Response of Some Mango Cultivars to Polyamines

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Abstract: Two field experiments were carried out during 2002/2003 and 2003/2004 seasons to explore the effect of polyamines on fruit set, fruitlet abscission, fruit retention, yield and fruit quality of some mango cultivars. Aqueous solutions of putrescine, spermidine and spermine at different concentrations (0, 125, 250 and 500 ppm) were sprayed on Succary Abiad at growing panicles prior to the anthesis (Exp. 1), while Fagri Kalan, Langra and Mabrouka were sprayed by spermidine at different concentrations (0, 125, 250 and 500 ppm) at the same growth stage (Exp. 2). In Succary Abiad cv., spermine at 250 ppm was more effective in increasing fruit set and reducing fruitlet abscission, while 125 ppm was significantly increased fruit retention and consequently number of fruits per tree and yield. Morever, polyamines (especially spermine) were more effective in reducing fruitlet abscission during the first week after fruit set. Significant increments in fruit firmness, SSC and acidity were exhibited in fruit treated with polyamines. When different cultivars were sprayed by spermidine, Langra cv. gave better fruit set, fruit retention and yield than Fagri Kalan or Mabrouka cvs, whereas 250 ppm recorded the minimum abscised fruitlets in Fagri Kalan and Mabrouka cvs. So, the response of mangoes to polyamines was influenced by type of polyamine, concentration and cultivar. In conclusion, polyamines reduced fruitlet abscission and improved fruit set and retention, number of fruits and yield without impairing fruit quality in all cultivars.

Keywords: Polyamines, putresciner, spermidine, spermine, mango, fruit set, fruit retention, fruit yield, fruit firmness, fruit let abscission

INTRODUCTION

Mango cultivation in the world is expanding due to the popularity of this fruit and ever increasing demand for fresh and processed mango products. Hence, there is also a great potential to expand our mango cultivation in Egypt, where it is grown on over an area of 130.34 faddans while its production is 375.46 tons. In Ismailia it is grown on 58.43 faddans, yielding 116.80 tons, which is about 44.82 and 32.67 % of total area and production, respectively (Ministry of Agriculture, Egypt. 2004).

In spite of adequate flowering, low fruit yield in mango orchards have been experienced because of low initial fruit set and subsequently higher fruitlet abscission (Singh and Singh, 1995). Fruitlet abscission is a very complex physiological process, occurs in many cultivars of mango and at all stages of development, but it is particularly high during the first 3-4 weeks after pollination and accounts for over 90% loss of set fruitlets (Chaha. 1993; Bains *et al.*, 1997; Guzman-Estrad, 1997 and Wahdan and Melouk, 2004).

Lower concentration of auxins, gibberellins and cytokinnins as well as higher concentration of abscissic acid during developing fruitlets and their pedicels have been associated with fruit abscission (Ram, 1992; Murti and Upreti, 1995; Bains *et al.*, 1997 and Murti and Upreti, 1997). A reduction in fruit abscission with spray of auxins and gibberellins indicated their role in abscission (Chadha, 1993). However, acceleration of fruitlet abscission in mango with exogenous application of ethephon have been reported by Malik and Singh (2003). On the other hand, increasing fruit retention with ethylene inhibitors such as silver, nickel or cobalt (Naqvi *et al.*, 1990) and polyamines (Singh and Singh, 1995; Singh and Janes, 2000 and Malik and Singh, 2003) indicate the involvement of ethylene in mango fruitlet abscission. So, the role of polyamines in reducing fruitlet abscission in mango is further supported by the fact that intact fruitlet and their pedicels had significantly higher endogenous polyamines and lower levels of endogenous ethylene compared with about-to-abscised ones (Malik and Singh, 2003 and Malik *et al.*, 2003). Furthermore, fruitlet abscission in apple and grape has been associated with lower levels of endogenous polyamines (Biasi *et al.*, 1988 and Aziz *et al.*, 2001).

Exogenous application of polyamines have been resulted in increasing fruit set and retention, fruit firmness, titratable acidity, TSS/acid ratio and fruit weight in many mango cultivars (Singh and Singh, 1995; Khattab *et al.*, 2000 a&b; Shaban, 2000; Singh and Janes, 2000 and Malik and Singh, 2005). Meanwhile, Khattab and Shaban (2005) reported that polyamines decreased fruit weight and TSS/acid ratio in mango cv Ewais. So, this study was undertaken to evaluate the effect of polyamines on mango, especially of the variables that determine the tree yield and fruit quality.

