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Physiological Studies on the Effect of Spraying Salicylic Acid on Fruiting of Sukkary Mango Trees

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Abstract: This study was carried out during 2013 and 2014 seasons to examine the impact of different concentrations (50 & 100 & 200 ppm) and frequencies (once, twice or twice) of salicylic acid on fruiting of Sukkary mango trees.

Using salicylic acid at 50 to 200 ppm once, twice or thrice considerably enhanced shoot length, leaf area, total chlorophylls, N, P and K in the leaves , yield and fruit quality rather than non- application. Increasing concentrations of salicylic from 100 to 200 ppm and frequencies from twice to thrice had negligible effect on all the investigated characters. Carrying out two sprays of salicylic acid at 100 ppm at growth start and just after fruit setting was responsible for improving yield and fruit quality of Sukkary mango trees.

Keywords: salicylic acid, Sukkary mango trees and fruiting.

Introduction

Because of the importance of Sukkary mango production in Egypt, it is natural for mango growers to be mindful the factors which may positively affect the productivity. Out of those factors, application of salicylic acid as important agent for increasing the withstand of mango trees to all stresses that cause poor yield.

Investigation on compounds capable of reducing the trees sensitivity of crops are of great importance from both the theoretical and the practical point of view. In terms of stress physiology, salicylic acid was first demonstrated to play a role in response to biotic stress. Salicylic acid plays a clear role in responses to abiotic stress effects. It may cause a temporary low level of oxidative stress in plants which acts as a hardening process, improving the antioxidative capacity of the plant and helping to induce the synthesis of protective compounds such as polymines [1,2]

Salicylic acid (SA) from latin salix willow tree is widely used in organic synthesis and function as a plant hormone. It is derived from the metabolism of salicin. It is a phenolic phytohormone and is found in plants with role in plant growth development, photosynthesis, transpiration as well as uptake and transport of nutrients. SA also induces specific changes in leaf anatomy and chloroplast structure. It is involved in endogenous signaling mediating in plant defense against pathogens. It is biosynthesized from the amino acids phenylalanine [3,4,5].

Nowadays, there is a necessary for using salicylic acid, since it is very effective in protecting plant cells from senescene and disorders as well as enhancing cell divisions, biosynthesis of natural hormones such as IAA, GA_3 and cytokinins, nutrient and water uptake as well as the biosynthesis of pigments[6].

Salicylic acid (SA) and methyle saliycylate (MesA)and endogenous signal molecules playing vital roles in regulating stress responses and plant developmental; processes including heat production or thermogenesis, photosynthesis stomatal conductance, transpiration, ion uptake and transport, disease resistance, seed germination, sex polarization crop yield and glycolysis[7]. Recently, SA has received a particular attention because it is a key signal molecule for expression of multiple modes of plant stress resistance. Although the focus has been mainly on the roles of SA on biotic stresses, several studies also support the major roles of salicylates in modulation of the plant response to several abiotic stresses, such as UV light, drought, salinity, chilling stress and heat shock [6, 8].

The role that salicylic acid plays in the defense response of plants against environmental stressful conditions has been extensively studied in the 15 last years. These studies have been performed in mutants a transgenic plants that have altered the salicylic acid signaling pathway or by evaluating the direct effect of treatment with salicylic acid or its functional analogs. The evidence indicates that salicylic acid together with oxygen reactive species which accumulate in stresses cells are essential signals to trigger local defense response or to activate transpiration of stress defense genes [9].

There is increasing interest in the interactive role between salicylic acid reactive oxygen species (ROS) and other plant signaling molecules in regulating cell death in plants. Initial evidence suggested that salicylic acid was a potent inhibitor of heme- containing enzymes such as catalase and ascorbate peroxidase thus capable of stimulating ROS accumulation during various biotic and abiotic stress conditions[5]. The mode of action of salicylic acid may in fact be related to its ability to prime the defnse response by increasing the levels of various defense compounds. Salicylic acid was also proposed as both a potent inducer of NAPPH oxidase and an inhibitor of the alternative oxidase thus capable of indirect regulation of the redox status of plant cells.

