Response of Superior Grapevines to Spraying Some Antioxidants

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Abstract: This study was carried out during 2013 and 2014 seasons for examining the effect of single and combined applications of vitamins B (B_1 + B_2+ B_6 + B_{12}) at 50 to 100 ppm as well as ascorbic and citric acids each at 500 to 1000 ppm on growth, vine nutritional status, berry setting %, yield, shot berries %, and quality of the berries. The three antioxidants were sprayed three times at growth start, just after berry setting and at one month later. Single and combined applications of the three antioxidants namely vitamins B, ascorbic acid and citric acid was very effective in improving growth, vine nutritional status, yield and fruit quality over the check treatment. The best antioxidant in this respect was citric acid followed by ascorbic acid and vitamins B. The antioxidant treatments effectively controlled shot berries %. Carrying out three sprays of a mixture of vitamins B at 50 ppm as well as both ascorbic and citric acids each at 500 ppm three times is suggested for promoting yield and fruit quality of Superior grapevines grown under Luxor conditions.

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1. Introduction

Nowadays, there is a widespread use of antioxidants. They are very effective in protecting plant cells from senescence and disorders (**Robinson, 1973**) as well as enhancing cell division, the biosynthesis of natural hormones such as IAA, GA_3 and cytokinins, nutrient and water uptake, photosynthesis, biosynthesis of plant pigments and proteins as well as the biosynthesis of alpha keto glutaric acid which is united with ammonia to form amino acids and proteins (**Oretili, 1987; Samiullah *et al.,* 1988; Foyer and Lelandias, 1993 and Singh, *et al.,* 2001**).

Superior grapevine cv is a popular grape cv. growing under Luxor region conditions. However, in this region it faces some problems such as poor yield and the occurrence of shot berries in their clusters which in turn negatively affect marketing of such grapevine cv. Therefore, many trials and attempts were made for finding out the non traditional methods for overcoming such problems and at the same time protecting our environment from pollution. Out of these methods application of vitamins and citric acid was arised.

Previous studies showed that using antioxidants was very effective in promoting yield and fruit quality in various grapevine cvs (**Ahmed *et al.,* 2010 ; El-Hanafy, 2011; Uwakiem (2011); Bondok- Sawsan *et al.,* (2011) ; El- Kady- Hanaa (2011) ; Ahmed *et al.,* (2011); Mekawy (2012) Ibrahim – Rehab (2012) Ahmed *et al.,* (2012b); Abdelaal (2012); Ahmed *et al.,* (2012a); Mohamed (2014) ; Abdelaal and Aly (2013); Abada (2014); Abd El- Letief (2014); Abdelaal *et al.,* (2014); Al- Wasfy (2014) and Abd El- Wahab (2015)**.

The target of this study was examining the effect of single and combined applications of ascorbic acid, citric acid and vitamins B on growth traits, nutritional status of the vines, yield and quality of Superior grapevines.

2. Material and Methods

This study was carried out during 2013 and 2014 seasons on 90 uniform in vigour 10-years old Superior grapevines grown in a private vineyard located at Luxor district, Luxor Governorate where the texture of the soil is clay, well drained and water table not less than two meters deep. All the selected vines are planted at 2.0 x 3.0 m apart. The chosen vines (90 vines) were pruned during the first week of January in the two seasons using cane pruning method with the assistance of Baron supporting system. Vine load was 72 eyes for all the selected vines on the basis of six fruiting canes X ten eyes plus six renewal spurs X two eyes. Drip irrigation system was followed using Nile water containing 150 ppm EC.

Mechanical, physical and chemical analysis of the tested soil were carried out at the start of the experiment according to the procedures of **Chapman and Pratt (1965)** and the data are shown in Table (1).

Except those dealing with the present treatments (application of vitamins and amino acids via foliage), all the selected vines (96 vines) received the usual horticultural practices which are commonly used in the vineyard.