MATERIALS AND METHODS

Two field experiments were carried out at the experimental farm of Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, during 2002/2003 and 2003/2004 seasons to explore the effect of polyamines on fruit set, fruitlet abscission, fruit retention, yield and fruit quality of mango trees. All the experimental trees subjected to the recommended management of mango orchard (El-Khoreiby, 1997).

Experiment (1): Effect of different polyamines at different levels:

Twenty-year-old, uniform trees of mango (*mangifera indica* L.) cv Succary Abiad planted in sandy soil, at 5 m apart were used. Selected trees sprayed by different polyamines (putrescine, spermidine and spermine) at concentrations 0, 125, 250 and 500 ppm with a surfactant, triton 0.1%, at growing panicles prior to the anthesis (5-8 cm long, last week of March). Control trees were sprayed with water and the surfactant. The treatments were arranged in split plot design with a single tree as treatment unit and three replicates, where the polyamines distributed in the main plots and concentrations occupied the sub-plots.

Experiment (2): Effect of spermidine on different cultivars:

Ten-year-old, mango trees of three commercially important cultivars; Fagri Kalan, Langra and Mabrouka, grafted on mango seedling rootstocks, planted in sandy soil at 5m apart, were used in this study. Aqueous solutions of spermidine (0, 125, 250 and 500 ppm) containing the surfactant, triton 0.1%, were sprayed at growing panicle prior to the anthesis (5-8 cm long, last week of March) onto each cultivar. The experiment was designed as a split plot with a single tree as treatment unit and included three replicates, where the cultivars involved in the main plots and concentrations of spermidine represented the sub-plots.

Field study:

Five panicles of different sizes per tree were collected to determine the total perfect flowers. In each tree, ten panicles from all directions were tagged, before treatment, by wrapping adhesive plastic around the shoots, 5 cm below the panicle. Initial fruit set was considered to have occurred when all the flowers were dried, but were still intact on the panicle. Total number of fruitlets on tagged panicles was counted at weekly interval for eight weeks. Fruit set percentage was calculated proportionally to number of total perfect flowers per panicle. Fruitlet abscission percentage was determined by subtracting the fruit present at each week from the initial fruit set. Fruit retention percentage was estimated at harvest by dividing the number of mature fruits per panicle by the number of setting fruits per panicle.

At commercial harvest, number of fruits per tree was counted and the yield was estimated by multiplying number of fruits by average fruit weight. Five firm ripe fruits per tree were randomly taken for determining:

Firmness (N) by using Effegi pentromter, fruit weight (g), soluble solids content (SSC %) by using Carl-Zeiss hand refractometer, titratable acidity (%) as citric acid according to A. O. A. C. (1995) and SSC/Acid ratio was calculated.

Statistical analysis:

Data were subjected to the analysis of variance. Split plot design was used in each experiment except fruit set and fruitlet abscission (exp. 1) which were analyzed as split-split plot design where the abscission date involved in sub-sub-plots (Steel and Torrie, 1980). Analyses of variance and means comparison (LSD, 5%) were done by using M-STAT program version 7 (1990).

RESULTS

Experiment (1): Effect of type of polyamines and concentrations:

A) Fruit set: The spray application of different polyamines at growing panicles of Succary Abiad mango prior to the anthesis significantly increased fruit set as compared to control trees in both seasons (Table 1). Spermine was more effective in increasing fruit set as compared to spermidine and control. The increase in fruit set was significantly higher with spermine (250 ppm) than with all other treatments. Within the three concentrations of putrescine and spermidine, fruit set was increased as the concentrations increased but fluctuation trend was observed only within the concentrations of spermine. Regarding fruit set in relation to fruit development, a significant reduction in fruit set was noted during the first three weeks from setting, then an insignificant continuous decrease was observed after that till the eighth week (May-June drop) in the two seasons.

B) Fruitlet abscission:

The three major polyamines were significantly reduced fruitlet abscission as compared with control (Table 2). Spermine was the most effective, by exhibiting the minimum fruitlet abscission (77.94 & 75.55 %) compared to control (80.9 & 82.43 %), while putrescine and spermidine came in between (79.96 & 78.34 %) and (80.27 & 77.92 %) in the tow seasons, respectively. The lowest fruitlet abscission (76.78 %) was recorded at 125 ppm spermidine in the first season but it did not confirm in the second one where spermine at 250 ppm gave the least fruitlet abscission (74.44 %). Morever, polyamines (especially spermine) were more effective in reducing fruitlet abscission during the first week after fruit set, while maximum fruitlet abscission was recorded (83.11 and 88.18 %) in untreated trees at the same date in the tow seasons, respectively. For fruitlet abscission during fruit growth, data (Table 2) indicated that the highest fruitlet abscission was found after the first and second weeks from fruit set (73.4 & 14.29 % and 73.58 & 10.86 %) in both seasons, respectively.

