Response of Zebda Mango Trees to Foliar Application of Some Amino Acids, Boron and Magnesium

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Abstract: During 2017 and 2018 seasons, mango cv. Zebda grown under Aswan condition was subjected to spraying amino acids (tryptophan, methionine and cysteine) at 0.1%, magnesium sulphate at 0.5% and boric acid at 0.05%, three times was very effective in improving the leaf area, chlorophylls a, b, total chlorophylls, total carotenoids, N, P, K, Mg, Zn, Fe and Mn, percentages of initial fruit setting, fruit retention, yield and fruit quality rather than non- application. Using amino acids, magnesium sulphate and boric acid in descending order was favourable in enhancing yield and fruit quality. Combined applications of these materials were superior than using each material alone in this connection. Three sprays of mixture of amino acids at 0.1%. Magnesium sulphate at 0.5% and boric acid at 0.05% was responsible for improving yield and fruit quality of Zebda mango trees.
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1. Introduction

The reasons of poor yield of Zebda mango cv. Grown under Aswan regional conditions is the unfavourable environmental conditions predominant in such region, which negatively effect fruit setting and increase fruit dropping. Therefore, the idea of using both some amino acids, magnesium sulphate and boric acid.

Amino acids with their antioxidative properties play an important role in plant defense against oxidative stress induced by unfavourable conditions.

Application of amino acids was accompanied with enhancing proteins biosynthesis as well as protecting plant cells from senescence and death, preventing the free radicals from oxidation of lipids the components of plasma membrane which is accompanied with the loss of permeability and controlling the incidence of disorders (**Orth *et al.*, 1993**).

They are responsible for stimulating the biosynthesis of natural hormones like IAA, ethylene, cytokinins and GA_3, cell division organic foods, enzymes as well as DNA and RNA.

These positive effects surely reflected on producing healthy trees (**Vianello and Marci, 1991 and Elade, 1992**).

Magnesium is essential for building chlorophylls, sugars, DNA, RNA, proteins, fats and amino acids. It is also responsible for enhancing P uptake and sugars translocation (**Nijjar, 1985**).

Boron plays an important role in enhancing cell division and cell wall development and the biosynthesis of nucleic acids, proteins, natural hormones, carbohydrates, photosynthesis, water uptake and pollen germination. It is responsible for stimulating nutrient uptake and sugars translocation and tolerance of the trees to disorders (Belvius **and Lukaszweski, 1998 and Perica *et al.*, 2001**).

2. Material and Methods

This investigation was conducted during the two consecutive seasons of 2017 and 2018 on twenty four 15- years old Zebda mango trees into Succary mango rootstock. The trees are grown in a private mango orchard located at Albirah area, Kom Ombo district, Aswan Governorate. The uniform in vigour trees of Zebda mango (24 trees)were planted at 5x5 metre apart. The soil texture of the tested orchard is silty clay with a water table depth not less than two meters. Surface irrigation system was followed.

The results of orchard soil analysis (according to **Wilde *et al.*, 1985**) are shown in Table (1).

The selected trees received a basal recommended fertilizer including the application of 20 m^3 farmyard manure (0.35 %N, 0.45 % P_2O_5 and 1.2 % K_2O) added in early December, 200 kg / fad. Monocalcium superphosphate (15.5 % P_2O_5) added in mid January, 450 kg/ fed. Ammonium sulphate (20.6 % N) added in three equal dressings in February, April and July and 200 kg/ fed. Potassium sulphate (48% K_2O) added in two equal dressing applied in mid February and April, in addition to the regular agricultural and horticultural practices which were already followed in the orchard including pruning, hoeing, irrigation with Nile water as well as pathogens, pests and weed control.

This experiment included the following eight treatments from spraying some amino acids, magnesium and boron.

1- Control treatment.
2- Spraying boric acid at 0.05%.
3- Spraying magnesium sulphate at 0.5%.
4- Spraying amino acids at 0.1%.
5- Spraying boric acid at 0.05% + magnesium sulphate at 0.5%.
6- Spraying boric acid at 0.05% + amino acids at 0.1%.
7- Spraying magnesium sulphate at 0.5% + amino acids at 0.1%.
8- Spraying boric acid at 0.05% + magnesium sulphate at 0.5% + amino acids at 0.1%.