Salicylic acid is an endogenous plant growth regulator. It causes growth promoting and protective effects against an abiotic stresses. Salicylic acid was shown to cause changes in hormonal system associated with transiatory parallel accomulation of IAA and ABA with no change in cytokinins led to no determintal effects which was followed by enhancing expression of genes of dehydrins and accumulation of proline.

Previous studies showed that using salicylic acid via leaves at various concentrations and frequencies had an obvious promotion on yield and fruit quality crops [10,11, 12, 13 ,14, 15, 16].

The target of this study was elucidating the effect of different concentrations and frequencies of salicylic acid on fruiting of Sukkary mango trees.

Material and Methods

This investigation was conducted during the two consecutive seasons of 2013 and 2014 on thirty 15-years old Sukkary mango trees onto polyembyonic seedling mango rootstock. The trees are grown in a private mango orchard located at El- Shorafa village, Minia district, Minia Governorate. The uniform in vigour trees of Sukkary mango (30 trees) are planted at 7x7 meters 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 **17**) are shown in Table (1).

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

Particle size distribution:	
Sand %	:11.1
Silt %	:52.7
Clay %	:36.2
Texture	:Silty clay
pH(1:2.5 extract)	:7.44
EC (1: 2.5 extract) (mmhos/Icm/25^{o}C)	:0.66
O.M. %	:2.22
$CaCO_3$ %	:1.69
Total N %	:0.14
Available P (ppm, Olsen)	:26
Available K (ppm/ ammonium acetate)	:4.95
Available Mg (ppm)	:146.00

Available S (ppm)	:6.96
B (ppm) (hot water extractable)	:0.27
Available EDTA extractable micronutrients (ppm)	
Zn	:1.31
Fe	:11.21
Mn	:10.25
Cu	:1.88

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/ fed/ mono calcium 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 sulpate (48 % K_2O) added in two equal dressings 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 study included the following ten treatments from different concentrations and frequencies of salicylic acid arranged as follows:

1. Control (water sprayed trees).
2. Spraying salicylic acid at 50 ppm, once at growth start (1^{st} week of Mar.).
3. Spraying salicylic acid at 50 ppm twice at growth start and just after fruit setting (last week of Apr.)
4. Spraying salicylic acid at 50 ppm three times at the previous two dates and at one month later (last week of May).
5. Spraying salicylic acid at 100 ppm once at growth start + (1^{st} week of Mar.)
6. Spraying salicylic acid at 100 ppm twice at growth start and just after fruit setting (last week of Apr.)
7. Spraying salicylic acid at 100 ppm three times at the previous two dates and at one month later (last week of May).
8. Spraying salicylic acid at 200 ppm once at growth start + (1^{st} week of Mar.)
9. Spraying salicylic acid at 200 ppm twice at growth start and just after fruit setting (last week of Apr.)
10. Spraying salicylic acid at 200 ppm three times at the previous two dates and at one month later (last week of May).

Each treatment was replicated three times , one tree per each. Salicylic acid solutions at all concentrations used were adjusted to pH 4 by using sodium hyrdoxid and few drops of ethyl alcohol were used to facilitate the solubility of salicylic acid. Triton B as a wetting agent was added to all salicylic acid solutions at 0.05 % and spraying was done till run off. Randomized complete block design (RCBD) was adopter.

During both seasons the following parameters were carried out, main shoot length (cm.), leaf area (cm^2) (**18**), total chlorophylls (mg/ 100 g F.W.) (chlorophyll a and b) (**19 and 20**), percentages of N, P and K on dry weight basis (**21; 22, 23**), fruit retention %, yield / tree / kg fruit weight (g.), percentages of weights of seeds, peels and pulp, T.S.S. %m total and reducing sugars (**24**) , total acidity % (as g citric acid / 100 g pulp), vitamin C (mg/ 100 g pulp) and total fibre % (**24**).

Statistical analysis was done according to **25** and the differences between treatment means were initiated using new L.S.D. at 5%.