C) Fruit retention and number of fruits per tree:

It is clear from table (3) that fruit retention and number of fruits per tree took a similar trend where putrescine, spermidine and spermine were significantly increased fruit retention and number of fruits compared to control treatment. Spermidine was better than putrescine and spermine. Meanwhile, spermidine at 125 ppm recorded the maximum fruit retention and consequently number of fruits per tree. However, within the three concentration of putrescine and spermine, fruit retention and number of fruits were increased up to certain level (250 ppm), then decreased when the high concentration (500 ppm) was applied; this indicate that the middle concentration (250 ppm) is considered the best effective concentration.

D) Fruit weight:

Spray of all the polyamines onto growing panicles prior to the anthesis significantly increased fruit weight of Succary Abiad cv as compared with the control trees (Table 3). The heaviest fruit weight in both seasons was obtained by putrescine followed by spermine and spermidine in descending order. However, putrescine at 500 ppm gave the heaviest fruit weight, while spermine at 125 ppm and spermidine at 250 ppm occupied the second rank in the first and second seasons, respectively.

E) Yield:

Significant increase in tree yield of Succary Abiad cv was exhibited due to spray of polyamines as shown in table (3). Spermidine was more effective in increasing tree yield as compared to spermine and putrescine. The yield was significantly higher with a spray of spermidine at 125 ppm or putrescine at 250 ppm compared to other concentrations.

F) Firmness:

Significant increments in fruit firmness were exhibited in fruits that trees treated with polyamines (Table 4). The comparison of the three concentrations within putrescine, spermidine and spermine revealed almost similar results, although the trends were inconsistent.

G) Soluble solids content (SSC) and acidity:

Mango trees treated with putrescine at 500 ppm recorded the maximum increase in soluble solids content (SSC) but spermidine at 125 ppm decreased SSC compared to control (Table 4). Fruit acidity was significantly increased as a result of using polyamines. Spermidine at 500 ppm was more effective in this regard than the other treatments, in both seasons. SSC/acid ratio was significantly reduced by polyamines, while this reduction was increased as the concentrations increased.

Experiment (2): Effects of spermidine on different cultivars:

Spermidine was significantly increased fruit set and retention as compared to control in all the studied cultivars (Table 5). The improvement in fruit set and retention varied among different mango cultivars. Fruit set and retention were significantly increased as the concentration of spermidine increased within the cv., however, spermidine at 250 ppm was the most effective in stimulating fruit set and retention in Langra cv. While 500 ppm resulted in higher fruit set and retention in Fagri Kalan and Mabrouka cvs.

In general, spermidine treatments resulted in a significant reduction of fruitlet abscission in all cultivars compared to control. Data in table (5) showed that fruitlet abscission decreased as the concentration of spermidine increased, however, this reduction decreased when the concentration exceeded 250 ppm. The interaction was significantly affected fruitlet abscission. Spermidine at 500 ppm was the best in reducing fruitlet abscission in Langra cv. However, when spermidine was sprayed at 250 ppm Fagri Kalan and Mabrouka cvs recorded the minimum abscised fruits. So, each of cultivar and concentration had effect on reducing fruitlet abscission.

The data in table (6) evident that spermidine was significantly increased the number of fruits per tree, fruit weight and yield in all studied cultivars comparing to the control in both seasons. The cultivar Langra showed more response in number of fruits and yield than the other two cultivars, but the inverse trend was observed in fruit weight

Number of fruits per tree, fruit weight and yield increased with increasing the concentration of spermidine, as the highest values were recorded with the highest concentration. The interaction effects evident that increasing the concentration of spermidine was effective in increasing number of fruits per tree, fruit weight and yield in all the cultivars.

DISCUSSION

The improvement of fruit set in all studied mango cultivars could be attributed to higher level of endogenous polyamines during cell division and early period of fruit growth as reported by Biasi *et al.* (1988) on apples. Recent reports also indicated that exogenous application of polyamines during the beginning of blooming, increased fruit set in mango Langra and Dusheri cvs (Singh and Singh, 1995), in Kensington Pride cv (Singh and Janes, 2000), in Alphonso cv (Khattab *et al.*, 2000a and Shaban, 2000) and in Ewais cv (Khattab and Shaban, 2005). So, the increment in initial fruit set was influenced by the particular polyamines, its concentration and cultivar.