Table (1): Mechanical, physical and chemical analysis of the tested orchard soil.

Characters	Values
Partical size distribution	
Sand %	11.5
Silt %	52.0
Clay %	36.5
Texture	Silty clay
pH (1: 2.5 extract)	7.25
EC (1:2.5 extract) (mmhos/ 1cm/ 25°C	0.68
O.M. %	2.25
$CaCO_3$ %	1.7
Macronutrients values	
Total N%	0.11
P (ppm, olsen method)	0.25
K (ppm ammonium acetate)	5.11
Mg (ppm)	6.0
EDTA extractable (ppm)	
Zn	2.8
Fe	3.9
Mn	5.3

Therefore, the experiment evolved eight treatments. Each treatment was replicated three times, one three per each. The three amino acids used were (tryptophan, methionine and cysteine).

Magnesium was applied in the source of magnesium sulphate (9.6 % Mg) and Boron was applied in the source of boric acid (17% B).

The three biostimulants namely amino acids, magnesium and boron were applied three times at growth started (1st week of March), just after fruit setting (last week of April and at one month later (last week of may). Triton B as a wetting agent at a 0.05 % was added to all spraying solutions (each tree needs about 50 L solution). Spraying was done till runoff. The untreated trees sprayed with water containing triton B.

During both seasons the following measurements were recorded:

1- Leaf area (**Ahmed and Morsy, 1999**) in cm^2.

2- Leaf pigments namely chlorophylls a, b, total chlorophylls and total carotenoids (mg/ 1 g F.W.) (**Von- Wettstein, 1957 and Hsicox and Isralstam, 1979**).

3- Leaf content of N, P, K and Mg (as %) and Zn, Fe and Mn (as ppm). (**Peach and Tracey, 1968; Evenhuis and Deward, 1980; Cottenie *et al.*, 1982 and Summer, 1985**).

4- Percentages of initial fruit setting and fruit retention, yield/ tree and number of fruit / tree.

5- Physical and chemical characteristics of the fruits namely weight (g.), length, width and thickness (cm) of fruits, percentages of T.S.S, %, total, reducing sugars %, total acidity % (as g citric acid/ 100 g pulp) and vitamin C (mg / 100 g pulp) (**A.O.A.C., 2000**) (**Lane and Eynon, 1965**).

Statistical analysis was done and treatment means were compared using New L.S.D. at 5% (**Mead *et al.*, 1993**).

3. Results

1-Effct of single and combined applications of boric acid, magnesium sulphate and amino acids on the leaf area.

It is clear from the obtained data Table (2) that varying boric acid, magnesium sulphate and amino acids treatments had significant effect on the leaf area. Single and combined applications of boric acid at 0.05%, magnesium sulphate at 0.5%, and amino acids at 0.1% significantly stimulated the leaf area comparing with eth control treatment.

The stimulation on the leaf area was significantly depended on using boric acid, magnesium sulphate and amino acids in ascending order. Application of amino acids occupied the first position in this respect combined applications were significantly superior than using each material alone in stimulating the leaf area. The maximum leaf area (110.0, 112.0 m^2) during both seasons, respectively were recorded on the trees that received three sprays of a mixture of boric acid at 0.05%. magnesium sulphate at 0.5% and amino acids at 0.1%. The untreated trees produced the minimum values (88.8, 89.5 cm) during both seasons, respectively. The percentage of increase on the leaf area due to using all materials together over the control treatment reached 23.9 and 25.1 % during 2017 and 2018 seasons, respectively. These results were true during both seasons.

2-Effect of single and combined applications of boric acid, magnesium sulphate and amino acids on chlorophylls a, b, total chlorophylls and total carotenoids in the leaves.