Table (1) : Analysis of the tested soil:

Constituents	Values
Particle size distribution:	
Sand %	10.0
Silt %	21.5
Clay %	68.5
Texture	Clay
pH(1:2.5 extract)	8.05
EC (1 :2.5 extract) (dsm^{-1}) 1 cm / 25°C.	1.03
O.M. %	1.88
$CaCO_3$ %	2.55
Total N %	0.10
Available P (Olsen, ppm)	2.22
Available K (ammonium acetate, ppm)	400

This study included the following fifteen treatments from application of single and combined sprays of citric acid, vitamins B and ascorbic acid in addition to the control treatment:

1- Control (untreated vines)
2- Spraying citric acid at 500 ppm
3- Spraying citric acid at 1000 ppm
4- Spraying ascorbic acid at 500 ppm
5- Spraying ascorbic acid at 1000 ppm.
6- Spraying vitamins B (B_1+ B_2 + B_6 + B_{12}) at 50 ppm.
7- Spraying vitamins B at 100 ppm.
8- Spraying citric + ascorbic acids each at 500 ppm.
9- Spraying citric + ascorbic acids each at 1000 ppm.
10- Spraying citric acid at 500 ppm + vitamin B at 50 ppm.
11- Spraying citric acid at 1000 ppm + vitamin B at 100 ppm.
12- Spraying ascorbic acid at 500 ppm + vitamin B at 50 ppm.
13- Spraying ascorbic acid at 1000 ppm + vitamin B at 100 ppm.
14- Spraying all antioxidants at the low concentration.
15- Spraying all antioxidants at the high concentration.

Each treatment was replicated three times, two vines per each. Vitamins B (B_1+B_2+B_6+B_{12}) & ascorbic acid and citric acid were easily dissolved in water. The selected vines received three sprays of these antioxidants at growth start (3rd week of Feb.), just after berry setting (3rd week of Mar) and at one month later (3rd week of Apr.).

Triton B as a wetting agent was used with all vitamins and citric acid at 0.05 % (0.5 ml/ l) . Spraying was done till run off (2 litres/ vine). Control treatment was carried out by spraying water and Triton B.

Randomized complete block design was followed where the experiment consisted of fifteen treatments, each treatment replicated three times, two vines per each.

During both seasons, the following measurements were recorded:

1- Main shoot length, number of leaves/ shoot and leaf area (**Ahmed and Morsy, 1999**).
2- Chlorophylls a & b, total chlorophylls and total carotenoids (**Von- Wettstein, 1957**).
3- Nutrients namely N, P, K, Mg, Ca, Zn, Fe, Mn and Cu (**Chapman and Pratt, 1965 and Balo *et al.*, 1988**).
4- Berry setting, yield, number of clusters/ vine as well as cluster weight and dimensions.
5- Percentage of shot berries.
6- Weight and dimensions of berry (longitudinal and equatorial).
7- T.S.S. %, total acidity %, T.S.S. / acid and reducing sugars % **(A.O.A.C. 2000).**

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

3. Results and Discussion

1-Effect of single and combined applications of some antioxidants on some vegetative growth characters:

It is clear from the obtained data in Table (2) that single and combined applications of vitamins B at 50 to 100 ppm, ascorbic acid at 500 to 1000 ppm and citric acid at 500 to 1000 ppm significantly was accompanied with stimulating the three growth characters namely main shoot length, number of leaves /shoot and leaf area rather than non-application. The promotion on these growth characters was significantly associated with using vitamins B, ascorbic acid and citric acid, in ascending order. Combined applications of these antioxidants were significantly favourable than using each alone in this respect: No significant promotion on these growth characters was observed among the two concentrations of each antioxidant. Using ascorbic acid and citric acid together at 1000 ppm considered the best double applications in this respect. Significant differences on these growth characters were observed among all antioxidants. Using the three antioxidants together at the higher concentrations gave the maximum values. The minimum values were recorded on untreated vines. These results were true during both seasons.

2- Effect of single and combined applications of some antioxidants on the leaf chemical composition.

It is clear from the data that in Tables (2 to 5) treating the vines three times with vitamins B at 50 to

100 ppm, ascorbic acid at 500 to 1000 ppm and citric acid at 500 to 1000 ppm either alone or in combinations significantly was accompanied with enhancing plant pigments, namely chlorophylls a &, b, total chlorophylls, total carotenoids, N, P, K, Mg, Ca, Zn, Fe, Mn and Cu in the leaves rather than non-application. Using citric acid at 500 to 1000 ppm, ascorbic acid at 500 to 1000 ppm and vitamins B at 50 to 100 ppm, in descending order significantly was followed by enhancing these pigments and nutrients in the leaves. Increasing concentrations from 500 to 1000 ppm of both citric acid and ascorbic acid and from 50 to 1000 ppm vitamins B failed significantly to show any promotion on these chemical constituents. Significant differences on these chemical characters were observed among all antioxidants. Combined applications were significantly superior than using single one in improving these chemical constituents. Treating the vines with all antioxidants at the higher concentrations gave the maximum values. The untreated vines produced the minimum values. Similar results were announced during both seasons.