The reduction in fruitlet abscission with exogenous application of polyamines was observed in all studied cultivars, as spermidine at 125 and 500 ppm emerged as the most effective on both Succary Abiad and Langra cvs, respectively. In this respect, Malik *et al.* (2003) found that about-to-abscise fruitlets and their pedicels produced more ethylene than intact fruits in Kensington Pride and Glen cvs. Similarly, higher levels of ethylene have been found in young abscised fruits of Haden cv but not in Sensation cv, which is less prone to abscission (Van Lelyved and Nel, 1982). The association of ethylene and fruitlet abscission in mango have also been reported by Nunez-Elisea and Davenport (1986). However, ethylene is synthesized from S-adenosylmethionine (SAM), which is also the precursor of polyamines (Walden *et al.*, 1997). Increases in polyamine biosynthesis, particularly via SAM decarboxylase activity, are likely to affect the rates of ethylene synthesis. Any changes in polyamines are more likely to affect 1-aminocyclopropane-1-carboxylic acid (ACC) and ethylene biosynthesis than vice versa (Galston and Kaur-Sawhney, 1995). So, polyamines inhibit the conversion of ACC to ethylene (Apelbaum and Icekson, 1983). Morever, higher levels of endogenous polyamines in intact fruitlets and their pedicels compared with about-to-abscised ones, and the reduction of fruitlet abscission with exogenous application of polyamines, as well as the acceleration of abscission with inhibitors of polyamines are confirmed the role of polyamines in mango fruitlet abscission (Murti and Upreti, 1999 and Malik and Singh, 2004).

The increment in fruit retention and number of fruits with the exogenous application of polyamines may be attributed to the inhibition of fruitlet abscission. Similar results have been reported in many mango cultivars by Singh and Singh, 1995; Khattab *et al.*, 2000a; Shaban, 2000; Singh and Janes, 2000 and Khattab and Shaban, 2005.

The polyamines treatments resulted in significantly increase of fruit weight due to higher levels of endogenous polyamines during cell division and early period of fruit growth (Galston and Kaur-Sawhney, 1995; and

Murti and Upreti, 2003). It may be argued that treatments with exogenous polyamines may have stimulated fruit weight because of increase cell division. These results are in line with those of Khattab *et al.*, 2000 b and Shaban, 2000 who reported that fruit weight of Alphonso cv increased by spraying putrescine (150 ppm), while the findings of Khattab and Shaban, 2005 are in contrast with these results, who reported that spermidine (10^{-3} M) decreased fruit weight of Ewais cv. These inconsistent results may be attributed to cultivar, concentration and type of polyamines that was applied. It has shown in Exp. (2) that fruit weight was influenced by cultivar, polyamine type and concentration.

The increase in tree yield of Succary Abiad cv due to spray of polyamines may be attributed to the inhibition of fruitlet abscission and to the increase in fruit retention and number of fruit per tree as well as fruit weight. For studying which factor was more effective on yield, a multi-correlation and regression coefficients among fruitlet abscission, fruit retention, number of fruit per tree, fruit weight and tree yield were done. So, it revealed significant negative correlation between yield and fruitlet abscission ($r= -0.82$). Conversely, significant positive correlation was detected between yield and fruit retention ($r= 0.65$), number of fruit per tree (r- 0.70) and fruit weight ($r= 0.45$). it meaning that a rise of 1 % in yield had resulted in a corresponding reduction in fruitlet abscission of about 0.82 % and increase in fruit retention, number of fruit and fruit weight of about 0.65, 0.70 and 0.45 %, respectively. Therefore, fruitlet abscission and number of fruit were more effective factors than fruit retention and fruit weight. In present study, putrescine, spermidine and spermine reduced fruitlet abscission down control (average two seasons) by about 1.91, 4.33 and 6.02 %, respectively. However, they increased fruit retention, number of fruits, fruit weight and yield over the control treatment as an average of the tow seasons by about (19.90, 41.07 and 22.28 %), (23.33, 32.52 and 19.48 %), (12.77, 7.96 and 17.11 %) and (33.35, 37.51 and 29.45 %), respectively.

More firm fruits treated with polyamines could be due to their ability to cross-link carboxylate groups of pectic substances in cell walls, resulting in rigidification (Valero *et al.*, 2002) or to an inhibition of polygalacturonase activity (Kramer *et al.*, 1989).

The application of polyamines significantly reduced the SSC/acid ratio, but they increased acidity. The lower SSC/acid ratio in polyamines treated fruit is due to the relatively higher acidity values compared to the control. These results are in harmony with those reported by Purwoko *et al.* (1998), Shaban (2000) and Khattab and Shaban (2005) on mangoes.

More studies were required to study the effect of polyamine at different times and concentrations or at various number of applications on fruit retention, yield and fruit quality of mangoes.