Varying boric acid, magnesium sulphate and amino acids had significant effect on the chlorophylls a, b, total chlorophylls and total carotenoids in the leaves (Table 2). Foliar application of boric acid at 0.05%, magnesium sulphate at 0.5% and amino acids at 0.1% either applied alone or in various combinations significantly was accompanied with enhancing all pigments in the leaves rather than non-application. The promotion was significantly related to using boric acid, magnesium sulphate and amino acids in ascending order. Using amino acids was significantly superior than using the other two materials namely magnesium sulphate and boric acid. Double and triple applications were significantly favourable than using each alone in this respect. The maximum values of chlorophyll a (6.2, 6.4 mg/ 100 g F.W.), chlorophyll b (2.2, 2.4 mg/ 100 g F.W.), total chlorophylls (8.4, 8.8 mg/ 100 g F.W.) and total carotenoids (2.3, 2.5 mg/ 100 g F.W.) were observed on the trees that received all materials together. The minimum values of chlorophyll a (3.9, 3.9 mg/ 100 g F.W.), chlorophyll b (1.1, 1.1 mg/ 100 g F.W.), total chlorophylls (5.0, 5.0 mg/ 100 g F.W.) and total carotenoids (0.9, 1.0 mg/ 100 g F.W.) were presented on the trees that did not subject to any materials. Similar results were obtained during both seasons.

3- Effect of single and combined applications of boric acid, magnesium sulphate and amino acids on the leaf content of N, P, K and Mg (as %) and Zn, Fe and Mn (as ppm) in the leaves.

It is evident from the obtained data (Tables 2, 3) that single and combined application of boric acid to 0.05% magnesium sulphate at 0.5 % and amino acids at 0.1% significantly was responsible for enhancing the seven nutrients in the leaves namely N, P, K, Mg, Zn, Fe and Mn comparing with the check treatment.

Table (2): Effect of some amino acids, Boron and magnesium on photosynthetic pigments and percentages of N and P of Zebda mango trees grown under Aswan climatic conditions during 2017 and 2018 seasons.

Treatments	Leaf area (cm)2		Chlorophyll a (mg/ 100 g F.W.)		Chlorophyll b (mg/ 100 g F.W.)		Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	88.8	89.5	3.9	3.9	1.1	1.1	5.0	5.0	0.9	1.0	1.44	1.51
Spraying boric acid at 0.05%	96.0	96.5	4.1	4.2	1.2	1.4	5.3	5.6	1.3	1.4	1.51	1.55
Spraying magnesium sulphate at 0.5%	98.5	99.2	4.3	4.5	1.6	1.7	5.9	6.2	1.5	1.6	1.60	1.62
Spraying amino acids at 0.1%	100.0	101.2	4.4	4.7	1.7	1.8	6.1	6.5	1.5	1.6	1.69	1.71
Spraying boric acid + magnesium sulphate	103.0	104.5	4.9	5.1	1.8	2.0	6.7	7.1	1.7	1.9	1.73	1.75
Spraying boric acid + amino acids	106.1	108.0	5.1	5.3	2.0	2.1	7.1	7.4	1.9	2.1	1.77	1.78
Spraying magnesium sulphate+ amino acids	108.5	110.0	5.5	5.8	2.1	2.3	7.6	8.1	2.1	2.2	1.79	1.81
Spraying all together at same conc.	110.0	112.0	6.2	6.4	2.2	2.4	8.4	8.8	2.3	2.5	1.83	1.85
New L.S.D. at 5%	1.2	1.1	0.3	0.3	0.3	0.3	0.4	0.5	0.2	0.3	0.04	0.05

Table (3): Effect of some amino acids, Boron and magnesium on percentages of K, Mg and Ca (as %) and Zn, Fe and Mn (as ppm) of Zebda mango trees grown under Aswan climatic conditions during 2017 and 2018 seasons.