3- Effect of single and combined applications of some antioxidants on berry setting %, yield and cluster characters:

It is obvious from the obtained data in Tables (6 & 7) that single and combined applications of the three antioxidants at the named concentrations significantly improved berry setting %, yield, number of clusters/ vine (In the 2nd season) as well as weight, length and width of cluster over the check treatment. The promotion significantly was associated with using citric acid, ascorbic acid and vitamins B, in descending order. Increasing concentrations from 200 to 1000 ppm of ascorbic acid and citric acid and from 50 to 100 ppm of vitamins B had no significant effect on these characters. Combined applications of these antioxidants significantly were superior than using each antioxidant alone in improving berry setting, yield and cluster characters. The best double application in this respect was using ascorbic acid and citric acid. Triple application was significantly superior than using double one in this respect. Economical point of view, using vitamins B at 50 pm, ascorbic acid at 500 ppm and citric acid at 500 ppm gave the best results with regard to yield. Under such promised treatment yield per vine reached 9.0 and 14.1 kg comparing with the yield of the control vines that reached 7.6 and 7.6 kg during both seasons, respectively. The percentage of increase on the yield due to application of the promised treatment over the check treatment reached 18.4 and 85.5% during both seasons, respectively. The antioxidant treatments had no significant effect on the number of clusters per vine in the first season of study. These results were true during both seasons.

4- Effect of single and combined applications of some antioxidants on the percentage of shot berries.

It is evident from the data in Table (7) that the percentage of shot berries in Superior grapevines significantly was declined with using single and combined applications of vitamins B at 50 to 100 ppm ascorbic acid at 500 to 1000 ppm, and citric acid at 500 to 1000 ppm over the check treatment. The reduction significantly was associated with using vitamins B, ascorbic acid and citric acid in ascending order. Combined applications of these antioxidants significantly were favourable than using each antioxidant alone in controlling the percentage of shot berries. The lowest values of shot berries were recorded on the vines that received the three antioxidants at the higher concentration, but because of the meaningless reduction among the lowest and highest concentrations of each antioxidant, the recommendation was using the lowest concentrations namely 50 ppm for vitamins B as well as 500 ppm for both ascorbic and citric acids. Values of shot berries under the previous treatment reached 1.7 & 1.6% during both seasons, respectively. The untreated vines produced 10.0 & 9.9 % shot berries during 2013 & 2014 seasons, respectively.

5- Effect of single and combined applications of some antioxidants on both physical and chemical characteristics of the berries

It is clear from the data in Tables (7 to 9) that single and combined applications of vitamins B at 50 to 100 ppm, ascorbic acid and citric acid each at 500 to 1000 ppm significantly was very effective in improving quality of the berries in terms of increasing berry weight and dimensions (longitudinal and equatorial), T.S.S. %, T.S.S./ acid and reducing sugars and decreasing total acidity % over the check treatment. The promotion on quality of the berries was significantly associated with using vitamins B; ascorbic acid and citric acid, in ascending order. Combined applications of these antioxidants were significantly in enhancing fruit quality than using each antioxidant alone. No significant promotion on quality of the berries was attributed to increasing concentrations from 500 to 1000 ppm for both ascorbic and citric acids and from 50 to 1000 ppm for vitamins B. Therefore, the best results on fruit quality from economical point of view were obtained due to using vitamins B at 50 ppm plus ascorbic and citric acids each at 500 ppm. Unfavorable effects on fruit quality were observed on untreated vines. These results were true during both seasons.

