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APPLICATION OF ALGAE EXTRACT AND BORIC ACID FOR OBTAINING HIGHER YIELD AND BETTER FRUIT QUALITY OF ANNA APPLE

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Rezumat: S-a studiat influența extractului de alge și a acidului boric asupra fructificării pomilor de măr din soiul Ana. S-a stabilit că aplicarea extractului de alge și a acidului boric a contribuit la sporirea suprafeței foliare, conținutului de elemente minerale în frunze și a recoltei. Folosirea acidului boric a avut o influență mai semnificativă decât a extractului de alge. Cele mai bune rezultate au fost obținute la îmbinarea combinată a lor.

Key words. Algae extract, Apple, Boric acid, Fruit quality, Yield.

INTRODUCTION

Improving yield of Anna apple trees quantitatively and qualitatively is considered the most important task for pomologists. The use of Algae biofertilizer was suggested to be as one possibility to restore the natural conditions. The mechanisms by which microorganisms stimulate plant growth include increasing the supply of essential nutrients and direct plant growth promotion by delivering natural hormones and vitamins to the plants. Biofertilizers produce amino acids, isopentenyladenine-like substances, vitamins B, cytokinins and GA3 (S. Kannaiyan, 2002).

Boron has a promising role in the nutrition of fruit crops. It is responsible for enhancing the biosynthesis and translocation of carbohydrates, activating cell division and fruiting and controlling various diseases (G. Gauch and W. Dugger, 1954; G. Nijjar, 1985).

Combined application of Algae extract and boron caused a striking promotion on production and fruit quality of fruit crops. Previous studies showed that using biofertilizers had an announced role on growth and fruiting of fruit crops (M. Adam, 1999; W. Abd El-Aziz, 2001; H. El-Sayed, 2001; Abd El-Ghany *et al.*, 2001; A. Gobara *et al.*, 2002; M. Abada, 2002; M. Mahran, 2005; Abd El-Hameed, 2005 and H. Abd El-Hameed and M. Rabeea, 2005).

The findings obtained by F. Ahmed *et al.*, 1993; Abd El-Aziz, 1994; P. Wojcik, A. Mika 1996; M. Povan, 1997; M. Zude *et al.*, 1998; E. Stover *et al.*, 1999; D. Velemis *et al.*, 1999; A. Nyomoro *et al.*, 1999; A. Ali, 2000; F. Ahmed Morsy, 2001 confirmed the profit of using boron on growth, yield and fruit quality in different fruit crops.

This study aimed to throw some light on the effect of Algae extract and boric acid on growth, yield and fruit quality of Anna apple trees.

MATERIALS AND METHODS

This study was conducted during 2004 and 2005 seasons on thirty of 12 years old Anna apple trees onto M.M 106 rootstock in a private orchard located at West Samalout, Minia region, Egypt. The texture of the soil is sandy. Trees were selected as uniform in vigour as possible and planted at 3.5×3.5 m apart.

Dorset Golden and Ein-Shemir apple trees as pollinizers were additionally planted and distributed between Anna apple trees at the proportion of four rows of Anna apple trees per one row of pollinizers to secure open pollination with the assistance of two hives of honeybees per feddan.

Soil analysis was carried out according to S. Wilde *et al.*, (1985) Pratt and the obtained data are shown in the next table.

Table I

Analysis of the tested soil

Constituents	Values
Sand %	83.5
Silt %	13.0
Clay %	3.5
Texture	Sandy
O.M.%	1.0
CaCO ₃ %	9.0
E.C (1:2.5, mmhos / cm)	
Available K (ppm)	
Available K (ppm)	
DTPA extractable micronutrients (ppm)	
Fe	1.2
Zn	1.0
Mn	1.1
Cu	0.5
B	0.4

The experiment included the following ten treatments:

1. Control (unsprayed trees).
2. Spraying Algae extract at 0.25%.
3. Spraying Algae extract at 0.50%.
4. Spraying Algae extract at 1.00%.
5. Spraying boric acid at 0.025%.
6. Spraying boric acid at 0.050%.
7. Spraying boric acid at 0.100%.
8. Spraying Algae extract and boric acid at low concentrations.
9. Spraying Algae extract and boric acid at medium concentrations.
10. Spraying Algae extract and boric acid at high concentrations.

