Response of Superior Grapevines to Foliar Application of Some Micronutrients, Calcium, Amino Acids and Salicylic Acid

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Abstract: This study was carried out during 2012 and 2013 seasons to examine the effect of treating Superior grapevines four times with chelated Zn, Fe and Mn each at 0.05%, calcium chloride at 0.05%, amino acids (tryptophane, methionene and cysteine) at 0.05 % and salicylic acid at 50 ppm on fruiting of the vines. Foliar application of micronutrients (Zn, Fe and Mn) and calcium besides amino acids/ or salicylic acid was very effective in enhancing the leaf area, weight of prunings, percentages of N, P, K and Mg in the leaves, yield and berries quality of Superior grapes over the check treatment. Using all nutrients, amino acids and salicylic acid gave the best results relatively to all the investigated treatments. The best results with regard to yield and quality of Superior grapes were obtained owing to spraying the vines four times with a mixture containing Zn, Fe and Mn in chelated form at 0.05%, calcium chloride at 0.05%, amino acids (tryptophane, methionene and cysteine) at 0.05% and salicylic acid at 50 ppm. This promised treatment materially controlled the phenomenon of shot berries in the clusters.
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1.Introduction

Yield decline and the occurrence of shot berries are considered the serious problems facing marketing of Superior grapevine cv to both local and foreign markets. Many trials were carried out for solving such drawbacks by using a mixture containing micronutrients, calcium, amino acid and salicylic acid at balanced rate. **Yagodin (1990) and Dalbo (1992)** disclosed that using micronutrients had announced promotion on the biosynthesis of organic foods, plant pigments and natural hormones. The promoting affect of amino acids on protecting plant cells from oxidation as well as enhancing the biosynthesis of proteins, plant pigments, natural hormones and cell division was reflected on stimulating vine nutritional status and fruiting of various grapevine cvs (**Davies, 1982**). The results of the work done by **Hayat *et al.*, (2010)** and **Joseph *et al.*, (2010)** emphasized the essential role of salicylic acid on enhancing cell division and the tolerance of the trees to all stresses around the trees.

Application of micronutrients (**Abd El-Gaber – Nermean, 2009; Abd El- Wahab, 2010; El-Kady, 2011 and Abd El- aal, 2012**), calcium (**Seleem- Basma and Abd El- Hameed, 2008 and Sayed- Heba, 2010**), amino acids (**Amin, 2007, Ahmed *et al.*, 2011; Wassel *et al.*, 2011; Abd El-aal, 2012 and Ahmed *et al.*, 2012**) and Salicylic acid (**Ahmed and Abd El- Hameed, 2004; Madian, 2004, Abd El- Kariem, 2009, Ahmed, *et al.*, 2010; El-Hanafy, 2011; El- Kady- Hanaa, 2011; Bondok-Sawsan *et al.*, 2011; Osman, 2014 and Ahmed *et al.*, 2014**) was very effective in improving growth, vine nutritional status, yield and berries quality in different grapevine cvs.

The merit of this study was examining the effect of some micronutrients, calcium, amino acids and salicylic acid on fruiting of Superior grapevines.

2. Material and Methods

This study was carried out during the two consecutive seasons 2012 and 2013 on one hundred and twenty uniform in vigour of 9-years old Superior grapevines. The selected vines are grown in a private vineyard located at El- Sheikh Hassan village; Matay district, Minia Governorate where the texture of the soil is sandy loam as shown in Table (1). Soil analysis was done according to the procedures that outlined by **Piper (1950)**. The selected vines are planted at 3.0 m (between rows) x 1.5 m (between vines) apart. The chosen vines were trained by cane system leaving 104 eyes / vine (eight fruiting canes x 12 eyes plus four renewal spurs / two eyes) using Gable supporting method. Winter pruning was carried out at the first week of January during 2012 and 2013 seasons. Drip irrigation system using Nile water was followed.

The selected vines (120 vines) received the same horticultural practices that are already applied in the vineyard.