Table (2): Effect of single and combined applications of some antioxidants on some vegetative growth characters and leaf chlorophyll a (mg / 100 g F.W.). of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Main shoot length (cm.)		No. of leaves / shoot		Leaf area $(cm)^2$		Chlorophyll a (mg / 100 F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	91.0	91.3	14.0	14.0	101.0	101.0	8.1	7.9
2- Vitamins B at 50 ppm	92.9	93.3	16.0	16.0	103.0	103.3	8.8	9.0
3- Vitamins B at 100 ppm	93.0	93.4	16.0	16.0	103.3	103.6	8.9	9.1
4-Ascorbic acid at 500 ppm.	95.0	95.7	18.0	18.0	106.9	107.0	10.0	10.1
5- Ascorbic acid at 1000 ppm.	95.3	95.8	18.0	18.0	107.0	107.1	10.1	10.2
6- Citric acid at 500 ppm.	97.9	98.6	20.0	20.0	110.0	110.0	11.3	11.5
7- Citric acid at 1000 ppm.	98.0	99.0	20.0	20.0	110.3	110.4	11.4	11.6
8- Vitamins B + Ascorbic at low conc.	100.3	101.9	22.0	22.0	113.0	113.4	12.6	12.7
9- Vitamins B + Ascorbic at high conc.	100.6	102.0	22.0	22.0	113.3	113.6	12.7	12.8
10- Vitamins B + citric at low conc.	105.0	106.0	24.0	24.0	117.0	117.9	14.0	14.1
11- Vitamins B + citric at high conc.	105.3	106.6	24.0	24.0	117.6	118.0	14.1	14.2
12-Ascorbic acid + citric at low conc.	107.6	108.5	25.0	25.0	120.0	121.0	15.3	15.9
13- Ascorbic acid + citric at high conc.	108.0	109.0	25.0	25.0	120.3	121.3	15.3	16.0
14- All antioxidants at low conc.	111.0	112.5	25.0	26.0	123.9	124.4	16.9	17.5
15- All antioxidants at high conc.	111.6	112.8	25.0	26.0	124.0	125.0	17.0	17.7
New L.S.D. at 5%	1.0	1.1	2.0	2.0	1.1	1.1	0.5	0.5

Table (3): Effect of single and combined applications of some antioxidants on some leaf pigments and the percentage pf N in the leaves of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Chlorophyll a (mg/ 100 g F.W.)		Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	4.1	4.0	12.2	11.9	4.4	4.9	1.60	
2- Vitamins B at 50 ppm	4.6	4.7	13.4	13.7	5.0	5.5	1.67	
3- Vitamins B at 100 ppm	4.7	4.8	13.6	18.9	5.1	5.6	1.68	
4-Ascorbic acid at 500 ppm.	5.3	5.4	15.3	15.5	5.6	6.0	1.76	
5- Ascorbic acid at 1000 ppm.	5.4	5.5	15.5	15.7	5.7	6.1	1.77	
6- Citric acid at 500 ppm.	6.1	6.1	17.4	17.6	6.4	6.6	1.85	
7- Citric acid at 1000 ppm.	6.2	6.3	17.6	17.9	6.5	6.7	1.86	
8- Vitamins B + Ascorbic at low conc.	7.1	7.2	19.7	19.9	7.2	7.4	1.92	
9- Vitamins B + Ascorbic at high conc.	7.2	7.3	19.9	20.1	7.3	7.5	1.93	
10- Vitamins B + citric at low conc.	8.0	8.3	22.0	22.4	8.0	8.1	1.99	
11- Vitamins B + citric at high conc.	8.1	8.4	22.2	22.6	8.1	8.2	2.00	
12-Ascorbic acid + citric at low conc.	9.1	9.5	24.1	25.4	8.7	9.0	2.06	
13- Ascorbic acid + citric at high conc.	9.2	9.6	24.5	25.6	8.8	9.1	2.07	
14- All antioxidants at low conc.	10.2	10.5	27.1	28.0	9.9	10.1	2.13	
15- All antioxidants at high conc.	10.3	10.6	27.3	28.3	10.0	10.2	2.14	
New L.S.D. at 5%	0.3	0.3	0.6	0.6	0.3	0.3	0.05	0.05