Table (1): Effect of different polyamines (putrescine, spermidine and spermine) on fruit set percentage of Succary Abiad mango during 2002 and 2003 seasons.

Date in weeks	Polyamines									Control	Mean (C)
	Putrescine (ppm)			Spermidine (ppm)			Spermine (ppm)				
	125	250	500	125	250	500	125	250	500		
2002 season											
1	8.95	11.01	14.05	6.18	8.35	9.92	11.44	14.14	11.02	5.65	10.08
2	1.82	2.25	2.11	2.97	1.65	2.13	1.67	3.90	2.33	1.43	2.23
3	1.49	1.43	1.99	1.25	1.19	1.38	1.25	2.58	1.45	1.04	1.51
4	0.91	0.97	0.89	0.87	0.67	0.97	0.78	1.95	1.08	0.77	0.99
5	0.83	0.78	0.75	0.78	0.58	0.68	0.70	0.81	0.97	0.65	0.75
6	0.64	0.57	0.68	0.63	0.44	0.59	0.63	0.80	0.71	0.41	0.61
7	0.43	0.51	0.57	0.45	0.45	0.58	0.52	0.77	0.55	0.32	0.51
8	0.35	0.43	0.54	0.43	0.41	0.51	0.40	0.71	0.50	0.21	0.44
Mean (A)	1.92	2.24	2.70	1.70	1.72	2.10	2.18	3.21	2.33	1.31	
Mean (B)		2.29			1.84			2.57		1.31	
2003 season											
1	8.89	10.25	12.23	6.45	7.81	8.70	11.5	13.41	9.63	7.35	9.62
2	2.03	2.38	2.48	1.37	1.57	1.78	2.33	3.54	2.45	1.62	2.16
3	1.67	1.47	1.51	0.94	1.03	1.25	1.58	2.74	1.47	0.83	1.36
4	0.89	1.39	1.15	0.75	0.91	0.67	1.09	1.38	0.68	0.63	0.96
5	0.67	0.98	0.86	0.61	0.64	0.59	0.87	0.97	0.68	0.41	0.73
6	0.65	0.65	0.86	0.55	0.51	0.55	0.81	0.86	0.54	0.33	0.64
7	0.53	0.58	0.79	0.50	0.48	0.55	0.61	0.76	0.59	0.24	0.56
8	0.44	0.49	0.59	0.50	0.40	0.50	0.53	0.70	0.40	0.24	0.48
Mean (A)	1.97	2.27	2.59	1.46	1.67	1.82	2.42	3.05	2.06	1.46	
Mean (B)		2.28			1.65			2.51		1.46	

LSD at 5% for concentrations (A) **2002**= 0.27, Polyamines (B)= 0.15, Date (C)= 0.55.
LSD at 5% for concentrations (A) **2003**= 0.28, Polyamines (B) = 0.17, Date (C)= 0.67.

Table (2): Effect of different polyamines (putrescine, spermidine and spermine) on fruitlet abscission percentage of Succary Abiad mango during 2002 and 2003 seasons.

Date in weeks	Polyamines									Control	Mean (C)
	Putrescine (ppm)			Spermidine (ppm)			Spermine (ppm)				
	125	250	500	125	250	500	125	250	500		
2002 season											
F.S.*	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
1	77.35	79.31	78.13	69.63	74.81	78.43	63.51	61.31	68.38	83.11	73.40
2	89.30	88.58	87.23	83.61	85.40	89.13	88.33	89.41	86.07	89.78	87.69
3	91.11	92.00	91.12	91.55	93.51	90.91	93.51	92.00	93.21	92.15	92.02
4	93.23	94.61	94.83	91.33	94.21	92.33	93.71	93.21	93.13	94.38	93.50
5	94.81	95.04	96.10	92.04	95.10	93.21	94.63	93.21	95.40	95.21	94.52
6	95.50	96.00	96.10	93.00	95.11	94.80	94.11	94.98	95.40	96.28	95.23
7	96.09	96.09	96.16	93.04	95.09	94.86	96.52	94.98	95.45	96.28	95.62
Mean (A)	79.73	80.20	79.96	76.78	79.15	79.10	78.04	77.39	78.39	80.90	
Mean (B)		79.96			78.34			77.94		77.94	
2003 season											
F.S.*	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
1	78.13	80.13	79.45	70.33	73.15	79.10	65.01	59.13	63.21	88.18	73.58
2	91.11	91.20	88.71	82.14	85.41	86.22	78.11	73.38	75.07	93.05	84.44
3	94.53	93.83	92.14	89.51	90.13	91.25	91.13	90.01	88.14	94.52	91.52
4	94.53	94.18	94.00	91.95	94.71	93.33	95.81	91.13	91.18	95.11	93.59
5	94.53	94.18	94.85	92.00	94.70	93.33	95.30	92.35	94.13	95.11	94.05
6	95.05	95.22	95.18	92.25	94.88	94.25	95.39	94.70	95.85	96.73	94.95
7	95.05	95.2	95.18	92.25	94.88	94.25	95.39	94.78	95.85	96.73	94.96
Mean (A)	80.37	80.50	79.94	76.30	78.48	78.97	76.77	74.44	75.43	82.43	
Mean (B)		77.92			77.92			75.55		82.43	