Treatments	Leaf P%		Leaf K %		Leaf Mg %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	0.21	0.20	1.08	1.09	0.45	0.47	78.1	77.5	86.0	85.8	55.0	57.5
Spraying boric acid at 0.05%	0.23	0.23	1.18	1.20	0.49	0.49	79.3	80.0	88.0	89.0	56.0	59.0
Spraying magnesium sulphate at 0.5%	0.26	0.27	1.23	1.24	0.58	0.60	80.5	81.2	89.5	90.8	57.9	60.5
Spraying amino acids at 0.1%	0.28	0.29	1.26	1.28	0.59	0.61	81.6	82.2	91.0	92.2	60.0	61.9
Spraying boric acid + magnesium sulphate	0.29	0.30	1.29	1.31	0.63	0.65	82.8	83.4	93.5	94.5	61.3	63.3
Spraying boric acid + amino acids	0.31	0.32	1.33	1.36	0.63	0.66	84.1	84.9	96.0	97.2	62.5	66.2
Spraying magnesium sulphate+ amino acids	0.32	0.33	1.41	1.46	0.69	0.70	86.1	87.1	97.2	98.5	63.5	67.3
Spraying all together at same conc.	0.33	0.34	1.44	1.49	0.71	0.73	87.5	88.3	98.8	99.2	67.2	69.5
New L.S.D. at 5%	0.01	0.02	0.06	0.07	0.02	0.03	1.1	1.2	1.3	1.4	1.0	1.1

Spraying amino acids, magnesium sulphate and boric acid in descending order was significantly followed by enhancing these plant nutrients. Combined applications of these materials were significantly superior than using each material alone in enhancing these nutrients. The highest values of N (1.83, 1.85 %), P (0.33, 0.34 %), K (1.44, 1.49%), Mg (0.71, 0.73 %), Zn, (87.5, 88.3 ppm), Fe (98.8,

99.2 ppm) and Mn (67.2, 69.5 ppm) during both seasons respectively were recorded on the trees that supplied with all material together at the second concentrations. The untreated trees produced the minimum values of N (1.44, 1.51 %), P (0.21, 0.20 %), K (1.08, 1.09 %), Mg (0.45, 0.47 %), Zn (78.1, 77.5 ppm), Fe (86.0, 85.8 ppm) and Mn (55.0, 57.5 ppm) during 2017 and 2018 seasons respectively. These results were true during both seasons.

4-Effect of single and combined applications of boric acid, magnesium sulphate and amino acids the percentages of initial fruit setting and fruit retention.

It is noticed from the obtained data (Table 4) that both percentages of initial fruit setting and fruit retentions were significantly varied among the eight boron, magnesium and amino acids treatments percentages of initial fruit setting and fruit retention were significantly improved due to using boric acid at 0.05%, magnesium sulphate at 0.5% and amino acids at 0.1% either singly or in all combinations rather than non application. Application of amino acids significantly surpassed the application of magnesium sulphate and boric acid in improving the two fruit setting characters. Using magnesium sulphate occupied the second position. The last position was presented by using boric acid. Combined applications were significantly very favourable than using each material alone in enhancing the percentages of initial fruit setting and fruit retention. The best results were obtained on the trees that treated with the three materials together. Under such promised treatment. Percentages of initial fruit setting and fruit retention reached (28.5 & 29.2 %) as well as (0.61, 0.63 %) during both seasons, respectively. The lowest values initial setting fruit (22.5, 22.6%) and fruit retention (0.20, 0.19 %) were observed on untreated trees during both seasons, respectively. These results were true during both seasons.

Table (4): Effect of some amino acids, Boron and magnesium on panicle length/ number of flowers/ panicle, percentages of initial fruit setting, fruit retention and yield / tree of Zebda mango trees grown under Aswan climatic conditions during 2017 and 2018 seasons.

