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Using Silicon And Salicylic Acid For Promoting Production Of Hindybisinnara Mango Trees Grown Under Sandy Soil.

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ABSTRACT

During 2011 and 2012 seasons, Hindy Bisinnara mango trees were treated four times with potassium silicate at 0.05 to 0.2 % and/ or salicylic acid at 50 to 200 ppm. Growth, yield as well as physical and chemical characteristics of the fruits in response to application of such two materials were investigated. Single and combined application of potassium silicate at 0.05 to 0.2 % and salicylic acid at 50 to 200 ppm was very effective in enhancing growth characters, percentages of N, P, K and Mg in the leaves, yield as well as physical and chemical characteristics of the fruits in the relative to the control treatment. Using potassium silicate was preferable than using salicylic acid in improving yield quantitively and qualitatively. Combined application of such two materials surpassed the application of each material alone in this respect. Meaningless promotion was detected among the higher two concentrations of each material. Four sprays of a mixture of potassium silicate at 0.1 % plus salicylic acid at 100 ppm are responsible for producing higher yield and better fruit quality of Hindy Bisinnara mongo trees.

Key words: Mango , Hindy Bisinnara , silicon , salicylic acid.

Introduction

Hindy Bisinnara mangoes grown under sandy soil conditions greatly suffers from soil and water stresses, consequently the yield was greatly declined. Many efforts had been established for finding out the best horticultural practices that are responsible for solving this problem. Recently, using silicon and salicylic acid had beneficial effects increasing the tolerance of plants to unfavourable environmental (Rao *et al*., 2003 and Epstein and Bloom, 2003).

Nowadays many efforts were done for promoting yield of different mango cvs by using recent horticultural practices. Although silicon is the most abundant element both on the surface of the earth crust and in the soil, it has not yet been listed among the essential elements for higher plants. Silicon is known to mitigate various abiotic stresses. This is attributed to, its beneficial effect on stimulating of antioxidant systems in plants as well as complexation or co- precipitation of toxic metal ions with silicon, immobilization of toxic metal ions in growth media, uptake processes and compartmentation of metal ions within plants (Epstein, 1999 and Epstein and Bloom, 2003).

The studies carried out by Matichenkov *et al*., (2000), Neumann and Zur- Nieden (2001); Ma and Takahashi (2002); Kanto (2002); Quin and Tian (2004) and Gad El- Kareem (2012) emphasized the importance of using silicon sources on growth and fruiting of different fruit crops.

Plant growth and development are greatly affected by various biotic and abiotic stress factors. Detection of compounds of reducing these stresses are of great important. Previous studies emphasized the beneficial effects of salicylic acid in reducing abiotic stress sensitivity in plants. It was also shown to influence a number of physiological processes including flowering, ion uptake and transport, photosynthesis rate and stomatal conductance (Lee *et al*., 1995; Elade, 1992; Raskin, 1992; Rao *et al*., 2000; Shah, 2003; Harvath *et al*., 2007 and Szepesi *et al*., 2009).

Using salicylic acid had beneficial effects on growth and fruiting of evergreen fruit crops (Gobara, 2004; Ragab, 2004; Mahmoud *et al*., 2007; Badran and Ahmed, 2009; Eshmawy, 2010; Saied, 2011; Ahmed, 2011).

The target of this study was studying the effect of using silicon and salicylic acid on promoting yield and fruit quality of Hindy Bisinnera mango trees grown under sandy soil conditions.

Materials And Methods

This investigations was carried out during 2011 and 2012 seasons on thirty 18- years old Hindy Bisinnara mango trees onto seedling mango rootstock in a private orchard situated at West Samalout, Minia Governorate. The selected and uniform in vigour trees were planted at 7 × 7 meters apart and irrigated via drip irrigation

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system. The texture of the soil is sandy. Soil analysis was done according to Wilde *et al*., (1985) (Table (1).