Results and Discussion

1- Growth characters:

It is clear from the data in Table (2) that spraying salicylic acid at 50 to 200 ppm once, twice or thrice had significant effect on the main shoot length and leaf area relative to the control treatment. There was a gradual promotion on such two growth characters with increasing concentrations of salicylic acid from 0.0 to 200 ppm and frequencies from once to thrice. No significant promotion was observed on such two growth characters among the higher two concentrations namely 100 and 200 ppm as well as among two and three sprays. The maximum values were recorded on the trees received three sprays of salicylic acid at 200 ppm. Untreated trees produced the minimum values. These results were true during both seasons.

2- Leaf chemical composition

Data in Table (2) obviously reveal that total chlorophylls N, P and K in the leaves of Sukkary mango trees were significantly enhanced in response to spraying salicylic acid either once, twice or three times at 50 to 200 ppm over the control treatment. There was a gradual promotion on the leaf chemical characters with increasing concentrations and frequencies of salicylic acid. Negligible promotion on these chemical nutrients was observed among the higher two concentrations and frequencies of salicylic acid. The maximum values of total chlorophylls (16.3 & 16.3 mg/ 100 g F.W.), N(2.13 & 2.15%) P (0.26 & 0.28%) and K (1.96 & 1.87) were recorded on the trees that supplied with 20 ppm salicylic acid at 200 ppm. The minimum values of these chemical characters were recorded on the untreated trees. Similar results were announced during both seasons.

3-Fruit retention % and yield/ tree:

It is evident from the data in Table (3) that treating Sukkary mango trees once, twice or thrice of salicylic acid at 50 to 200 ppm was significantly accompanied with improving fruit retention and yield/ tree relative to the check treatment. The promotion on the yield and fruit retention was associated with increasing concentrations and frequencies of salicylic acid. Increasing concentration of salicylic acid from 100 to 200 ppm and frequencies from twice to thrice failed significantly to promote the yield, therefore, the recommended concentration and frequency of salicylic acid were 100 ppm and twice, respectively. The best results economically point of view with regard to yield of Sukakry mango trees were obtained due to treating the trees twice with salicylic acid at 100 ppm. Yield per tree under such promised treatment reached 44.6 and 46.6 kg/ tree during both seasons, respectively. The yield of the control trees reached 27.5 & 28.0 kg during both seasons, respectively.

The percentage of increase on the yield due to using the promised treatment over the check treatment reached 62.2 and 66.4 % during both seasons, respectively. These results were true during both seasons.

4- Fruit quality:

Data in Tables (3 & 4) clearly show that treating Sukkary mango trees once, twice, or thrice with salicylic acid at 50 to 200 ppm was significantly very effective in enhancing fruit weight, pulp%, T.S.S. %, total and reducing sugars % and vitamin C and decreasing percentages of seeds and peels , total acidity % and total fibre % over the control treatment. The promotion on fruit quality was depended on enhancing concentrations and frequencies of salicylic acid application. Meaningless promotion on fruit quality was occurred among the higher two concentrations (100 & 200 ppm) and frequencies (twice or thrice) on fruit quality. The best treatment with regard to fruit quality from economical point of view was the application of salicylic acid twice at 100 ppm. Unfavourable effects on fruit quality were attributed due to unapplication of salicylic acid. These results were true during both seasons.

Discussion:

The previous beneficial effects of salicylic acid on fruiting of Sukkary mango trees might be attributed to its positive action ion enhancing cell division , the biosynthesis of carbohydrates and plant pigments, the resistance of the trees to biotic and abiotic stress as well as it is role on reducing reactive oxygen species which lead to protect the trees from all stresses around the trees [7,6,8,4,5].

These results are in agreement with those obtained by[10,12,14,15,17]

Conclusion:

Treating Sukkary mango trees twice at growth start and last after fruit setting with salicylic acid at 100 ppm was responsible for promoting yield and fruit quality.

Table (2): Effect of different concentrations and frequencies of salicylic acid on main shoot length, leaf area, chlorophylls and percentages of N, P and K in the leaves of Sukkary mango trees during 2013 and 2014 seasons.

