

Impact of Vitamins B and C, Glutamic Acid and Silicon on Fruiting of Superior Grapevines

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Abstract: Growth, plant pigments, vine nutritional status, yield and berries quality of Superior grapevines in response to foliar application of vitamins B at 50 ppm, C at 1000 ppm, glutamic acid at 1000 ppm and potassium silicate at 0.1% were investigated during 2013 & 2014 seasons. The vines received four sprays. Spraying vitamins B & C and glutamic acid with or without silicon considerably enhanced growth characters, plant pigments, N, P, K, Mg, Ca, Zn, Fe and Mn, yield and quality of the berries relative to the check treatment. Using glutamic acid was superior than using vitamins B & C in this connection. Using silicon along with vitamins B & C and glutamic acid was preferable than using vitamins B & C in combined with glutamic acid in this connection. For promoting yield and fruit quality of Superior grapevines, it is advised to spray the vines four times with a mixture containing vitamins B ($B_1 + B_2 + B_6 + B_{12}$) at 50 ppm + vitamin C at 1000 ppm + glutamic acid at 1000 ppm + potassium silicate at 0.1%.

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1.Introduction

The decline of yield as well as the problem of shot berries in Superior vineyards are the major problems facing grape production. Unbalanced or malnutrition as well as undesirable environmental conditions and the incidence of pests are considered to be the main causes for poor cropping (Levitt, 1980). Recently, more studies confirmed the great benefits of using silicon vitamins and boron on fruiting of different grapevine cvs. Recent researches showed that Si is a functional plant nutrient and using it can considerably enhance insect pest resistance in plants with consequent yield increases. Most reports showed that the responses to Si application in reducing pest populations and plant damage was more obvious in susceptible than in resistant varieties. Recent evidence suggests that Si deposition in the plant may reinforce plant insect resistance by providing a mechanical barrier against insect pests and physiological resistance to diseases. Silicon is widely considered as an activator by stimulating the expression of natural defense reaction through the production of phenolic compounds (Kanto, 2002 and Epstein and Bloom, 2003).

Vitamins are known as important factors responsible for enhancing growth and influencing many physiological processes. The basic physiological significance connected with vitamin B₁ as a coenzyme in various types of decarboxylation. It has been suggested that the effect of thiamine upon the meristem may partly have indirect nature and its mediated by the nature tissue through an altered supply of metabolites to the apex. Most of thiamine in

plants is present as free vitamin (Samiullah *et al.*, 1988).

Recently, it was suggested that vitamins participate in plant growth and development indirectly by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellins. Most vitamins are synthesized in the leaves and translocated in the phloem to the other organs. For more than two decades studying of the role of vitamins in plants attracted sporadic attraction. These studies indicated that various physiological process such as nutrient uptakes, absorption of water, translocation of organic foods, building of natural hormones, respiration, photosynthesis as well as chlorophyll and protein synthesis depended more or less on the availability of vitamins (Samiullah *et al.*, 1988). Vitamins with their antioxidants properties play an important role in plant defense against oxidative stress induces by surfactants and selected pesticides. Application of vitamins is accompanied with enhancing alpha kept glutaric acid biosynthesis which is interact with ammonia to form amino acids and proteins (Oretili, 1987) Vitamins are known as important factors responsible for enhancing growth and influencing many physiological process. There basic physiological significance connected with B₁ vitamin is its role as coenzyme in various types of decarboxylation. (Karabanov, 1977). Most of thiamine (B₁ vitamin) on plants is presented as free vitamin (Robinson, 1973). It has a pronounced role in photosynthesis Ascorbic acid (Vitamin C) as an antioxidant compound has an auxinic action and synergistic effect on the biosynthesis of carbohydrates and controlling the incidence of most fungi on plants.

Generally, the use of vitamins is safe for human animal and environment (Mer, 1995).

Amino acids considered as important antioxidants. They are responsible for enhancing cell division and, proteins and natural hormones and protecting plants from all stresses (Yagodin, 1990).

The results of Ma *et al.* (2001); Ma and Takahashi (2002); Kanto (2002) and Abd El-Hameed (2012) emphasized the beneficial effects of using silicon in enhancing growth and fruiting of fruit crops.