Table 1: Analysis of the tested soil:

Values	Constituents
84.3	Sand %
8.0	Silt %
7.7	Clay %
Sandy	Texture
8.11	pH (1:2.5 extract)
700	E.C (1: 2.5 extract) (ppm)
11.0	Total CO_3 %
0.6	O.M %
0.03	Total N %
1.5	Available P (Olsen, ppm)
110	Available K (ammonium acetate, ppm)

This study involved the following ten treatments:-

1 Control (untreated trees).
2 Spraying potassium silicate at 0.05 %.
3 Spraying potassium silicate at 0.1 %.
4 Spraying potassium silicate at 0.2 %.
5 Spraying salicylic acid at 50 ppm.
6 Spraying salicylic acid at 100 ppm.
7 Spraying salicylic acid at 200 ppm.
8 Spraying both at the lower concentration.
9 Spraying both at the medium concentration.
10 Spraying both at the higher concentration.

Each treatment was replicated three times, one tree per each. Potassium silicate (25 % S + 10 % K_2O) and salicylic acid were sprayed four times during each growing season at the first week of March, April, May and June. Salicylic acid concentrations were prepared by adding few drops of Ethyl alcohol to the assigned amounts to give the named concentrations. Triton B as a wetting agent was added to all solutions at 0.05 %. Spraying was done till runoff (30 L water/ tree). The layout of this experiment was randomized complete block design. The selected thirty trees received the same horticultural practices that were carried out in the orchard as usual.

In both seasons, four branches one year old were chosen on each tree, one toward each direction. Four shoots in the Spring growth cycle, on each branch were labeled for measuring shoot length (cm.), number of leaves per shoot and leaf area (cm^2) (according to Ahmed and Morsy, 1999). Twenty mature leaves (7 months-old) were picked from nonfruiting shoots in the Spring growth cycle of each tree (1^{st} week of Sept.) (Kim, 1985). Percentages of N, P, K and Mg on the dry weight basis were determined using the standard methods that outlined by Wilde *et al*., (1985). Yield expressed in weight (kg.) per tree was recorded on the middle of June in both seasons. Physical and chemical characteristics of the fruits namely fruit weight (g.), T.S.S %, total and reducing sugars % and total acidity % (as g citric acid/ 100 g pulp) (according to A.O.A.C., 1995) were determined. Also, ascorbic acid content in 100 g pulp was determined by using 2, 6 dichlorophenol endophenol dye (A.O.A.C., 1995).

All the obtained data were tabulated and statistically analyzed according to Mead *et al*., (1993) and using new L.S.D test at 0.05 for made all comparisons among the investigated treatment means.

Results And Discussion

Growth and leaf content of N, P, K and Mg:

It is clear from the data in Table (2) that single and combined applications of potassium silicate at 0.05 to 0.2 % and salicylic acid (SA) at 50 to 200 ppm significantly was accompanied with stimulating shoot length, number of leaves/ shoot, leaf area as well as N, P, K and Mg in leaves in relative to the Check treatment. The promotion was significantly depended on increasing concentrations of potassium silicate from 0.05 to 0.2 % and SA from 50 to 200 ppm. No significant promotion on these parameters was recorded among the higher two concentrations of potassium silicate (0.1 and 0.2 %) and SA (100 and 200 ppm). Therefore, the suggested concentrations must be used for potassium silicate and SA were 0.1 and 100 ppm, respectively. It is worth to mention that combined applications of potassium silicate and using SA at all concentrations were superior than using each alone in this connection. Using potassium silicate at 0.05 to 0.2 % was superior than SA at 50 to 200 ppm in this respect. The maximum values were recorded on the trees that received potassium silicate at 0.2 % plus SA at 200 ppm together. The lowest values were recorded on untreated trees. These results were true during

both seasons.