This experiment included forty treatments from two factors (A & B). The first factor (A) consisted from ten micro (Zn, Fe and Mn) and calcium treatments arranged as follows:

a_1) Untreated vines (sprayed with water vines).
a_2) Spraying Zn + Mn in chelated form at 0.05%.
a_3) Spraying Mn + Fe in chelated form at 0.05%.
a_4) Spraying Zn + Fe in chelated form at 0.05%.
a_5) Spraying Zn + Mn + Fe in chelated form at 0.05%.
a_6) Spraying calcium chloride at 1 %.
a_7) Spraying calcium + Zn + Mn
a_8) Spraying calcium + Mn + Fe
a_9) Spraying calcium + Zn + Fe
a_{10}) Spraying calcium Zn + Mn + Fe

Table (1): Analysis of the tested vineyard soil

Characters	Values
Particle size distribution:	
Sand %	55.0
Silt %	22.0
Clay %	23.0
Texture	Sandy loam
pH (1: 2.5 extract)	7.97
EC(1: 2.5 extract) mmhos/ 1cm/ 25°C	1.41
O.M. %	0.9
Total N %	0.05
Available P (ppm)	2.3
Available K (ppm)	95

While the second factor (B) involved four treatments from salicylic acid and/ or amino acids namely b_1) Untreated, b_2)Using salicylic acid at 50ppm, b_3) Using amino acids (methionene, tryptophane and cysteine) at 0.05% and b_4) Using salicylic acid + amino acids together. Therefore, this experiment included forty treatments. Each treatment was replicated three times, one vine per each. Nutrients, salicylic acid and amino acids were applied at fixed concentrations according to the previous studied carried out by **El- Hanafy (2011)**. Salicylic acid solubilized in few drops of ethyle alcohol was adjusted to pH 6 by using sodium hydroxide (1.0 N). All nutrients, salicylic acid and amino acids were sprayed four times at growth start (1st week of March); just after fruit setting (2nd week of April) and at three week intervals (1st and last weeks of May) during both seasons. Triton B as a wetting agent was added to spraying solutions and spraying was done till runoff.

This investigation was statistically analyzed using randomized complete block design in split plot arrangement (RCBD). The ten micronutrient and Ca treatments occupied the main plots. The four salicylic and/ or amino acid treatments ranked the sup- plots.

During both seasons, the following parameters were carried out:

1- Leaf area (cm2) (according to Ahmed and Morsy, 1999) and pruning weight (kg.) per vine.
2- Percentages of N, P, K and Mg in the leaves (according to Piper, 1950; Wilde et al., 1985; Summer, 1985; Balo et al., 1985; Chapman and Pratt, 1987 and Cottenie et al., 1982).
3- Yield was harvested when T.S.S./ acid in the control reached at least 25/1 (Weaver, 1976), yield expressed in weight (kg.) and cluster weight (g.) were recorded.
4- Percentage of shot berries.
5- Quality of the berries in terms of berry weight (g.), T.S.S.% and total acidity % (as g tartaric acid / 100 ml juice) (A.O.A.C., 2000).

Statistical analysis was done and new L.S.D. test was used for made all comparisons among different treatment means (**Mead *et al.*, 1993**).

3. Results

1-Effect of some amino acids, nutrient and salicylic acid treatments on some vegetative growth characters

Table (2) show the effect of some amino acids, nutrient and salicylic acid treatments on the growth characters namely leaf area, and pruning weight of Superior grapevines during 2012 and 2013 seasons.

a) Specific effect of nutrients:

It is clear from the obtained data that varying micronutrients and calcium treatments had significant effect on the two growth characters namely leaf area and weight of prunings. Results further reveal that application of two, three, four micronutrients and /or calcium significantly was accompanied with enhancing such two growth characters relatively to the check treatment. Using calcium was significantly superior than using double applications of Zn, Fe and Mn in enhancing growth characters but when the three micronutrients were applied together at 0.05% growth characters were significantly improved rather than application of calcium alone. Using calcium plus micronutrients was significantly superior than using micronutrients alone in this respect. Combined application of the three micronutrients (Zn, Fe, Mn) plus calcium gave the maximum values. The untreated vines produced the minimum values. These results were true during both seasons.

b) Specific effect of using salicylic acid and/ or amino acids

Application of salicylic acid at 50 ppm and/ or amino acids at 0.05 % significantly stimulated the

two growth characters namely leaf area, pruning weight rather than non- application and using amino acids significantly surpassed the application of salicylic acid in this connection. Combined application of salicylic acid plus amino acids was significantly superior than using each alone in this respect. The maximum values were recorded on the vines that sprayed with salicylic acid and amino acids. Untreated trees produced the little values. Similar results were announced during both seasons.

c) The interaction effect between nutrients, salicylic acid and amino acids

All growth characters were significantly affected by the studied interaction. They were maximized on the vines that received Zn, Fe, Mn, Ca, Salicylic acid and amino acids together. The untreated vines produced the lowest values similar trend was noticed during both seasons.