Vitamins are responsible for enhancing growth and fruiting of different grapevine cvs (Ahmed and Seleem – Basma, 2008; Abada and Abd El- Hameed, 2009; El- Kady- Hanaa, 2011; Ahmed *et al.*, 2012a & 2012b & 2012 c; Mohamed-Ebtesam, 2012 Abdelaal and Aly, 2013, Abdelaal *et al.*, 2014 and Abd El-Latif, 2014).

Previous studied showed that using amino acids was very essential in stimulating growth, vine nutritional status and yield in various grapevine cvs (Ahmed and Abd El- Hameed, 2003; Madian and Refaai, 2011; Abdelaal, 2012 and Abdelaal *et al.*, 2013).

The main objective of this study was elucidating the effect of spraying vitamins B & C, glutamic acid and silicon on fruiting of Superior grapevines.

2. Material and Methods

This study was carried out during 2013 and 2014 seasons on uniform in vigour 42 six – years old Superior grapevines in a private vineyard located at Luxor district where the texture of the soil is sandy soil. Vines are spaced at 2 x 3 m apart. The vines were planted during the first week of Jan. during both seasons. Cane pruning system using Gable supporting system was followed. Vine load was adjusted to 84 eyes for all the selected vines (in the basis of fruiting canes x twelve eyes plus six renewal spurts x two eyes). Drip irrigation system was followed using two drippers vine (Each drip drainage 4 L/h). Horticultural practices were carried out as usual except those dealing with the application of amino acids, vitamins B & C and silicon.

This study involved the following seven treatments:

- 1- Control (water sprayed vines)
- 2- Spraying two soluble in water vitamins namely vitamin B complex (B₁ + B₂ + B₆ + B₁₂) at 50 ppm in combined with vitamin C at 1000 ppm.
- 3- Spraying the essential amino acid namely glutamic acid at 1000 ppm.
- 4- Spraying vitamins B complex at 50 ppm plus vitamin C at 1000 ppm and glutamic acid at 1000 ppm.

- 5- Spraying vitamins B & C + potassium silicate at 0.1% (as a source of silicon).
- 6- Spraying glutamic acid plus silicon.
- 7- Spraying vitamins B & C + glutamic acid + silicon.

Each treatment was replicated three times, two vines per each. Spraying was done four times at growth start (2nd week of Mar) and at three week intervals (1st week of Apr., last week of Apr. 3rd week of May during both season). Triton B as a wetting agent was added to all spraying solutions at 0.05% and spraying was done till run off. All vitamins, glutamic acid and silicon treatments were applied at the recommended concentrations (Mohamed and Ebtesam, 2012). Randomized complete block design was followed.

During both seasons, the following parameters were recorded:

- 1- Vegetative growth characters namely main shoot length(cm.), number of leaves/ shoot and leaf area(cm²) (Ahmed and Morsy, 1999),
- 2- Plant pigments namely chlorophylls a & b, total chlorophylls and total carotenoids (mg/ 100 g F.W.) (according to Von- Wettstein, 1957).
- 3- Percentages of N, P, K, Mg and Ca as well as leaf content of Fe, Mn and Zn (as ppm) (according to Wild, *et al.*, 1985; Chapman and Pratt, 1987 and Balo *et al.*, 1988).
- 4- Berry setting %, yield, number of clusters/ vine as well as cluster weight and dimensions (length & width in cm), shot berries % berry weight (g.) and dimensions (equatorial and longitudinal in cm); T.S.S. %, total acidity %, (as tartaric acid) T.S.S./ acid and reducing sugars %.

Statistical analysis was done using new L.S.D. test at 5% (Mead *et al.*, 1993).

3. Results:

1- Effect of spraying vitamins B, C, glutamic acid and silicon on vegetative growth characters.