Therefore, the experiment included ten treatments, each treatment was replicated three times, one tree per each. Algae extract and boric acid were sprayed three times during each season at growth start (1st week of Feb.), just after fruit setting (2nd week of April) and at one month later (2nd week of May). Triton B as a wetting agent at 0.1% was added to boric acid solutions only. The untreated trees sprayed with tap water. The trees were sprayed till runoff (10 L/tree). Completely randomized block design was adopted.

All trees received regular program (except the application of Algae extract or any biofertilizers and boric acid) which was followed in the orchard in concern for horticultural practices.

Determination of growth characters and leaf chemical composition.

At the end of each season, shoot length (cm) was recorded. Ten leaves from the middle part of the shoots were taken from each tree for measuring the average leaf area (cm²) according to F. Ahmed and M. Morsy (1999) using the following formula:

$$L. A. = 0.73 (L \times W) + 0.16$$

Where L.A. = Leaf area in cm² and L and W were the maximum length and width of the leaf (cm).

Leaves were over dried for determining the total carbohydrate % (according to A.O.A.C., 1985) and leaf N%, P%, K%, Mg% and B (ppm) (on dry weight basis) according to the procedures outlined by S. Wilde *et al.* (1985).

Determination of yield and fruit quality.

At the second week of July as fruits reached maturity, trees were harvested and the yield per tree expressed in weight (kg) was recorded.

Ten fruits per tree were randomly taken for determination of the following physical and chemical characteristics:

1. Average fruit weight (g) and dimensions (length and width, cm).
2. Percentage of total soluble solids.
3. Percentage of total acidity (as g malic acid/100 ml juice, A.O.A.C., 1985).
4. Percentage of total and reducing sugars according to Lane and Eynon procedure outlined in A.O.A.C. (1985).

All the obtained data were tabulated and statistically analysed according to R. Mead *et al.* (1993) using New L.S.D. test at 5% for various comparisons among all the studied treatment means.

RESULTS AND DISCUSSION

It is clear from the obtained data in tables (2 & 3) that single application of Algae extract at 0.25 to 1.0% and boric acid promotion at 0.025 to 0.1% as well as combined application of both at low, medium and high concentrations significantly stimulated the shoot length, leaf area, leaf total carbohydrates and leaf content N, P, K, Mg and B compared to the check treatment. Increasing concentrations of each material was followed by gradual promotion on such characters. Application of boric acid was superior to the application of Algae extract in stimulating these parameters. Combined application was more favourable than using each alone in this respect. In all cases, no significant promotion was observed among medium and high concentrations of each compound.

The maximum values were detected on the trees which received three sprays of a mixture containing Algae extract and boric acid at a high concentration. The untreated trees produced the minimum values. These results were true in both seasons.

Table 2

Effect of Algae extract and boric acid on shoot length, leaf area, carbohydrate% and percentage of N in the leaves of Anna apple trees during 2004 and 2005 seasons

Treatment	Shoot length (cm)		Leaf area (cm ²)	
	2004	2005	2004	2005
Control	30.5	31.3	38.2	36.0
Algae extract at 0.25%	31.9	33.3	39.5	37.9
Algae extract at 0.50%	32.9	35.0	41.2	39.2
Algae extract at 1.00%	33.0	35.2	41.3	39.5
Boric acid at 0.025%	34.8	36.0	43.0	41.2
Boric acid at 0.050%	36.0	37.5	44.8	42.8
Boric acid at 0.100%	36.3	38.0	45.0	44.0
Both at low conc.	38.9	39.5	46.0	45.9
Both at medium conc.	41.9	43.3	48.0	47.5
Both at high conc.	42.0	43.5	48.2	47.8
New L.S.D at 5%	1.0	1.2	0.8	1.0
	Leaf carbohydrates		Leaf N%	
Control	14.1	15.0	1.11	1.18
Algae extract at 0.25%	15.3	16.2	1.22	1.29
Algae extract at 0.50%	16.5	17.5	1.29	1.39
Algae extract at 1.00%	16.6	17.6	1.30	1.40
Boric acid at 0.025%	17.9	18.0	1.40	1.50
Boric acid at 0.050%	18.9	19.1	1.49	1.55
Boric acid at 0.100%	19.0	19.2	1.51	1.56
Both at low conc.	19.9	20.9	1.62	1.69
Both at medium conc.	21.0	21.9	1.69	1.79
Both at high conc.	21.3	22.0	1.70	1.80
New L.S.D at 5%	1.0	1.0	0.04	0.03