2-Effect of some amino acids, nutrient and salicylic acid treatments on the leaf chemical composition

Data concerning the effect of some amino acid, nutrient and salicylic acid treatments on the percentages of N, P, K and Mg in the leaves of Superior grapevines are shown in Tables (3 &4).

a)Specific effect of nutrients:

Nutrients namely N, P, K and Mg in the leaves of Superior grapevines were significantly enhanced in response to application of the three micronutrients and / or Ca relatively to the check treatment. The promotion was associated significantly with using calcium rather than application of any one of the double applications of micronutrients. Using the three micronutrients plus calcium was significantly preferable than using micronutrients alone in this connection. The maximum values were recorded on the vines that received all nutrients together. The untreated vines produced the minimum values. These results were true during both seasons.

b) Specific effect of using salicylic acid and/ or amino acids

Supplying Superior grapevines four times with salicylic acid and/ or the three amino acids significantly enhanced all nutrients in the leaves rather than non- application. Using the three amino acids together was significantly favourable than using salicylic acid in this respect. Combined application of salicylic acid and amino acids gave the best results rather than application of each alone in this respect. The maximum values were recorded on the vines that sprayed with salicylic acid plus amino acids. The control vines gave the least values. These results were true during both seasons.

c) The interaction effect between nutrients, salicylic acid and amino acids

All nutrients in the leaves were significantly affected by the studied interaction. The maximum N (2.45 & 2.51 %), P (0.55 & 0.49 %), K (1.99 & 1.80%) and Mg (0.74 & 0.75%), during both seasons, respectively were recorded on the vines that received all nutrients amino acids and salicylic acid. The lowest values were recorded on the untreated vines. These results were true during both seasons.

3-Effect of some amino acids, nutrient and salicylic acid treatments on the percentage of berry setting, and yield.

Data in Table (5) show the effect of some amino acid, nutrient and salicylic acid treatments on the percentage of berry setting, and yield of Superior grapevines during 2012 & 2013 seasons.

a) Specific effect of nutrients:

It is clear from the obtained data that foliar application of micronutrients (Zn, Fe & Mn) and/ or calcium was significantly very effective in improving berry setting %, and yield expressed in weight per vine relatively to the check treatment. Using calcium alone was significantly superior than using micronutrients in double phases in improving berry setting, and yield. Triple application of the three micronutrients significantly surpassed the application of calcium in this respect. A significant promotion was recorded when calcium was sprayed along the three micronutrients when compared with using micronutrients alone. The maximum values were recorded on the vines that foliage sprayed with all nutrients. The lowest values were recorded on untreated vines.

b) Specific effect of using salicylic acid and/ or amino acids

Single and combined applications of salicylic acid and amino acids significantly improved berry setting, and yield expressed in weight relatively to the check treatment. The promotion was significantly associated with using amino acids compared to using salicylic acid. Combined application of salicylic acid and amino acids was significantly preferable than using each alone in this respect. The best results were recorded on the vines that received salicylic acid plus amino acids. The lowest values were recorded on untreated vines. These results were true during both seasons.

c) The interaction effect between nutrients, salicylic acid and amino acids

The investigated interaction had significant effect on berry setting, and yield. Using all nutrients, amino acids and salicylic acid gave the maximum values. Under such best treatment berry setting reached (14 & 14.1 %) and yield expressed in weight (kg.) / vine recorded 10.5 and 13.8 kg during both seasons, respectively. The lowest values of berry

setting (8.1 and 9.2 %) and yield (7.7 and 7.5 kg) were recorded on untreated vines. The percentage of increase on the yield due to application of the present promised treatment over the check treatment reached 29.6 and 79.2 % during both seasons, respectively.