It is clear from the data in Table (1) that spraying Superior grapevines four times with vitamins B & C and glutamic acid as well as vitamins B & C plus glutamic acid with or without silicon significantly was responsible for stimulating the leaf area, number of leaves/ shoot and leaf area comparing with the control treatment. Single application of glutamic acid at 1000 ppm caused a significant stimulation on these growth traits rather than using vitamins B & C. Using vitamins plus glutamic acid was significantly favourable than using each alone in these respect. Using these vitamins and glutamic acid enriched with silicon was significantly very effective in enhancing these growth aspects compared to using vitamins and glutamic acid alone(without silicon). Using vitamins B & C, glutamic acid and silicon gave the maximum

values. The minimum values were recorded on untreated vines. These results were true during both seasons.

2-Effect of spraying vitamins B, C, glutamic acid and silicon on plant pigments and leaf content of N, P, K, Mg and Ca (as %) and Zn, Fe, Mn and Cu (as ppm)

Data in Tables (1 & 2) show that treating the vines with vitamins B & C and / or glutamic acid with or without the application of silicon significantly enhanced chlorophylls a, b, total chlorophylls, total carotenoids, N, P, K, Mg, Ca, Zn, Fe, and Mn in the leaves rather than the check treatment. Using glutamic acid was superior than using vitamins in this respect. Combined application of vitamins and glutamic acid was preferable than using each alone in this connection. Supplying the vines with silicon besides all vitamins and glutamic acid was significantly very effective in enhancing plant pigments and different nutrients rather than application of vitamins and glutamic acid alone. The maximum values were recorded on the vines that supplied with vitamins B & C, glutamic acid and silicon. The untreated vines produced the minimum values. The present treatments had no significant effect on the leaf content of Cu. Similar results were announced during 2013 & 2014 seasons.

3- Effect of spraying vitamins B, C, glutamic acid and silicon on berry setting %, yield and cluster characters:

It is revealed from the data in Tables (2 & 3) that supplying the vines via leaves with vitamins B & C and / or glutamic acid with or without using silicon significantly improved berry setting, yield expressed in weight and number of clusters/ vine as well as cluster weight and dimensions (length & width) over the check treatment. Using glutamic acid significantly surpassed the application of vitamins B & C and using both together significantly was superior than using each alone. Application of vitamins and glutamic acid in combined with silicon was significantly accompanied with improving berry setting, yield and cluster weight and dimensions comparing with using vitamins and glutamic acid without silicon. The maximum yield (8.2 & 10.9 kg) during both seasons, respectively were recorded on the vines that treated with vitamins, glutamic acid and silicon together. The untreated vines produced the minimum values (6.1 & 5.8 kg) during both seasons, respectively. The percentage of increase on the yield due to using the previous best treatment over the check treatment reached 34.4 and 87.9 % during both seasons, respectively. The present treatments had no significant effect on the number of clusters / vine in the first season of study.

4- Effect of spraying vitamins B, C, glutamic acid and silicon on the percentage of shot berries.

Data in Table (3) clearly show that spraying vitamins B & C and/ or glutamic acid with or without the application of silicon significantly was potent for controlling shot berries in the clusters of Superior grapevines rather than non – application. Supplying the vines with glutamic acid was significantly responsible for reducing shot berries % comparing with using vitamins. Using both vitamins and glutamic acid was significantly preferable than using each alone in this respect. In all cases, enriching vitamins and glutamic acid mixture with silicon was significantly responsible for reducing shot berries rather than using vitamins and silicon alone. The lowest shot berries during both seasons (3.2 & 2.9 %) was recorded on the vines that amended with vitamins B & C + glutamic acid + silicon. The highest values namely 8.6 and 8.3% were recorded on untreated vines during both seasons, respectively. These results were true during both seasons.

5- Effect of spraying vitamins B, C, glutamic acid and silicon on quality of the berries.