* F.S.= fruit set.

LSD at 5% for concentrations (A) **2002** = 0.59, Polyamines (B)= 0.42, Date (C)= 3.17.

LSD at 5% for concentrations (A) **2003** = 0.99, Polyamines (B) = 0.86, Date (C)= 2.38.

Table (3): Effect of different polyamines (putrescine, spermidine and spermine) on fruit retention, number of fruits per tree, fruit weight and tree yield of Succary Abiad mango during 2002 and 2003 seasons.

Parameters	Polyamines									control
	Putrescine (ppm)			Spermidine (ppm)			Spermine (ppm)			
	125	250	500	125	250	500	125	250	500	
2002 season										
Fruit retention (%)	3.91 ^{d}	3.91 ^{d}	3.84 ^{d}	6.96 ^{a}	4.91 ^{bc}	5.14 ^{b}	3.84 ^{d}	5.02 ^{b}	4.55 ^{c}	3.72 ^{d}
		3.89 C			5.67 A			4.53 B		3.72 D
No. of fruit per tree	420.83 ^{d}	440.71 ^{c}	397.35 ^{e}	517.00 ^{a}	444.90 ^{c}	471.20 ^{b}	377.00 ^{f}	430.40 ^{cd}	381.31 ^{ef}	322.00 ^{g}
		419.63 B			477.70 A			396.24 C		322.00 D
Fruit weight (g)	321.54 ^{e}	328.68 ^{c}	338.66 ^{a}	310.93 ^{g}	325.01 ^{d}	318.13 ^{f}	336.93 ^{b}	319.68 ^{ef}	327.34 ^{c}	311.65 ^{g}
		329.63 A			318.02 B			327.98 A		311.65 C
Tree yield (kg)	135.31 ^{d}	149.85 ^{b}	134.57 ^{d}	160.75 ^{a}	144.60 ^{c}	144.90 ^{c}	127.02 ^{e}	137.59 ^{d}	124.82 ^{e}	100.35 ^{f}
		139.31 B			150.08 A			129.81 C		100.35 D
2003 season										
Fruit retention (%)	4.95 ^{cd}	4.78 ^{cd}	4.82 ^{cd}	7.75 ^{a}	5.12 ^{cd}	5.75 ^{b}	4.61 ^{de}	5.22 ^{bc}	4.15 ^{e}	3.27 ^{f}
		4.85 B			6.21 A			4.66 B		3.27 C
No. of fruit per tree	438.33 ^{bcd}	445.00 ^{bcd}	429.56 ^{cd}	587.01 ^{a}	446.00 ^{bc}	456.17 ^{b}	394.40 ^{e}	439.51 ^{bcd}	426.20 ^{d}	335.30 ^{f}
		437.63 B			496.39 A			420.04 C		335.30 D
Fruit weight (g)	367.63 ^{cd}	379.41 ^{b}	389.35 ^{a}	303.11 ^{e}	380.83 ^{b}	372.13 ^{c}	363.55 ^{d}	371.22 ^{c}	385.19 ^{ab}	305.05 ^{e}
		378.80 A			352.02 B			373.32 A		305.05 C
Tree yield (kg)	161.14 ^{d}	170.73 ^{b}	165.53 ^{bcd}	177.92 ^{a}	169.85 ^{b}	169.75 ^{b}	143.38 ^{e}	163.95 ^{cd}	165.87 ^{bc}	102.28 ^{f}
		165.80 B			172.51 A			157.46 C		102.28 D

Mean followed by the same small or capital letters in each row are not significantly different by LSD at 5 %.

Table (4): Effect of different polyamines (putrescine, spermidine and spermine) on firmness (N), soluble solids content (SSC) % and SSC / acidity ratio of Succary Abiad mango fruits during 2002 and 2003 seasons.