Table (4): Effect of single and combined applications of some antioxidants on the percentages of P, K, Mg and Ca in the leaves of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Leaf P %		Leaf K %		Leaf Mg %		Leaf Ca %	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	0.12	0.12	1.30	1.27	0.49	0.50	2.11	2.20
2- Vitamins B at 50 ppm	0.15	0.16	1.35	1.34	0.54	0.55	2.20	2.30
3- Vitamins B at 100 ppm	0.16	0.16	1.36	1.35	0.55	0.56	2.21	2.31
4-Ascorbic acid at 500 ppm.	0.18	0.18	1.41	1.41	0.59	0.60	2.30	2.40
5- Ascorbic acid at 1000 ppm.	0.19	0.19	1.42	1.42	0.60	0.61	2.31	2.41
6- Citric acid at 500 ppm.	0.21	0.22	1.47	1.48	0.64	0.65	2.39	2.50
7- Citric acid at 1000 ppm.	0.22	0.22	1.48	1.49	0.65	0.66	2.40	2.51
8- Vitamins B + Ascorbic at low conc.	0.25	0.25	1.55	1.54	0.71	0.72	2.47	2.59
9- Vitamins B + Ascorbic at high conc.	0.26	0.25	1.55	1.55	0.72	0.73	2.48	2.60
10- Vitamins B + citric at low conc.	0.28	0.28	1.61	1.61	0.74	0.75	2.57	2.71
11- Vitamins B + citric at high conc.	0.29	0.29	1.62	1.62	0.75	0.76	2.58	2.72
12-Ascorbic acid + citric at low conc.	0.31	0.32	1.71	1.72	0.81	0.82	2.69	2.82
13- Ascorbic acid + citric at high conc.	0.31	0.33	1.72	1.73	0.81	0.83	2.70	2.83
14- All antioxidants at low conc.	0.33	0.35	1.77	1.79	0.86	0.88	2.78	2.91
15- All antioxidants at high conc.	0.33	0.36	1.78	1.80	0.87	0.89	2.79	2.92
New L.S.D. at 5%	0.02	0.02	0.04	0.03	0.03	0.03	0.06	0.06

Table (5): Effect of single and combined applications of some antioxidants on the leaf content of Zn, Fe, Mn and Cu (as ppm) of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)		Leaf Cu (ppm)	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	51.0	51.5	45.0	45.4	47.0	46.8	1.00	1.02
2- Vitamins B at 50 ppm	54.0	54.5	47.9	48.0	50.0	50.1	1.11	1.14
3- Vitamins B at 100 ppm	54.6	55.1	48.0	48.0	50.6	50.2	1.12	1.15
4-Ascorbic acid at 500 ppm.	58.0	58.6	51.0	51.1	53.0	53.7	1.20	1.22
5- Ascorbic acid at 1000 ppm.	58.3	58.8	51.3	51.4	53.3	53.9	1.21	1.23
6- Citric acid at 500 ppm.	61.9	62.4	54.0	54.1	55.9	56.9	1.30	1.31
7- Citric acid at 1000 ppm.	62.0	62.5	54.3	54.5	56.0	57.0	1.31	1.32
8- Vitamins B + Ascorbic at low conc.	66.0	66.6	57.3	57.4	59.0	60.0	1.36	1.37
9- Vitamins B + Ascorbic at high conc.	66.6	67.2	57.5	57.6	59.3	60.3	1.37	1.37
10- Vitamins B + citric at low conc.	70.0	70.7	60.0	60.1	62.1	62.9	1.41	1.42
11- Vitamins B + citric at high conc.	70.6	70.8	60.3	60.2	62.2	63.0	1.42	1.43
12-Ascorbic acid + citric at low conc.	74.0	74.9	62.9	63.0	64.9	65.9	1.49	1.50
13- Ascorbic acid + citric at high conc.	74.3	75.0	63.0	63.1	65.0	66.0	1.50	1.51
14- All antioxidants at low conc.	78.0	78.7	66.0	66.9	68.9	69.9	1.56	1.57
15- All antioxidants at high conc.	78.6	79.0	66.3	67.0	69.0	70.1	1.57	1.57
New L.S.D. at 5%	2.0	2.0	1.9	2.0	1.9	1.9	0.03	0.03