Treatments	Initial fruit setting %		Fruit retention %		No. of fruit / tree		Yield/ tree (kg.)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	22.5	22.6	0.20	0.19	250.0	252.0	77.5	78.1
Spraying boric acid at 0.05%	25.2	25.8	0.39	0.41	260.0	266.0	81.9	85.1
Spraying magnesium sulphate at 0.5%	24.5	25.0	0.49	0.50	265.0	270.0	84.8	86.1
Spraying amino acids at 0.1%	25.7	26.0	0.51	0.53	268.0	272.0	87.1	89.8
Spraying boric acid + magnesium sulphate	26.2	26.8	0.53	0.55	272.0	275.0	89.8	92.1
Spraying boric acid + amino acids	26.5	27.0	0.55	0.57	275.0	280.0	93.5	95.8
Spraying magnesium sulphate+ amino acids	26.9	27.5	0.57	0.58	280.0	283.0	98.0	100.5
Spraying all together at same conc.	28.5	29.2	0.61	0.63	285.0	290.0	101.2	104.4
New L.S.D. at 5%	1.1	1.2	0.04	0.06	7.0	6.0	1.7	1.6

5-Effect of single and combined applications of boric acid, magnesium sulphate and amino acids on the yield.

One can stated (Table 4) that single and combined applications of boric acids at 0.05%, magnesium sulphate at 0.5% and amino acids at 0.1% was significantly very effective in improving the yield and number of fruits/ tree relative to the check treatment. Significantly differences on the yield and number of fruits/ tree were observed among all treatments. Using boric acid, magnesium sulphate and amino acids in ascending order was significantly preferable in improving yield and number of fruits/ tree. Using amino acids ranked the first position followed by magnesium sulphate in this connection combined applications were significantly superior than using each material alone in his respect. The best results were obtained due to treating the trees three times with a mixture of boric acid, magnesium sulphate and amino acids at the named concentration.

Under such promised treatment yield per tree reached (101.2, 104.4 kg) while number of fruits / tree was (285.0, 290.0 fruits) during both seasons respectively. The lowest yield (77.5, 78.1 kg) and number of fruits / tree (250.0, 252.0 fruits) during both seasons, respectively were recorded on the untreated trees. The percentage of increase on the yield expressed in weight due to application of the Superior treatment over the check treatment reached (30.6, 33.7 %) during both seasons, respectively. These results were true during both seasons.

6-Effect of single and combined applications of boric acid magnesium sulphate and amino acids on both physical and chemical characteristics of the fruits.

It is obvious from eth obtained data (Tables 5, 6) that both physical and chemical characteristics of the fruits were significantly varied among the eight boron, magnesium and amino acids treatments. A significantly promotion on fruit quality was observed owing to using boric acid, magnesium sulphate and amino acids either applied alone or when used in combinations comparing with non- application. A significantly promotion on fruit quality was observed due to using amino acids, magnesium sulphate and boric acid in descending order. The promotion on fruit quality was appeared in terms of increasing weight, length, width and thickness of fruit, T.S.S. %, total and reducing sugars % and vitamin C content and decreasing percentages of total acidity % and crude fibre %.

Table (5): Effect of some amino acids, Boron and magnesium on some physical characteristics of the fruits of Zebda mango trees grown under Aswan climatic conditions during 2017 and 2018 seasons.

Treatments	Av. Fruit weight (g.)		Av. Fruit height (cm.)		Av. Fruit diameter (cm)		Av. Fruit thickness (cm.)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	310.0	310.0	11.5	11.3	7.5	7.6	5.5	5.6
Spraying boric acid at 0.05%	315.0	320.0	11.8	11.9	7.9	8.0	5.9	6.0
Spraying magnesium sulphate at 0.5%	320.0	322.0	12.2	12.3	8.2	8.3	6.2	6.3
Spraying amino acids at 0.1%	325.0	330.0	12.5	12.6	8.4	8.4	6.4	6.4
Spraying boric acid + magnesium sulphate	330.0	335.0	12.7	12.9	8.7	8.8	6.7	6.8
Spraying boric acid + amino acids	340.0	342.0	13.0	13.1	8.9	9.0	6.9	7.0
Spraying magnesium sulphate+ amino acids	350.0	355.0	13.1	13.3	9.1	9.2	7.1	7.2
Spraying all together at same conc.	355.0	360.0	13.2	13.4	9.2	9.4	7.2	7.4
New L.S.D. at 5%	8.1	7.3	0.3	0.2	0.2	0.2	0.2	0.2

Table (6): Effect of some amino acids, Boron and magnesium on some chemical characteristics of the fruits of Zebda mango trees grown under Aswan climatic conditions during 2017 and 2018 seasons.