4-Effect of some amino acids, nutrient and salicylic acid treatments on the percentage of shot berries

Table (6) show the effect of some amino acid, nutrient and salicylic acid treatments on the percentages of shot berries of Superior grapevines during 2012 and 2013 seasons.

a) Specific effect of nutrients:

It is evident from the obtained data that foliar application of micronutrients and/ or calcium caused significant reduction on shot berries % relatively to the control treatment. Using calcium alone was significantly preferable than using micronutrient as double applications in reducing shot berries %. However, using all micronutrients together was significantly superior than using calcium alone in checking this character. Enriching the three micronutrients with calcium significantly controlled such unfavourable phenomenon rather than using micronutrients alone. The lowest values of shot berries were recorded on the cluster harvested from vines received all nutrients together. The vice versa was recorded on untreated vines. These results were true during both seasons.

b) Specific effect of using salicylic acid and/ or amino acids

A significant reduction on the percentage of shot berries was observed due to spraying the vines four times with salicylic acid and /or amino acids rather than non application. Using amino acid was significantly superior than using salicylic acid in controlling shot berries in the clusters. However, great and significant reduction, on shot berries was recorded on the vines that received salicylic acid and amino acids together. The maximum values were detected on untreated vines. These results were true during both seasons.

c) The interaction effect between nutrients, salicylic acid and amino acids

The studied interaction had significant effect on the percentage of shot berries. The lowest values (3.1 and 1.4 %) were recorded on the vines that received all nutrients, amino acid and salicylic acid together. The untreated vines produced the maximum values (8.1 and 7.7%) during both seasons, respectively. These results were true during both seasons.

5-Effect of some amino acids, nutrient and salicylic acid treatments on quality of the berries

Data concerning the effect of some amino acid, nutrient and salicylic acid treatments on berry weight, T.,S.S., and total acidity %, in the berries of Superior grapes during 2012 and 2013 seasons are illustrated in Tables (6 & 7).

a) Specific effect of nutrients:

It is obvious from the obtained data that supplying the vines with micronutrients and/ or calcium was significantly very effective in improving quality of the berries in terms of increasing berry weight and T.S.S. %, and decreasing total acidity % over the check treatment. Using calcium was significantly superior than using micronutrients in double phase in improving quality of the berries. However, application of the three micronutrients together was significantly favourable than using calcium alone in such connection. Using all micronutrients enriched with calcium was significantly very effective in promoting fruit quality over the application of micronutrients without calcium. The best results were obtained with using all nutrients (Zn, Fe, Mn and Ca) together. Unfavourable effects on berry quality were detected on untreated vines. These results were true during both seasons.

b) Specific effect of using salicylic acid and/ or amino acids

Single and combined application of salicylic acid and amino acids significantly proved to be very effective for improving quality of the berries relatively to the check treatment. A great and significant promotion on berries quality was observed due to application of salicylic acid and amino acids together. Unfavourable effects on fruit quality were appeared in untreated vines.

c) The interaction effect between nutrients, salicylic acid and amino acids

A significant promotion on quality of Superior grapes was observed with supplying the vines with Zn, Fe, Mn, Ca, amino acids and salicylic acid together. The check vines produced undesirable effects on quality of the berries. Similar results were announced during both seasons.

4. Discussion

The previous benefits for using amino acids on growth and fruiting of Superior grapevines might be attributed to their positive action on protecting plants from oxidative stress, as well as improving the biosynthesis of proteins, IAA, cyokinins, GA_3 ethylene, DNA and RNA (**Davies, 1982**).

These results are in agreement with those obtained by **Amin (2007); Seleem – Basma and Abd El- Hameed (2008); Sayed- Heba (2010); Ahmed *et al.*, (2011); Wassel *et al.*, (2011); Abd El-aal (2012) and Ahmed *et al.*, (2012)** on different grapevine cvs. The essential roles of micronutrients on activating most enzymes involved in plant metabolism as well as enhancing the biosynthesis of organic foods and IAA,

cell division, water and nutrients absorption and transport and berry setting (**Yagodin, 1990 and Dalbo, 1992)** could explain the present results.

These results are in concordance with those obtained by **Seleem- Basma and Abd El- Hameed (2008); Abd El- Wahab (2010). Sayed – Heba (2010); El- Kady (2011) and Abd El-aal (2012)** on various grapevine cvs.

The positive action of salicylic acid on adjusting the balance between promoters and inhibitors with plant tissues as well as improving the tolerance of plants to all stresses and cell division (**Hayat *et al*., 2010 and Joseph *et al.*, 2010**) could explain the present results.