Treatment	Main shoot length (cm.)		Leaf area (cm^2)		Total chlorophylls (mg/ 100 g F.W.)		Leaf N %		Leaf P %		Leaf K %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	10.1	11.0	41.9	42.3	7.9	8.1	1.64	1.71	0.12	0.11	1.39	1.40
Salicylic acid at 50 ppm once	11.2	12.0	44.4	43.7	10.0	10.1	1.74	1.81	0.15	0.14	1.45	1.46
Salicylic acid at 50 ppm twice	12.8	13.1	46.0	45.9	11.9	13.4	1.82	1.92	0.18	0.17	1.52	1.52
Salicylic acid at 50 ppm thrice	12.9	13.3	46.2	46.0	12.0	13.5	1.83	1.93	0.19	0.18	1.53	1.53
Salicylic acid at 100 ppm once	14.3	14.0	49.0	50.5	14.1	14.6	1.95	2.02	0.22	0.23	1.63	1.64
Salicylic acid at 100 ppm twice	15.7	15.2	54.0	53.0	15.9	16.0	2.11	2.13	0.24	0.26	1.74	1.75
Salicylic acid at 100 ppm thrice	16.0	15.3	55.0	53.9	16.0	16.2	2.12	2.14	0.25	0.27	1.75	1.76
Salicylic acid at 200 ppm once	14.4	14.1	49.1	51.0	14.2	14.7	1.96	2.03	0.23	0.24	1.85	1.65
Salicylic acid at 200 ppm twice	15.8	15.3	54.5	53.2	16.0	16.1	2.12	2.14	0.25	0.27	1.95	1.86
Salicylic acid at 200 ppm thrice	16.1	15.4	55.5	54.0	16.3	16.3	2.13	2.15	0.26	0.28	1.96	1.87
New L.S.D. at 5%	1.0	0.9	1.0	1.0	0.8	0.7	0.06	0.06	0.02	0.02	0.05	0.04

Table (3): Effect of different concentrations and frequencies of salicylic acid the percentage of fruit retention, yield per tree and some physical characters of the fruits of Sukkary mango trees during 2013 and 2014 seasons.

Treatment	Fruit retention %		Yield / tree (kg.)		Fruit weight (g.)		Seeds %		Peel %		Pulp %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	0.50	0.51	27.5	28.0	171.0	173.5	26.0	25.5	24.0	24.3	50.0	50.2
Salicylic acid at 50 ppm once	0.61	0.61	30.0	31.0	181.3	183.0	25.0	24.0	23.7	24.0	51.3	52.0
Salicylic acid at 50 ppm twice	0.81	0.79	33.0	34.5	192.9	194.7	24.1	23.9	21.0	21.2	54.9	54.9
Salicylic acid at 50 ppm thrice	0.82	0.80	34.9	34.6	193.3	195.0	24.0	23.7	20.9	21.0	55.1	55.3
Salicylic acid at 100 ppm once	0.91	0.94	39.0	41.0	201.9	213.0	22.0	23.0	20.0	20.3	58.0	56.7
Salicylic acid at 100 ppm twice	0.97	0.99	44.6	46.6	231.0	234.0	20.0	20.0	18.7	19.0	61.3	61.0
Salicylic acid at 100 ppm thrice	0.98	1.00	45.0	46.8	232.2	235.0	19.5	19.4	18.6	19.0	61.9	61.6
Salicylic acid at 200 ppm once	0.92	0.95	39.3	41.5	202.0	213.0	21.9	22.9	19.9	20.1	58.2	57.0
Salicylic acid at 200 ppm twice	0.98	1.01	45.0	46.7	231.0	235.0	19.9	19.9	18.6	18.9	61.5	61.2
Salicylic acid at 200 ppm thrice	0.99	1.02	45.5	46.7	233.0	235.5	19.4	19.3	18.4	18.7	62.2	62.0
New L.S.D. at 5%	0.05	0.05	1.8	1.7	6.1	6.4	0.9	1.0	0.7	0.8	1.9	2.0

Table (4): Effect of different concentrations and frequencies of salicylic acid on some chemical characteristics of the fruits of Sukkary mango trees during 2013 and 2014 seasons.