Treatments	T.S.S. %		Total acidity %		Total sugar %		Reducing sugars %		Vitamin C (mg/ 100 ml pulp)		Total crude fibre %	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Control	14.5	14.6	0.370	0.368	12.5	12.8	3.1	3.1	46.5	46.8	0.41	0.42
Spraying boric acid at 0.05%	14.9	15.1	0.366	0.360	12.9	13.1	3.4	3.6	47.8	48.0	0.38	0.36
Spraying magnesium sulphate at 0.5%	15.2	15.4	0.350	0.344	13.1	13.3	3.7	3.9	48.5	48.9	0.35	0.33
Spraying amino acids at 0.1%	15.5	15.8	0.340	0.333	13.4	13.7	4.0	4.1	49.9	50.3	0.31	0.29
Spraying boric acid + magnesium sulphate	15.9	16.1	0.322	0.315	13.8	14.0	4.2	4.3	50.5	51.0	0.28	0.27
Spraying boric acid + amino acids	16.2	16.3	0.311	0.300	14.1	14.3	4.4	4.6	51.6	52.0	0.25	0.24
Spraying magnesium sulphate+ amino acids	16.5	16.7	0.299	0.292	14.4	14.6	4.6	4.8	52.3	53.1	0.24	0.23
Spraying all together at same conc.	16.8	17.0	0.280	0.276	14.7	15.0	4.8	5.0	53.1	53.9	0.21	0.19
New L.S.D. at 5%	0.3	0.4	0.016	0.014	0.5	0.4	0.2	0.3	1.3	1.2	0.04	0.03

The best results were obtained due to using all materials together. Under such promised treatment fruit weight reaches (355.0, 360.0 g) while T.S.S. % was (16.8, 17.0 %) during both seasons, respectively. The untreated trees produced undesirable fruits. These results were true during both seasons.

4. Discussion

Amino acids with their antioxidative properties play an important role in plant defense against oxidative stress induced by unfavourable conditions. Application of amino acids was accompanied with enhancing proteins biosynthesis as well as protecting plant cells from senescence and death preventing the free radicals from oxidation of lipids the components of plasma membrane which the loss of permeability and controlling the incidence of disorders (**Orth *et al.*, 1993**).

They are responsible for stimulating the biosynthesis of natural hormones like IAA, ethylene, cytokinins and GA_3cell division organic foods, enzymes as well as DNA and RNA. These positive effects surely reflected on producing healthy trees (**Vianello and Marci, 1991 and Elade, 1992).** These results are agreement with those obtained by **(El-Badawy and Abd El-aal (2013); Fathalal (2013); Rabeh *et al.*, (2014) and Awad (2019)**.

The beneficial effects of magnesium on fruiting of Zebda mango trees might be attributed to its essential roles on enhancing activity of different enzymes the biosynthesis and translocation of carbohydrates, fats, proteins and natural hormones, cell division, cell enlargement uptake of water and nutrients, building of chlorophylls and amino acids and seed formation. (**Devlin and Withdam, 1983; Nijjar, 1985 and Mengel and Kirkby, 1987**).

These results are in agreement with those obtained by (**El- Sayed – Esraa (2010) Mohamed and Mohamed (2013), Hassan- Huda (2014) and Ahmed *et al.*, (2014)**.

The beneficial effects of boron on enhancing cell division, root development, proteins and natural hormones, biosynthesis, building and movement of carbohydrates, photosynthesis uptake of water and nutrients and pollen, germination (**Sister *et al.*, (1965); Pilbeam and Kirky (1983) and Belevius and Lukaszweski, (1998)**.

These results are in agreement with those obtained by **(Mohamed (1998); Ebeid- Sanaa (2007) and Noby (2016)**.

Conclusion

Treating Zebda mango trees three times at growth start, just after fruit setting and at one month later with a mixture of amino acids at 0.1% magnesium sulphate at 0.5% and boric acid at 0.05 % was essential for promoting yield and fruit quality.

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