Table (6): Effect of single and combined applications of some antioxidants on the percentage of berry setting , yield and cluster weight of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Berry setting %		No. of clusters / vine		Yield/ vine (kg.)		Cluster weight (g.)	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	7.0	6.9	19.0	19.0	7.6	7.6	401.0	399.0
2- Vitamins B at 50 ppm	7.6	7.8	19.0	21.0	7.8	8.6	411.0	411.0
3- Vitamins B at 100 ppm	7.7	7.8	19.0	21.0	7.8	8.6	412.0	411.0
4-Ascorbic acid at 500 ppm.	8.1	8.4	19.0	21.0	8.0	8.8	423.0	420.0
5- Ascorbic acid at 1000 ppm.	8.2	8.5	19.0	21.0	8.1	8.8	424.0	421.0
6- Citric acid at 500 ppm.	9.0	9.2	19.0	23.0	8.0	9.8	420.0	425.0
7- Citric acid at 1000 ppm.	9.0	9.3	19.0	23.0	8.0	9.8	421.0	426.0
8- Vitamins B + Ascorbic at low conc.	9.7	9.8	20.0	25.0	8.7	10.9	435.0	436.0
9- Vitamins B + Ascorbic at high conc.	9.8	9.8	20.0	25.0	8.7	11.0	436.0	438.0
10- Vitamins B + citric at low conc.	10.5	10.7	20.0	27.0	8.8	11.9	440.0	441.0
11- Vitamins B + citric at high conc.	10.5	10.8	20.0	27.0	8.8	11.9	441.0	442.0
12-Ascorbic acid + citric at low conc.	11.1	11.2	20.0	29.0	8.9	12.9	444.0	446.0
13- Ascorbic acid + citric at high conc.	11.2	11.2	20.0	29.0	8.9	13.0	445.0	447.0
14- All antioxidants at low conc.	11.8	11.9	20.0	31.0	9.0	14.1	450.0	455.0
15- All antioxidants at high conc.	11.9	12.0	20.0	31.0	9.0	14.1	451.0	456.0
New L.S.D. at 5%	0.4	0.4	NS	2.0	0.4	0.4	9.0	8.9

Table (7): Effect of single and combined applications of some antioxidants on cluster dimensions, length & width) percentage of shot berries, and berry weight of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Cluster length (cm.)		Cluster width (cm.)		Shot berries %		Berry weight (g.)	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	20.9	21.0	12.9	13.0	10.0	9.9	3.51	3.55
2- Vitamins B at 50 ppm	21.5	21.6	13.5	13.5	9.4	9.3	3.60	3.64
3- Vitamins B at 100 ppm	21.6	21.7	13.6	13.6	9.3	9.2	3.61	3.65
4-Ascorbic acid at 500 ppm.	22.4	22.5	14.0	14.1	8.0	7.9	3.70	3.75
5- Ascorbic acid at 1000 ppm.	22.5	22.6	14.1	14.2	7.9	7.8	3.71	3.76
6- Citric acid at 500 ppm.	23.3	23.4	14.7	14.9	6.0	5.9	3.80	3.85
7- Citric acid at 1000 ppm.	23.4	23.5	14.8	15.0	5.9	5.9	3.81	3.86
8- Vitamins B + Ascorbic at low conc.	24.1	24.2	15.5	15.7	4.0	3.9	3.91	3.95
9- Vitamins B + Ascorbic at high conc.	24.2	24.3	15.6	15.8	3.9	3.8	3.92	3.96
10- Vitamins B + citric at low conc.	25.0	25.1	16.1	16.3	3.5	3.4	3.98	3.99
11- Vitamins B + citric at high conc.	25.1	25.2	16.2	16.4	3.4	3.3	4.00	4.00
12-Ascorbic acid + citric at low conc.	25.7	25.9	16.6	16.8	2.2	2.1	4.07	4.14
13- Ascorbic acid + citric at high conc.	25.8	26.0	16.7	16.9	2.1	2.0	4.08	4.15
14- All antioxidants at low conc.	26.9	27.0	17.2	17.3	1.7	1.6	4.13	4.22
15- All antioxidants at high conc.	27.0	27.1	17.3	17.4	1.6	1.5	4.14	4.23
New L.S.D. at 5%	0.5	0.4	0.4	0.4	0.4	0.4	0.06	0.06