Table 3

Effect of Algae extract and boric acid on leaf content of P, K, Mg and B of Anna apple trees during 2004 and 2005 seasons

Treatment	Leaf P%		Leaf K%	
	2004	2005	2004	2005
Control	0.18	0.20	0.98	1.01
Algae extract at 0.25%	0.21	0.22	1.05	1.07
Algae extract at 0.50%	0.24	0.25	1.11	1.11
Algae extract at 1.00%	0.25	0.26	1.12	1.12
Boric acid at 0.025%	0.28	0.28	1.20	1.27
Boric acid at 0.050%	0.31	0.31	1.29	1.37
Boric acid at 0.100%	0.32	0.32	1.31	1.40
Both at low conc.	0.35	0.35	1.40	1.50
Both at medium conc.	0.38	0.38	1.46	1.55
Both at high conc.	0.39	0.39	1.47	1.56
New L.S.D at 5%	0.02	0.02	0.04	0.03
	Leaf Mg%		Leaf B%	
Control	0.22	0.24	40.2	40.0
Algae extract at 0.25%	0.28	0.27	41.5	42.2
Algae extract at 0.50%	0.33	0.31	43.0	44.0
Algae extract at 1.00%	0.34	0.31	43.3	44.5
Boric acid at 0.025%	0.39	0.36	46.0	50.0
Boric acid at 0.050%	0.44	0.41	50.0	55.0
Boric acid at 0.100%	0.45	0.42	51.0	55.8
Both at low conc.	0.51	0.49	55.0	59.0
Both at medium conc.	0.56	0.54	60.0	63.0
Both at high conc.	0.56	0.55	61.0	63.7
New L.S.D at 5%	0.03	0.03	1.2	1.3

These results could be explained on the light of the promoting effect of Algae extract and boric acid on the biosynthesis of natural hormones and cell division process (G. Nijjar, 1985; M. Adam, 1999). Their important roles in enhancing the biosynthesis of organic foods could result in enhancing growth aspects.

These results are in harmony with those obtained by M Abada (2002), M. Mahran (2005) and H. Abd El-Hameed (2005) who worked on biofertilizers, as well as A. Ali (2000) and F. Ahmed, M. Morsy (2001) who worked on boric acid.

It is clear from the obtained data in table 4 that the yield was positively affected by the application of Algae extract and/or boric acid compared to the control treatment. Application of boric acid surpassed the application of Algae extract in promoting the yield. Significant differences on the yield were detected among the treated and untreated trees. Significant differences were observed between all concentrations of the investigated material except between using the medium and high concentrations. Combined application was beneficial in improving the yield than the application of each alone. The maximum and economical yields were detected on the trees received three sprays of Algae extract + boric acid each at 0.5 and 0.05%, respectively. Under such promising treatment, the yield reached 36 38 Kg in both seasons, respectively. The untreated trees which produced the minimum values (21.5 and 22.2 Kg in both seasons, respectively). Similar results were obtained in both seasons.

The improving effect of Algae extract and boric acid on growth and nutritional status of the trees could result in promoting the yield.

These results are in agreement with those obtained by W. Abd El-Aziz (2001), H. El-Sayed (2001)

Table 4

Effect of Algae extract and boric acid on yield/tree (kg) and fruit dimensions (cm) of Anna apple trees during 2004 and 2005 seasons

Treatment	Yield/tree (kg)		Fruit weight (g)	
	2004	2005	2004	2005
Control	21.5	22.2	100.5	96.2
Algae extract at 0.25%	24.0	25.2	111.0	108.5
Algae extract at 0.50%	26.5	28.9	122.0	121.0
Algae extract at 1.00%	27.0	29.0	123.0	121.9
Boric acid at 0.025%	29.0	31.0	130.0	127.0
Boric acid at 0.050%	33.0	33.3	139.0	131.0
Boric acid at 0.100%	33.3	33.5	140.0	132.0
Both at low conc.	34.9	35.9	145.0	149.0
Both at medium conc.	36.0	38.0	150.0	155.0
Both at high conc.	36.4	38.1	152.0	156.2
New L.S.D at 5%	1.9	2.0	5.1	4.2
	Fruit length (cm)		Fruit width (cm)	
Control	5.6	5.4	5.0	4.8
Algae extract at 0.25%	5.9	5.8	5.3	5.1
Algae extract at 0.50%	6.4	6.2	5.7	5.5
Algae extract at 1.00%	6.5	6.3	5.8	5.6
Boric acid at 0.025%	6.8	7.1	6.0	6.1
Boric acid at 0.050%	7.1	7.4	6.4	6.4
Boric acid at 0.100%	7.1	7.5	6.5	6.5
Both at low conc.	7.4	7.7	6.9	6.8
Both at medium conc.	7.7	8.0	7.2	7.4
Both at high conc.	7.7	8.0	7.3	7.5
New L.S.D at 5%	0.3	0.3	0.2	0.2