These results are in harmony with those obtained by **Ahmed and Abd El- Hameed (2004); Madian (2004) Abd El- Kariem (2009); Ahmed *et al.*, (2010); El- Hanafy (2011); El- Kady- hanaa (2011); Bondok – Sawsan *et al.*, (2011); Osman (2014) and Ahmed *et al.*, (2014).**

Table (2): Effect of some amino acids, nutrient and salicylic acid treatments on the leaf area and weight of prunings / vine of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	Leaf area (cm^2)										Weight of prunings / vine (kg.)									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	110.0	111.0	112.0	113.3	111.6	109.1	110.1	111.3	112.4	110.8	1.33	1.39	1.45	1.51	1.4	1.41	1.46	1.51	1.57	1.5
a_2 Zn + Mn	111.9	113.0	114.0	115.5	113.6	110.3	111.3	112.6	112.0	112.0	1.40	1.46	1.52	1.58	1.5	1.46	1.52	1.57	1.64	1.5
a_3 Mn + Fe	113.4	115.4	116.5	118.0	116.1	111.9	113.0	114.0	113.5	113.5	1.48	1.55	1.60	1.66	1.6	1.51	1.57	1.63	1.70	1.6
a_4 Zn + Fe	116.0	117.3	118.5	119.9	118.0	113.0	114.7	115.8	115.1	115.1	1.56	1.62	1.67	1.72	1.6	1.56	1.62	1.68	1.73	1.6
a_5 Zn + Fe + Mn	118.3	119.5	120.6	122.0	120.1	117.3	118.4	119.6	119.0	119.0	1.72	1.77	1.82	1.87	1.8	1.67	1.73	1.80	1.83	1.8
a_6 Ca	117.0	118.0	119.0	120.3	118.8	114.9	116.1	117.3	116.7	116.7	1.64	1.69	1.74	1.79	1.7	1.61	1.66	1.71	1.77	1.7
a_7 Ca + Zn + Mn	120.0	121.1	122.3	123.3	121.7	118.7	119.8	120.9	120.4	120.4	1.78	1.73	1.88	1.93	1.9	1.73	1.80	1.86	1.92	1.8
a_8 Ca + Mn + Fe	121.0	122.0	123.9	125.0	123.0	120.0	121.0	122.1	121.3	121.3	1.84	1.89	1.94	1.99	1.9	1.81	1.87	1.93	2.00	1.8
a_9 Ca + Zn + Fe	122.0	123.1	125.0	127.0	124.0	121.3	122.3	123.3	122.8	122.8	1.40	1.95	2.00	2.05	2.0	1.86	1.92	1.97	2.05	2.0
a_{10} Ca + Zn + Mn + Fe	123.3	124.1	125.3	129.9	125.7	123.0	124.9	126.0	125.3	125.3	1.95	2.00	2.06	2.22	2.1	1.92	1.97	2.04	2.25	2.0
Mean (B)	117.4	118.5	119.7	121.4	119.3	116.0	117.2	118.3	177.8	177.8	1.7	1.70	1.8	1.8	1.75	1.7	1.7	1.8	1.8	1.7
New L.S.D. at 5%	A 0.9	B 0.8		AB 2.5		A 0.9	B 0.7		AB 2.2		A 0.06	B 0.05		AB 0.16		A 0.05	B 0.05		AB 0.16	

SA= salicylic acid

Table (3): Effect of some amino acids, nutrient and salicylic acid treatments on the percentages of N and P in the leaves of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	Leaf N %										Leaf P %									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	1.51	1.57	1.64	1.71	1.6	1.53	1.59	1.65	1.72	1.6	0.17	0.19	0.21	0.23	0.2	0.16	0.18	0.20	0.22	0.19
a_2 Zn + Mn	1.58	1.64	1.71	1.78	1.7	1.59	1.65	1.71	1.78	1.7	0.20	0.22	0.24	0.26	0.2	0.19	0.21	0.23	0.25	0.22
a_3 Mn + Fe	1.65	1.71	1.78	1.85	1.7	1.65	1.71	1.77	1.85	1.7	0.23	0.25	0.27	0.29	0.26	0.22	0.24	0.26	0.28	0.25
a_4 Zn + Fe	1.73	1.80	1.88	1.95	1.8	1.72	1.78	1.84	1.91	1.8	0.26	0.28	0.30	0.32	0.29	0.25	0.27	0.29	0.31	0.28
a_5 Zn + Fe + Mn	1.88	1.96	2.04	2.11	2.0	1.88	1.94	2.00	2.07	2.0	033	0.35	0.37	0.39	0.38	0.31	0.33	0.35	0.38	0.34
a_6 Ca	1.80	1.87	1.94	2.01	2.0	1.80	1.86	1.92	1.99	1.9	0.30	0.32	0.34	0.36	0.33	0.28	0.30	0.32	0.35	0.31
a_7 Ca + Zn + Mn	1.95	2.03	2.10	2.18	2.1	1.95	2.02	2.08	2.15	2.0	0.36	0.38	0.40	0.41	0.38	0.34	0.36	0.38	0.40	0.37
a_8 Ca + Mn + Fe	2.03	2.11	2.15	2.26	2.1	2.02	2.08	2.15	2.2	2.1	0.39	0.41	0.43	0.46	0.40	0.37	0.39	0.41	0.43	0.40
a_9 Ca + Zn + Fe	2.11	2.20	2.28	2.36	2.2	2.11	2.18	2.24	2.31	2.2	0.42	0.44	0.46	0.49	0.42	0.40	0.42	0.44	0.46	0.43
a_{10} Ca + Zn + Mn + Fe	2.20	2.29	2.37	2.45	2.3	2.22	2.29	2.36	2.51	2.3	0.45	0.47	0.49	0.55	0.45	0.43	0.45	0.47	0.49	0.46
Mean (B)	1.8	1.8	2.0	2.1		1.8	1.9	2.0	2.0		0.3	0.3	0..35	0.38	0.49	0.3	0.3	0.33	0.36	
New L.S.D. at 5%	A 0.06	B 0.05		AB 0.16		A 0.06	B 0.05		AB 0.16		A 0.03	B 0.02		AB 0.06		A 0.03	B 0.02		AB 0.06	