The essential role of silicon on stimulating of antioxidant systems in plants as well as immobilization of toxic metals and uptake of essential nutrients effectively encouraged cell division and the biosynthesis of organic foods could explain the present results (Epstein and Bloom, 2003). The positive action of SA on reducing biotic and abiotic stresses as well as enhancing ion uptake and transport, photosynthesis and stomatal conductance could explain the present results (Szepesi *et al*., 2009).

These results are in agreement with these obtained by Eshmawy (2010); Saied (2011) and Ahmed (2011) on salicylic acid and Kanto (2002) and Gad El- Kareem (2012) on silicon.

Yield/ tree:

One can say from the data in Table (3) that yield per tree was significantly improved with using potassium silicate at 0.05 to 0.2 % and SA at 50 to 200 ppm either alone or in combinations when compared with the check treatment. There was a gradual and significant promotion on the yield with increasing concentrations of the two materials. No significant promotion was observed among the higher two concentrations of each materials in this respect. Combined applications of such two substances were significantly very favourable in improving the yield in relative to using each product alone. Application of potassium silicate was significantly preferable than using SA in this connection. The maximum yield from economical point of view was presented on the trees that received four sprays of a mixture containing potassium silicate at 0.1 % and SA at 100 ppm (since no significant differences were observed among 0.1 and 0.2 % potassium silicate and 100 and 200 ppm SA). Under such promised treatment, yield reached 45 and 46.5 kg compared with 32.3 and 33.0 kg produced by untreated vines during both seasons, respectively. The percentage of yield increase due to application of the promised treatment reached 39.32 and 40.90 % in relative to the control treatment. These results were true during both seasons.

The effect of silicon and SA on enhancing growth and nutritional status of the trees surely reflected on improving the yield.

These results are in agreement with these obtained by Eshmawy (2010); Saied (2011) and Ahmed (2011) on salicylic acid and Kanto (2002) and Gad El- Kareem (2012) on silicon.

Some physical and chemical characteristics of the fruits:

It is worth to mention from the data in Table (3) that single and combined applications of potassium silicate and SA significantly was very effective in improving quality of the fruits in terms of increasing fruit weight, T.S.S %, total and reducing sugars % and vitamin C content and decreasing total acidity % in relative to the control treatment. The promotion on fruit quality was significantly associated with increasing concentrations of silicon and SA. Using potassium silicate was superior than using SA in improving quality of the fruits. Increasing concentrations of potassium silicate from 0.1 to 0.2 % and SA from 100 to 200 ppm failed to show significant effect on quality of the fruits. Combined applications of such two materials were preferable than using each alone in this respect. The best results with regard to quality of the fruits were obtained with using silicon and SA together. Unfavourable effects on fruit quality were obtained on untreated trees. These results were true during both seasons.

The promoting effect of silicon and SA on plant pigments and the biosynthesis of carbohydrates surely reflected on advancing maturity and improving fruit quality (Epstein and Bloom, 2003 and Shah, 2003).

These results are in agreement with these obtained by Eshmawy (2010); Saied (2011) and Ahmed (2011) on salicylic acid and Kanto (2002) and Gad El- Kareem (2012) on silicon.

As a conclusion, it is suggested to use a mixture of potassium silicate at 0.1 % plus salicylic acid at 100 ppm four times for improving yield and fruit quality of Hindy Bisinnara mango trees.

Table 2: Effect of spraying potassium silicate and/ or salicylic acid on some growth characters and leaf content of N, P, K and Mg in the leaves of Hindy Bisinnara mango trees during 2011 and 2012 seasons.