Treatment	T.S.S. %		Total sugars %		Reducing sugars %		Total acidity %		Vitamin C (mg / 100 g pulp)		Total fiber %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	14.5	14.8	10.1	10.0	3.0	2.9	0.400	0.411	38.3	38.0	1.11	1.14
Salicylic acid at 50 ppm once	15.2	15.9	11.0	11.0	3.3	3.3	0.360	0.361	41.0	41.4	1.04	1.00
Salicylic acid at 50 ppm twice	16.0	17.1	11.7	11.9	3.6	3.7	0.329	0.330	44.4	44.9	0.96	0.92
Salicylic acid at 50 ppm thrice	16.1	17.2	11.8	12.0	3.7	3.8	0.328	0.329	45.0	45.1	0.95	0.91
Salicylic acid at 100 ppm once	17.5	18.0	13.0	13.1	4.0	4.1	0.297	0.298	47.0	47.7	0.88	0.84
Salicylic acid at 100 ppm twice	18.9	18.7	13.7	14.0	4.4	4.5	0.260	0.259	49.9	50.6	0.82	0.78
Salicylic acid at 100 ppm thrice	19.0	19.0	13.8	14.1	4.5	4.6	0.259	0.258	50.0	51.0	0.81	0.77
Salicylic acid at 200 ppm once	17.6	18.1	13.1	13.1	4.1	4.2	0.296	0.297	47.1	47.8	0.87	0.83
Salicylic acid at 200 ppm twice	19.0	18.8	13.8	14.1	4.5	4.6	0.259	0.257	50.0	50.7	0.81	0.77
Salicylic acid at 200 ppm thrice	19.1	19.1	13.9	14.2	4.6	4.7	0.257	0.255	50.1	51.1	0.80	0.76
New L.S.D. at 5%	0.6	0.6	0.5	0.5	0.2	0.2	0.030	0.031	1.1	1.2	0.05	0.05