Parameters	Polyamines									control
	Putrescine (ppm)			Spermidine (ppm)			Spermine (ppm)			
	125	250	500	125	250	500	125	250	500	
2002 season										
Firmness (N)	21.85 ^{ab}	21.71 ^{ab}	20.89 ^{d}	21.42 ^{bc}	21.02 ^{cd}	22.13 ^{a}	19.02 ^{e}	21.86 ^{ab}	21.05 ^{cd}	18.52 f
		21.48 A			21.52 A			20.64 B		18.52 c
SSC (%)	14.70 ^{de}	16.87 ^{b}	17.67 ^{a}	12.20 ^{g}	1367 ^{f}	14.40 ^{e}	15.04 ^{cde}	15.33 ^{cd}	17.00 ^{ab}	15.67 c
		16.41 A			13.42 C			15.79 B		15.67 B
Acidity (%)	0.33 ^{g}	0.41 ^{f}	0.61 ^{c}	0.30 ^{g}	0.66 ^{b}	0.75 ^{a}	0.32 ^{g}	0.45 ^{e}	0.51 ^{d}	0.28 g
		0.54 B			0.57 A			0.43 C		0.28 D
SSC/ acidity ratio	44.55 ^{b}	41.15 ^{c}	28.97 ^{e}	40.67 ^{c}	20.71 ^{f}	19.20 ^{f}	47.00 ^{b}	34.07 ^{d}	33.33 ^{d}	55.96 a
		38.22 B			26.86 C			38.13 B		55.96 A
2003 season										
Firmness (N)	20.33 ^{cd}	19.68 ^{f}	20.20 ^{de}	21.36 ^{a}	20.78 ^{c}	20.80 ^{b}	20.66 ^{cd}	19.92 ^{ef}	20.18 ^{de}	17.20 g
		20.06 B			20.98 A			20.25 B		17.20 C
SSC (%)	14.33 ^{g}	16.67 ^{b}	17.67 ^{a}	13.45 ^{h}	14.38 ^{fg}	15.41 ^{cde}	14.60 ^{efg}	15.67 ^{cd}	16.00 ^{c}	14.93 def
		16.22 A			14.41 D			15.42 B		14.93 C
Acidity (%)	0.35 ^{c}	0.48 ^{d}	0.59 ^{c}	0.32 ^{ef}	0.60 ^{bc}	0.87 ^{a}	0.29 ^{ef}	0.32 ^{ef}	0.55 ^{cd}	0.25 f
		0.47 B			0.59 A			0.39 B		0.25 C
SSC/ acidity ratio	40.94 ^{c}	34.73 ^{d}	29.95 ^{d}	42.03 ^{c}	23.97 ^{c}	17.71 ^{f}	50.34 ^{b}	48.97 ^{b}	29.09 ^{de}	59.72 a
		35.21 C			27.90 D			42.80 B		59.72 A

Mean followed by the same small or capital letters in each row are not significantly different by LSD at 5 %

Table (5): Effect of spermidine on fruit set, retention and fruitlet abscission in different mango cultivars during 2003 and 2004 seasons.

cultivars	Initial fruit set %				Mean	Fruit retention %				Mean	Fruitlet abscission %				Mean
	0	125	250	500	(A)	0	125	250	500	(A)	0	125	250	500	(A)
								2003 season							
Fagri kalan	6.12	10.22	14.05	18.82	12.30C	1.51	2.48	5.81	3.90	3.43C	98.49	97.52	94.19	96.10	96.58A
Langra	14.44	18.80	28.00	20.31	20.39A	2.75	3.46	4.72	7.21	4.54A	91.25	96.54	95.28	92.79	94.22B
Mabrouka	10.25	14.50	18.36	22.42	16.38B	1.83	2.74	6.93	4.10	3.90B	98.17	97.26	93.07	95.95	96.10A
Mean (B)	10.27 c	14.51 b	20.14 a	20.52 a		2.03 b	2.89 b	5.82 a	5.07 a		97.97 a	97.11 a	94.18 b	94.93 b	
								2004 season							
Fagri kalan	6.75	8.52	12.05	16.26	10.89 C	1.57	2.92	6.82	3.08	3.60 B	98.43	97.08	93.18	96.92	96.40 A
Langra	12.38	14.67	24.47	18.84	17.60 A	2.18	3.83	4.50	8.34	4.71 A	91.82	96.17	95.50	91.66	95.29 B
Mabrouka	8.60	12.45	16.31	20.32	14.42 B	1.46	3.59	7.76	5.31	4.53 A	98.54	96.41	92.24	94.69	95.47 B
Mean (B)	9.24 c	11.88 b	17.61 a	18.49 a		1.74 c	3.44 b	6.36 a	5.58 a		98.26 a	96.55 b	93.64 c	94.42 c	