Table (8): Effect of single and combined applications of some antioxidants on some physical and chemical characteristics of the berries of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	Berry longitudinal (cm)		Berry equatorial (cm.)		T.S.S. %		Total acidity %	
	2013	2014	2013	2014	2013	2014	2013	2014
1- Control	2.11	2.18	2.00	2.09	18.0	18.1	0.719	0.714
2- Vitamins B at 50 ppm	2.21	2.28	2.09	2.19	18.4	18.4	0.694	0.690
3- Vitamins B at 100 ppm	2.22	2.29	2.10	2.20	18.5	18.5	0.693	0.689
4-Ascorbic acid at 500 ppm.	2.32	2.42	2.17	2.29	19.0	19.0	0.670	0.666
5- Ascorbic acid at 1000 ppm.	2.33	2.43	2.18	2.30	19.1	19.1	0.669	0.665
6- Citric acid at 500 ppm.	2.41	2.51	2.30	2.40	19.9	20.0	0.640	0.635
7- Citric acid at 1000 ppm.	2.42	2.52	2.31	2.41	20.0	20.0	0.638	0.634
8- Vitamins B + Ascorbic at low conc.	2.50	2.60	2.41	2.50	20.5	20.5	0.616	0.611
9- Vitamins B + Ascorbic at high conc.	2.50	2.61	2.42	2.51	20.6	20.6	0.615	0.610
10- Vitamins B + citric at low conc.	2.57	2.69	2.49	2.61	21.0	21.0	0.594	0.590
11- Vitamins B + citric at high conc.	2.58	2.70	2.50	2.62	21.0	21.1	0.593	0.589
12-Ascorbic acid + citric at low conc.	2.66	2.77	2.59	2.69	21.5	21.6	0.571	0.570
13- Ascorbic acid + citric at high conc.	2.67	2.78	2.60	2.70	21.6	21.7	0.570	0.569
14- All antioxidants at low conc.	2.77	2.90	2.69	2.81	22.0	22.0	0.550	0.545
15- All antioxidants at high conc.	2.78	2.91	2.70	2.82	22.0	22.1	0.549	0.544
New L.S.D. at 5%	0.09	0.09	0.07	0.07	0.3	0.3	0.020	0.020

Table (9): Effect of single and combined applications of some antioxidants on T.S.S. / acid and percentage of reducing sugars in the berries of Superior grapevines during 2013 and 2014 seasons.

Antioxidant treatments	T.S.S. / acid		Reducing sugars %	
	2013	2014	2013	2014
1- Control	25.0	25.4	15.7	15.9
2- Vitamins B at 50 ppm	26.5	26.7	16.0	16.2
3- Vitamins B at 100 ppm	26.7	26.9	16.1	16.3
4-Ascorbic acid at 500 ppm.	28.4	28.5	16.5	16.7
5- Ascorbic acid at 1000 ppm.	28.6	28.9	16.6	16.8
6- Citric acid at 500 ppm.	31.1	31.5	17.0	17.2
7- Citric acid at 1000 ppm.	31.3	31.5	17.1	17.3
8- Vitamins B + Ascorbic at low conc.	33.3	33.6	17.5	17.7
9- Vitamins B + Ascorbic at high conc.	33.5	3.8	17.6	17.8
10- Vitamins B + citric at low conc.	35.4	35.6	17.9	18.1
11- Vitamins B + citric at high conc.	35.4	35.8	18.0	18.2
12-Ascorbic acid + citric at low conc.	37.7	37.9	18.4	18.6
13- Ascorbic acid + citric at high conc.	37.8	38.1	18.5	18.7
14- All antioxidants at low conc.	40.0	40.4	18.8	19.0
15- All antioxidants at high conc.	40.1	40.6	18.9	19.1
New L.S.D. at 5%	0.3	0.2	0.3	0.2

B) Discussion

The positive action of vitamins on fruiting of Superior grapevine might be attributed to their essential roles on protecting the plant cells from senescence and disorders as well as enhancing cell division, the biosynthesis of natural hormones such IAA and ethylene, nutrient and water uptake, photosynthesis, building of plant pigments and proteins, amino acids and plant metabolism. These important functions of vitamins were surely reflected on enhancing growth and vine nutritional status in favor of enhancing yield and fruit quality. (**Robinson, 1973; Oretili, 1987; Samiullah *et al.*, 1988; Foyer and Lelandias, 1993 and Singh *et al.*, 2001)**.

These results are in harmony with those obtained by **Ahmed *et al.*, (2010); Bondok- Sawsan *et al.*, (2011); Uwakiem (2011), El Hanafy (2011); El-Kady- Hanaa(2011); Ahmed *et al.*, (2011a); Mekawy (2012); Ibrahim- Rehab(2012); Ahmed *et al.*, (2012b), Abdelaal (2012) Ahmed *et al.*, (2012a); Mohamed (2014), Abdelaal and Aly (2013); Abada (2014); Abd El- Latief (2014); Abdelaal *et al.*, (2014); Al- Wasfy (2014) and Abd El- Wahab (2015).**

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