References

1. Janda, T., Harvath, E.; Szalai, G. and Faldi, E. (2007): Role of salicylic acid in the induction of abiotic stress tolerance, Hayat S. and Ahmed, A. (eds.) salicylic acid a plant hormone chapter 5 pp. 91- 105.
2. Joseph, B.; Jim, D. and Sujatha, S. (2010): Insight into the role of exogenous salicylic acid on plants grown under salt environment, Asian J. Crop Sci., 2 : 226-235.
3. Taiz, A. and Zeiger, M. (2002): Plant physiology, third Ed. 306 p. Academic press, London.
4. Hayat, S. and Ahmad, A. (2007a): Salicylic acid, A plant hormone chapter 9. Date, J.F., Capelli, N and Dan-Breusegem, the interplay between salicylic acid and reactive oxygen species during cell death m plants Springer p. 247-276.
5. Hayat, S. and Ahmad, A. (2007b): Salicylic acid, A plant hormone chapter 9. Date, J.F., Capelli, N and Dan-Breusegem, the interplay between salicylic acid and reactive oxygen species during cell death in plants Springer p. 247-276.
6. Ding, C.K.; Wang, C.Y.; Gross, K.C. & Smith, D.L. (2001): Reduction of chilling injury and transcript accumulation of heat shock protein genes in tomatoes by methyl jasmonate and methyle sahcylate. plant science, 161, 1153-1159.
7. Foyer, C. H. and Lelandias, S. (1993): The role of ascorbate in regulation of photosynthesis. In Yamamato, Y.; Smith, C. 11. (Ed), photosymhetic responses to the environment.
8. Ding, C.K. and Wang, C.Y. (2003): The dual effects of methyl saliylate on ripening and expression of ethylene biosynthetic genes in tomato fruit. Plant science, 164, 589-596.
9. Lobez- Delgado, H.A.; Scott, I,.M. and Mora- Herrera, M.E. (2007): Stress and antistress effects of salicylic acid and acetyl salicylic acid on potato culture technology. From Hayat, S and Ahmad (eds.) salicylic acid. A plant hormone, springer pp. 1632-195.
10. Ahmed, E.F.S (2011): Response of Sakkoti date palms to foliar application of salicylic acid. Minia J. of Res. Dev. Vol. 21 (2): 305-316.
11. Abd El- Rahman, M.M.A. and El- Masry, S.M.A (2012): Response of Valencia trees to foliar application of some vitamins, salicylic acid and turmeric extract, Minia J. of Agric. Res. Dev. Vol. 32: (5): 851-867.
12. Ahmed, F.F.; Mansour, A.E.M.; Mohamed, A.Y.; Mostafa, E.A.M. and Ashour, N.E. (2013): Using silicon and salicylic acid form promoting production of Hindy bisinnara mango trees grown under sandy soil. Middle East. J. of Agric. Res. 2 (2): 51-55.
13. Masoud, A.A.B. and El- Shenawy, O.A.M. (2012): Effect of some vitamins and salicylic acid on fruiting of Washington Navel orange trees. J. of Applied Sci. Res. 8(4): 1936-1943.
14. Abdel-aal, A.M.K. and Oraby- Mona, M.M. (2013): Using salicylic acid for alleviating the adverse effects of water salinity on growth and nutritional status of mango cv. Alphonse seedlings. World Rural Observations 5 (2): 41- 46.
15. Ahmed, F.F.; Kamel, M. Kh. and Ibrahim, H.LM. (2014): The synergistic effect of using plant extracts and salicylic acid on yield and fruit quality of Keitte mango trees. Stem Cell; . 5 (2): 30-39.
16. Abd El- Mageed, M.M.H. (2015): Response of Sakkoti date palms to spraying salicylic acid under Aswan region conditions. M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
17. Wilde, S. A.; Corey, R. B.; Layer, J. G. and Voigt, G. K. (1985): Soils and Plant Analysis for Tree Culture. Oxford, and 1131-1, publishing Co., New Delhi, pp. 96-106.
18. Ahmed, F.F.; Ibrahim, I.M. and Abd El- Megeed, M.M.H. (2015): Response of Sakkoti date palms to spraying salicylic acid. Word Rural Observations. 1(1): 10-20.
19. Ahmed, F. F and Morsy, M. H. (1999): A new method for measuring leaf area in different fruit species. Minia. J. of Agric .Rec. &Dev.l9: 97- 105.
20. Von- Wettstein, D.V. (1957): Chlorophyll- Lthale under submikrosphpische formiuechrel der plastiden celi, Drp. Trop./ Res. Amer. Soc. Hort. S. 20 pp. 427-433.
21. Hiscox, A. and Isralstam B. (1979): Method for the extraction of chlorophyll from leaf tissue without maceraiton. Can. J. Bot. 57:1332-1334.
22. Peach, K and Tracey, I.M.V. (1968): Modem Methods of Plant Analysis, Vol. 11 p. 37-38. Summer, M.E. (1985): Diagnosis and Recommendation Integrated system (DRIS) as a guide to orchard fertilization. Hort. Abst. 55(8): 7502.
23. Cottenie, A.; Cerloo, M.; Kiekens, L.; Velgle, G. and Amerlynuck, R. (1982): Chemical analysis of plant and soil. 34-51. Laboratory of Analytical and Agroch. State Univ. Belgium, Gent.
24. Summer, M.E. (1985): Diagnosis and Recommendation Integrated system (DRIS) as a guide to orchard fertilization. Hort. Abst. 55(8): 7502.
25. Association of Official Agricultural Chemists (A.O.A.C.) (2000): Official Methods of Analysis (A.O.A.C), 12th Ed., Benjamin Franklin Station, Washington D.C., U.S.A. pp. 490-510.
26. Mead, R.; Currnow, R. N. and Harted, A. M. (1993): Statistical Biology. 2nd Ed. Methods in Agriculture and Experimental and Hall, London pp. 10-20.

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