SA= salicylic acid

Table (4): Effect of some amino acids, nutrient and salicylic acid treatments on the percentages of K and Mg in the leaves of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	Leaf K %										Leaf Mg %									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	B1.23$_4$ both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	1.11	1.16	1.21	1.27	1.2	1.09	1.14	1.18	1.26	1.6	0.31	0.33	0.35	0.38	0.34	0.32	0.35	0.38	0.41	0.36
a_2 Zn + Mn	1.17	1.22	1.27	1.34	1.25	1.14	1.19	1.23	1.26	1.2	0.34	0.36	0.38	0.41	0.37	0.35	0.38	0.41	0.44	0.39
a_3 Mn + Fe	1.23	1.30	1.36	1.36	1.33	1.19	1.25	1.30	1.33	1.26	0.37	0.40	0.43	0.46	0.41	0.39	0.42	0.45	0.48	0.43
a_4 Zn + Fe	1.30	1.35	1.41	1.41	1.38	1.24	1.29	1.34	1.37	1.31	0.40	0.44	0.48	0.51	0.45	0.43	0.46	0.44	0.52	0.46
a_5 Zn + Fe + Mn	1.44	1.49	1.55	1.55	1.52	1.35	1.39	1.44	1.47	1.41	0.48	0.52	0.56	0.59	0.53	0.51	0.54	0.57	0.61	0.55
a_6 Ca	1.37	1.42	1.48	1.48	1.45	1.30	1.35	1.40	1.45	1.37	0.44	0.47	0.50	0.53	0.48	0.46	0.50	0.53	0.57	0.51
a_7 Ca + Zn + Mn	1.50	1.55	1.61	1.61	1.58	1.41	1.45	1.50	1.55	1.47	0.51	0.54	0.57	0.61	0.55	0.54	0.57	0.60	0.64	0.58
a_8 Ca + Mn + Fe	1.55	1.60	1.66	1.66	1.63	1.47	1.51	1.56	1.61	1.53	0.54	0.57	0.60	0.64	0.62	0.57	0.60	0.64	0.67	0.62
a_9 Ca + Zn + Fe	1.61	1.66	1.72	1.72	1.71	1.52	1.57	1.62	1.67	1.59	0.57	0.60	0.64	0.67	0.63	0.60	0.63	0.66	0.68	0.64
a_{10} Ca + Zn + Mn + Fe	1.66	1.71	1.79	1.79	1.78	1.58	1.62	1.68	1.80	1.67	0.64	0.64	0.67	0.74	0.63	0.64	0.67	0.71	0.75	0.69
Mean (B)	1.56	1.46	1.45	1.5		1.3	1.4	1.4	1.5		0.5	0.5	0.55	0.50		0.48	0.51	0.53	0.57	
New L.S.D. at 5%	A 0.05	B 0.04		AB 0.13		A 0.04	B 0.04		AB 0.14		A 0.03	B 0.02		AB 0.06		A 0.03	B 0.02		AB 0.06	