and Abd El-Ghany *et al.* (2001) who worked on biofertilizers, as well as M. Povan (1997), M. Zude *et al.* (1998), D. Velemis *et al.* (1999) and F. Ahmed, M. Morsy (2001) who worked on boric acid.

Tables 4 & 5 show that single or combined application of Algae extract and boric acid significantly improved physical and chemical characteristics of the fruits in terms of increasing fruit weight and dimensions (length and width), total soluble solids and reducing sugars and in decreasing total acidity compared to the check treatment. The promotion on fruit quality was associated with increasing concentrations of each material. Application of boric acid was preferable than using Algae extract in improving quality fruits. The most promising effects were detected on treatments included the application of both compounds together. A slight and insignificant promotion was recorded among using the medium and high concentrations of each material.

Good results with regard to fruit quality were recorded on the trees received Algae extract plus boric acid. Unfavourable effects were detected at untreated trees. These results were true in both seasons.

The improving effect of Algae extract and boric acid on the biosynthesis and translocation of carbohydrates could explain the present findings.

These results are in agreement with those obtained by W. Abd El-Aziz (2001), H. El-Sayed (2001) and Abd El-Ghany *et al.* (2001) who worked on biofertilizers, as well as M. Povan (1997), M. Zude *et al.* (1998), D. Velemis *et al.* (1999) and F. Ahmed, M. Morsy (2001) who worked on boric acid.

As a conclusion, for obtaining an economical yield with better fruit quality of Anna apple trees, it is suggested to use combined treatment containing Algae extract at 0.5% plus boric acid at 0.05% three times.

Table 5

Effect of Algae extract and boric acid on some chemical characters of Anna apple trees during 2004 and 2005 seasons

Treatment	T.S.S%		Total acidity%	
	2004	2005	2004	2005
Control	13.1	12.9	0.611	0.599
Algae extract at 0.25%	13.4	13.2	0.570	0.540
Algae extract at 0.50%	13.7	13.5	0.530	0.496
Algae extract at 1.00%	13.8	13.6	0.528	0.490
Boric acid at 0.025%	14.0	13.8	0.500	0.440
Boric acid at 0.050%	14.3	14.1	0.460	0.399
Boric acid at 0.100%	14.4	14.1	0.455	0.397
Both at low conc.	14.6	14.4	0.420	0.350
Both at medium conc.	14.9	14.6	0.390	0.305
Both at high conc.	15.0	14.7	0.388	0.303
New L.S.D at 5%	0.2	0.2	0.031	0.041
	Total sugars%		Reducing sugars%	
Control	9.0	8.9	6.0	5.8
Algae extract at 0.25%	9.4	9.2	6.4	6.1
Algae extract at 0.50%	9.9	9.9	6.7	6.4
Algae extract at 1.00%	10.0	10.0	6.8	6.5
Boric acid at 0.025%	10.5	10.4	7.0	6.9
Boric acid at 0.050%	10.9	10.9	7.5	7.4
Boric acid at 0.100%	11.1	11.1	7.6	7.5
Both at low conc.	11.5	12.0	7.9	7.8
Both at medium conc.	11.9	12.5	8.2	8.3
Both at high conc.	12.0	12.6	8.2	8.4
New L.S.D at 5%	0.3	0.2	0.2	0.2

CONCLUSIONS

The findings obtained by analysing the experimental data established that single or combined application of Algae extract and boric acid were very effective in stimulating shoot length, leaf area, leaf total carbohydrates, leaf content of N, P, K, Mg and B, yield as well as physical and chemical characters rather than their non-application. The promotion was associated with increasing concentrations. Using boric acid was more favourable than using Algae extract in all the studied characters. Combined application gave the best results. Good results with regard to yield and fruit quality were obtained by using three sprays of Algae extract at 0.50% plus boric acid at 0.05%.

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