Treatment	Leaf Mg %		Leaf K %		Leaf P %		Leaf N %		Leaf area (cm^2)		No. of leaves/ shoot		Shoot length (cm)	
	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011
Control (untreated trees).	0.35	0.37	1.00	0.97	0.09	0.11	1.18	1.22	59.5	59.0	8.0	8.0	9.0	8.9
Potassium silicate at 0.05 %	0.51	0.51	1.15	1.11	0.18	0.18	1.46	1.45	66.6	66.0	11.0	11.0	10.1	10.1
Potassium silicate at 0.1 %	0.56	0.55	1.20	1.29	0.22	0.21	1.53	1.52	68.5	68.3	12.0	12.0	10.6	10.5
Potassium silicate at 0.2 %	0.57	0.56	1.29	1.30	0.23	0.22	1.54	1.53	69.0	68.6	12.0	12.0	10.7	10.6
Salicylic acid at 50 ppm	0.41	0.41	1.05	1.01	0.13	0.13	1.25	1.30	61.4	61.0	9.0	9.0	9.4	9.3
Salicylic acid at 100 ppm	0.46	0.45	1.10	1.05	0.16	0.15	1.33	1.37	64.0	63.3	10.0	10.0	9.7	9.6
Salicylic acid at 200 ppm	0.47	0.46	1.11	1.11	0.17	0.16	1.34	1.38	64.3	64.3	11.0	10.0	9.8	9.7
Both at the lower conc.	0.60	0.60	1.35	1.35	0.25	0.24	1.62	1.61	70.8	70.8	14.0	13.0	11.4	11.3
Both at the medium conc.	0.66	0.64	1.40	1.40	0.28	0.27	1.70	1.69	73.0	73.0	14.0	13.0	11.6	11.6
Both at the higher conc.	0.67	0.65	1.41	1.41	0.28	0.28	1.71	1.70	73.4	73.4	14.0	13.0	11.8	11.7
New L.S.D at 5 %	0.03	0.03	0.03	0.03	0.02	0.02	0.06	0.06	1.5	1.6	1.0	1.0	0.3	0.3

Table 3: Effect of spraying potassium silicate and or salicylic acid on the yield as well as physical and chemical characteristics of the fruits of Hindy Bisinnara mango trees during 2011 and 2012 seasons.

Treatment	V. C (mg/ 100 g pulp)		Total acidity %		Reducing sugars %		Total sugars %		T.S.S %		Fruit weight (g.)		Yield/ tree (kg.)	
	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011
Control (untreated trees).	40.0	39.2	0.569	0.571	3.6	3.5	7.7	7.8	11.6	11.8	149.0	151.0	33.0	32.3
Potassium silicate at 0.05 %	46.7	46.0	0.490	0.491	4.8	4.7	9.0	9.0	14.1	14.0	174.0	174.0	40.7	39.0
Potassium silicate at 0.1 %	48.7	47.9	0.471	0.471	5.0	5.0	9.6	9.6	14.6	14.5	181.5	181.0	42.6	41.0
Potassium silicate at 0.2 %	48.8	48.0	0.467	0.469	5.2	5.1	9.7	9.7	14.7	14.6	182.0	182.0	42.7	41.3
Salicylic acid at 50 ppm	41.9	41.5	0.538	0.540	3.9	3.8	8.2	8.2	12.5	12.3	159.0	158.0	34.5	34.1
Salicylic acid at 100 ppm	44.0	43.9	0.518	0.520	4.3	4.1	8.7	8.7	13.2	13.0	166.0	165.0	36.6	36.2
Salicylic acid at 200 ppm	44.3	44.0	0.516	0.518	4.4	4.2	8.8	8.8	13.3	13.1	167.0	166.0	37.0	36.9
Both at the lower conc.	49.9	49.7	0.439	0.441	5.7	5.5	10.3	10.3	15.3	15.0	190.0	188.0	44.5	43.0
Both at the medium conc.	51.9	51.5	0.420	0.422	6.1	5.8	10.6	10.4	15.6	15.3	197.0	195.0	46.5	45.0
Both at the higher conc.	52.0	51.6	0.415	0.417	6.2	5.9	10.7	10.5	15.6	15.4	197.5	196.0	47.0	45.3
New L.S.D at 5 %	1.5	1.4	0.019	0.018	0.2	0.2	0.3	0.3	0.3	0.3	6.3	6.1	1.9	1.7

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