SA= salicylic acid

Table (5): Effect of some amino acids, nutrient and salicylic acid treatments on the yield per vine and average luster weight of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	Yield / vine (kg.)										Av. Cluster weight (g.)									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	7.7	7.9	8.1	8.2	7.9	7.5	8.3	8.9	9.5	8.55	350.0	357.0	366.0	374.0	361.7	355.0	363	370	379	366.7
a_2 Zn + Mn	7.9	8.1	8.3	8.4	8.2	8.0	8.5	9.5	10.1	9.25	357.0	366.0	375.0	383.0	370.2	363.0	371	380	390	.76
a_3 Mn + Fe	8.1	8.2	8.4	8.6	8.3	8.2	8.8	9.8	10.4	9.3	366.0	374.0	381.0	390.0	377.7	371.0	381	390	400	385.5
a_4 Zn + Fe	8.2	8.4	8.6	8.7	8.4	8.2	9.0	10.0	10.6	9.4	374.0	381.0	390.0	327.0	385.5	380.0	390	400	408	394.5
a_5 Zn + Fe + Mn	8.7	8.9	9.1	9.2	8.9	8.8	9.4	10.5	11.1	9.9	396.0	405.0	413.0	420.0	408.5	400	410	419	427	414
a_6 Ca	8.5	9.0	9.2	9.4	9.5	8.6	9.2	10.3	10.9	9.8	385.0	392.0	400	410	396.7	391	400	410	420	405.2
a_7 Ca + Zn + Mn	9.4	9.5	9.8	10.0	9.9	9.8	10.9	11.6	12.3	11.1	407.0	414	424	435	420	409	419	430	440	424.2
a_8 Ca + Mn + Fe	9.5	9.8	10.0	10.3	10.1	10.0	11.4	12.2	12.9	11.6	415.0	425	436	447	430.7	416	424	435	445	430
a_9 Ca + Zn + Fe	9.8	10.0	10.2	10.4	10	10.2	11.7	12.5	13.7	12.1	425.0	435	442	450	438	424	435	445	455	439.7
a_{10} Ca + Zn + Mn + Fe	10.0	10.1	10.3	10.5	10.22	10.5	12.0	13.2	13.8	12.3	433.0	440	447	455	443.7	436	446	456	461	439.7
Mean (B)	8.8	8.9	9.2	9.3		8.9	9.9	10.8	11.5		390	398	407	416		394	403.9	413	422.5	
New L.S.D. at 5%	A 0.2	B 0.2		AB 0.6		A 0.3	B 0.2		AB 0.6		A 0.7	B 6.9		AB 21.8		A 7.1	B 6.9		AB 21.8	

SA= salicylic acid

Table (6): Effect of some amino acids, nutrient and salicylic acid treatments on the percentage of shot berries and average berry weight of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	Shot berries %										Av. berry weight (g.)									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	8.1	7.6	7.2	6.8	7.42	7.7	7.2	6.7	6.1	6.9	4.11	4.20	4.30	4.41	4.25	4.15	4.25	4.35	4.45	4.3
a_2 Zn + Mn	7.7	7.3	6.9	6.4	7.07	7.2	6.7	6.1	5.5	6.4	4.20	4.30	4.39	4.50	4.30	4.25	4.35	4.45	4.55	4.4
a_3 Mn + Fe	7.2	6.8	6.4	6.0	6.6	6.5	6.0	5.5	4.9	5.7	4.29	4.41	4.50	4.60	4.41	4.35	4.45	4.55	4.65	4.5
a_4 Zn + Fe	6.8	6.3	5.9	5.5	6.12	5.8	5.3	4.8	4.3	5.1	4.39	4.50	4.60	4.71	4.5	4.40	4.49	4.59	4.71	4.5
a_5 Zn + Fe + Mn	6.0	5.5	5.0	4.6	5.27	4.8	4.3	3.8	3.3	4	4.60	4.71	4.80	4.85	4.7	4.65	4.75	4.85	4.95	4.8
a_6 Ca	6.4	5.9	5.5	5.1	5.72	5.3	4.8	4.3	3.8	4.5	4.50	4.59	4.69	4.75	4.6	4.55	4.65	4.75	4.85	4.7
a_7 Ca + Zn + Mn	5.6	5.2	4.8	4.4	5	4.3	3.8	3.3	2.8	3.5	4.69	4.79	4.80	4.90	4.8	4.75	4.85	4.92	5.00	4.9
a_8 Ca + Mn + Fe	5.2	4.8	4.4	4.0	4.6	3.6	3.1	2.6	2.1	2.8	4.80	4.88	4.98	5.11	4.9	4.85	4.95	5.00	5.10	5
a_9 Ca + Zn + Fe	4.8	4.3	3.9	3.5	4.1	3.1	2.6	2.1	1.6	2.35	4.90	5.11	5.20	5.27	5.1	4.92	4.99	5.10	5.20	5
a_{10} Ca + Zn + Mn + Fe	4.3	3.9	3.5	3.1	3.7	2.6	2.1	1.9	1.4	2	4.97	5.22	5.30	5.39	5.2	4.99	5.15	5.25	5.37	5.2
Mean (B)	6.21	5.76	5.35	4.9		5.1	4.59	4.11	3.58		4.5	4.9	4.7	4.8		4.6	4.7	4.7	4.8	
New L.S.D. at 5%	A 0.4	B 0.3		AB 0.9		A 0.5	B 0.4		AB 0.3		A 0.05	B 0.04		AB 0.3		A 0.05	B 0.04		AB 0.3	

