	13.41
GA_3	0.36	37	14.62	4.36	8.37	12.73
Urea	0.27	33	14.83	4.24	8.66	12.90
put+NAA	0.30	35	14.12	3.86	8.60	12.02
put+GA_3	0.38	41	14.76	4.32	7.57	11.89
put+urea	0.23	32	13.96	5.03	6.73	11.76
NAA+GA_3	0.30	28	14.08	3.82	8.04	11.86
NAA+urea	0.40	30	13.62	3.46	8.00	11.46
GA_3+urea	0.23	36	15.02	4.82	7.81	12.63
$L.S.D_{0.05}$	0.04	7	0.93	0.36	0.77	1.21

Table 4. Effect of putrescine, NAA, GA_3 and urea spray on fruit chemical quality of Zebda mango, during 2003 season.

Treatment	Acidity (%)	V.C. (mg/100 g juice)	T.S.S (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
Control	0.43	33	12.72	3.32	7.19	10.51
Putrescine	0.40	35	13.13	3.68	7.54	11.22
NAA	0.30	42	14.82	4.23	8.48	12.71
GA_3	0.36	42	14.68	4.42	8.11	12.53
Urea	0.28	46	15.18	5.03	8.06	13.09
put+NAA	0.33	41	14.86	3.76	8.67	12.43
put+GA_3	0.40	46	14.61	4.13	8.60	12.73
put+urea	0.29	39	14.62	4.06	8.15	12.21
NAA+GA_3	0.27	48	15.06	4.22	8.80	13.02
NAA+urea	0.30	50	14.82	4.41	7.97	12.38
GA_3+urea	0.28	39	15.06	4.62	8.59	13.21
$L.S.D_{0.05}$	0.07	4	0.86	0.52	0.65	1.02

الملخص العربى

بقاء الثمار والمحصول وصفات جودة ثمار المانجو وعلاقتهـــا بـــ:
ا- الرش الورقى بالبيتروسين، حامض الجبريلليك،
نفتالين حامض الخليك واليوريا

حسن على قاسم و هند على مرزوق

قسم الفاكهة – كلية الزراعة (بالشاطبى) –جامعة الأسكندرية

أجريـــت هذه الدراسة على أشجار مانجو صنف زبدة خلال موسمى النمو ٢٠٠٢ و ٢٠٠٣. وقد أدت جميع معاملات الرش ماعدا رش اليوريا منفردة إلى انخفاض نسبة التساقط وزيادة بقاء الثمار وزيادة المحصول وزيـــادة محـــتوى الـــثمار مـــن فيتامين ج و المواد الصلبة الذائبة الكلية والسكريات بينما أدت المعاملات الى الانخفاض فى وزن وطول وقطر الثمار. وكانت معاملة الرش باليوريا فقط هى الأقل تأثيرا على معظم الصفات المدروســـة. وعموماً فإن الاضافات المشتركة من البيتروسين مع أى من المواد الأخرى أعطى نتائج لم تختلف كثيراً عما لو أضيف منفردا على معظم الصفات المدروسة. وكان رش حمض الجبريلليك ونفتالين حمض الخليك والـــيوريا مخـــتلطة مع البيتروسين أفضل من رشها بمفردها أو مختلطة مع بعضها وخصوصاً على بقاء الثمار والمحصول.