Mean followed by the same small letters in each row or capital letters in each column are not significantly different by LSD at 5 %

Table (6): Effect of spermidine on number of fruits per tree, fruit weight (g) and tree yield (kg) in different mango cultivars during 2003 and 2004 seasons.

cultivars	No. of fruits per tree				Mean	Fruit weight (g)				Mean	Tree yield (kg)				Mean
	0	125	250	500	(A)	0	125	250	500	(A)	0	125	250	500	(A)
								2003 season							
Fagri kalan	103.02	115.32	125.27	140.17	120.94C	431.66	440.38	448.10	450.59	442.68A	44.47	50.78	56.13	63.16	53.64C
Langra	310.12	344.00	350.09	356.82	340.26A	210.80	216.00	222.47	230.17	219.86C	65.37	74.30	77.89	82.13	74.92B
Mabrouka	175.30	187.16	195.31	205.12	190.72B	321.59	324.06	330.34	336.77	328.19B	56.37	60.65	64.52	69.10	62.66A
Mean (B)	196.15 d	215.49 c	223.59 b	234.04 a		321.35 d	326.81 c	333.64 b	339.18 a		55.40 d	61.91 c	66.18 b	71.46 a	
								2004 season							
Fagri kalan	98.43	111.42	119.07	132.78	115.43C	435.74	446.63	447.22	449.51	444.75A	42.89	49.76	53.25	59.69	51.39B
Langra	265.16	284.10	293.00	301.71	285.99A	221.89	227.97	231.13	233.37	228.59C	58.84	64.77	67.72	70.41	65.44A
Mabrouka	181.13	190.41	200.81	210.55	195.73B	310.45	318.16	325.38	328.60	320.65B	56.23	60.58	65.34	69.19	62.84A
Mean (B)	181.57 d	195.31 c	204.29 b	215.01 a		322.69 c	330.92 b	334.58 a	337.16 a		52.65 c	58.37 b	62.10 ab	66.43 a	

Mean followed by the same small letters in each row or capital letters in each column are not significantly different by LSD at 5 %

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إستجابة بعض أصناف المانجو للرش بالبولى أمينز

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أجرى هذا البحث فى تجربتين فى محطة تجارب كلية الزراعة، جامعة قناة السويس. فى التجربة الأولى رشت أشجار المانجو صنف سكري أبيض بمحلول مائي من البولى أمينز (البيتروسين، الإسبرميدين، الإسبرمين) بتركيزات صفر، ١٢٥، ٢٥٠، ٥٠٠ جزء فى المليون.فى التجربة الثانية تم رش أشجار مانجو أصناف فجرى كلان، لانجرا و مبروكة بمحلول مائي من الإسبرميدين بتركيزات صفر، ١٢٥، ٢٥٠، ٥٠٠ جزء فى المليون، وأجرى الرش (فى التجربتين) أثناء نمو النورات الزهرية وقبل التزهير (عند وصول طول النورة ٥ - ٨ سم أى فى الأسبوع الأخير من شهر مارس). وذلك بهدف دراسة تأثير هذه المواد على العقد والتساقط والثمار المتبقية والمحصول وخصائص الثمار عند الحصاد مقارنة بالكنترول. أوضحت النتائج أن الإسبرميدين كان أكثر تأثيراً فى الصنف السكرى الأبيض حيث أدى إلى زيادة العقد وانخفاض معدل تساقط الثميرات عن أشجار الكنترول، بينما الإسبرميدين بتركيز ١٢٥ جزء فى المليون أحدث زيادة معنوية فى كل من الثمار المتبقية وعدد الثمار على الشجرة وأيضاً المحصول بالمقارنة بالمعاملات الأخرى، كما أظهرت المعاملة بالبولى أمينز زيادة معنوية فى صلابة الثمار ومحتوى المواد الصلبة وكذلك الحموضة. وعند رش الأصناف تحت الدراسة من المانجو فإن الصنف لانجرا كان أكثر استجابة للإسبرميدين بتركيز ٢٥٠ جزء فى المليون عن الصنفين فجرى كلان ومبروكة حيث أعطى زيادة واضحة فى العقد والثمار المتبقية والمحصول، وكذلك قلل معدل تساقط الثمار. وقد أتضح أن استجابة أصناف المانجو للبولى أمينز تعتمد على نوع البولى أمين وتركيزه والصنف المستخدم. ومن ثم يمكن القول أن استخدام البولى أمينز قلل معدل تساقط الثمار وزاد نسبة العقد والثمار المتبقية وعدد الثمار على الشجرة وكذلك المحصول مع المحافظة على صفات الجودة.