SA= salicylic acid

Table (7): Effect of some amino acids, nutrient and salicylic acid treatments on the percentages of total soluble solids and total acidity in the grapes of Superior grapevines during 2012 and 2013 seasons.

Nutrient treatments (A)	T.S.S. %										Total acidity %									
	2012					2013					2012					2013				
	Salicylic acid and amino acid treatments (B)																			
	b_1 Untreated	B_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)	b_1 Untreated	B_2 SA	B_3 Amino	b_4 both	Mean (A)	b_1 Untreated	b_2 SA	b_3 Amino	b_4 both	Mean (A)
a_1 Untreated vines	18.0	18.2	18.5	18.7	18.4	17.8	18.0	18.2	18.5	18.1	0.721	0.700	0.680	0.660	0.690	0.711	0.688	0.666	0.646	0.677
a_2 Zn + Mn	18.3	18.5	18.7	19.0	18.6	18.1	18.3	18.6	19.0	18.5	0.700	0.680	0.660	0.630	0.667	0.689	0.660	0.640	0.620	0.652
a_3 Mn + Fe	18.6	18.8	19.0	19.2	18.9	18.4	18.6	19.0	19.2	18.8	0.680	0.660	0.639	0.609	0.647	0.669	0.640	0.620	0.600	0.647
a_4 Zn + Fe	19.0	19.2	19.5	19.7	19.4	18.7	19.0	19.3	19.5	19.1	0.660	0.640	0.620	0.600	0.630	0.649	0.611	0.581	0.560	0.600
a_5 Zn + Fe + Mn	14.7	19.9	20.1	20.3	20	19.3	19.5	19.8	20.0	19.65	0.619	0.591	0.571	0.551	0.583	0.600	0.581	0.561	0.541	0.570
a_6 Ca	19.3	19.5	19.7	20.0	19.6	19.0	19.2	19.5	19.7	19.35	0.640	0.610	0.591	0.571	.603	0.620	0.600	0.580	0.560	0.590
a_7 Ca + Zn + Mn	20.0	20.2	20.5	20.7	20.4	19.6	19.8	20.0	20.2	19.8	0.605	0.580	0.560	0.541	.574	0.571	0.551	0.520	0.500	0.535
a_8 Ca + Mn + Fe	20.3	20.5	20.7	21.0	20.6	20.0	20.3	20.5	20.7	20.4	0.597	0.571	0.550	0.522	.560	0.550	0.530	0.510	0.480	0.517
a_9 Ca + Zn + Fe	20.5	20.7	21.0	21.2	20.9	20.3	20.6	20.8	21.0	20.6	0.570	0.550	0.531	0.511	.540	0.530	0.510	0.491	0.471	0.500
a_{10} Ca + Zn + Mn + Fe	20.7	21.0	21.2	21.5	21	20.6	20.9	21.1	21.2	20.9	0.550	0.522	0.500	0.480	.513	0.511	0.480	0.460	0.440	0.472
Mean (B)	19.4	19.7	19.9	20.1		19.2	19.4	19.7	19.9		0.634	0.610	0.590	0.54		0.610	0.585	0.562	0.548	
New L.S.D. at 5%	A 0.3	B 0.3		AB 0.6		A 0.3	B 0.2		AB 0.6		A 0.018	B 0.017		AB 0.054		A 0.019	B 0.018		AB 0.055	

SA= salicylic acid

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