It is evident from the data in Table (3) that carrying out four sprays of vitamins B & C and/ or glutamic acid with or without using silicon significantly was very effective in improving quality of the berries in terms of increasing berry weight & dimensions, T.S.S. %, T.S.S./ acid and reducing sugars % and decreasing total acidity % relative to the check treatment. There was a significant promotion on the quality of the berries with using glutamic acid rather than using vitamins. Using all vitamins plus glutamic acid was significantly favourable in promoting quality when compared with using any one alone. Enriching vitamins and glutamic acid with silicon was significantly favourable than using vitamins and glutamic acid alone in enhancing quality of the berries. The best results with regard to quality of the berries were recorded when the vines were sprayed four times with a mixture of vitamins B & C, glutamic acid and silicon. Unfavourable effects on fruit quality were recorded on untreated vines. These results were true during both seasons.

b) Discussion

The beneficial effects of silicon on increasing the tolerance of plants to all stresses (**Kanto, 2002 and Epstein and Bloom, 2003**) could explain the present results.

The promoting effect of silicon on growth and fruiting of Superior grapevines was supported by the results of **Abd El- Hameed (2012)**.

The positive action of vitamins on enhancing cell division, the biosynthesis of sugars, plant pigments and natural growth regulators as well as enhancing the resistance of plants to all unfavourable

environment (Samuiullah *et al.*, 1988) could explain the present results.

The results of Abdelaal and Aly (2013), Abdelaal *et al.*, (2014) and Abd El-Latif (2014) confirmed the present results concerning the great benefits of vitamins on growth and fruiting. The

beneficial effects of glutamic acid as an essential amino acid on counteracting the adverse effects of all stresses around the trees as well as its effect on forming proteins and other related compounds (Yagodin, 1990) could explain the present results.

Table (1): Effect of single and combined application of vitamins B& C, glutamic acid and silicon on some vegetative growth characters and chlorophylls a and b, total chlorophylls and percentages of N, P and K in the leaves of Superior grapevines during 2013 & 2014 seasons.

Treatments	Main shoot length (cm.)		No. of leaves shoot		Leaf area (cm ²)		Chlorophyll a (mg/ 100 g F.W.)		Chlorophyll b (mg/ 100 g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	90.3	91.0	14.0	13.0	105.3	106.6	13.3	14.0	4.1	4.3
Vitamins B + C	94.0	95.0	15.3	15.0	107.0	108.3	15.0	15.8	4.8	5.3
Glutamic acid	95.9	96.7	17.0	16.7	108.6	110.0	17.6	18.3	5.6	6.6
Vitamins B+C+glutamic	98.9	99.0	18.5	18.6	110.0	112.0	18.9	20.0	6.6	7.5
Vitamins B+C+silicon	101.3	102.6	19.6	19.3	111.9	114.0	21.0	21.9	6.9	8.5
Glutamic acid + silicon	105.5	106.7	20.7	21.0	113.0	116.0	23.0	24.0	9.9	10.0
Vitamins B + C + glutamic + silicon	110.3	112.0	24.3	23.3	121.9	124.0	25.6	26.6	11.0	11.3
New L.S.D. at 5%	1.1	1.0	1.0	1.0	0.7	0.8	0.7	0.8	0.4	0.4
Character	Total chlorophylls (mg/ 100 g F.W.)		Total carotenoids (mg/ 100 g F.W.)		Leaf N %		Leaf P %		Leaf K %	
Control	17.4	18.3	3.9	3.8	1.62	1.60	0.12	0.10	1.21	1.18
Vitamins B + C	19.8	21.1	4.4	4.5	1.71	1.73	0.15	0.14	1.29	1.28
Glutamic acid	23.2	24.9	5.0	5.2	1.80	1.81	0.17	0.16	1.37	1.38
Vitamins B+C+glutamic	25.5	27.5	5.3	5.9	1.91	1.90	0.20	0.19	1.45	1.44
Vitamins B + C + silicon	28.9	30.4	5.6	7.2	1.98	1.99	0.22	0.22	1.52	1.50
Glutamic acid + silicon	32.9	34.0	6.6	7.6	2.09	2.10	0.24	0.25	1.59	1.56
Vitamins B + C + glutamic + silicon	36.6	37.9	7.2	7.9	2.21	2.23	0.27	0.29	1.66	1.62
New L.S.D. at 5%	0.5	0.5	0.3	0.3	0.06	0.06	0.02	0.02	0.05	0.05

Table (2): Effect of single and combined application of vitamins B& C, glutamic acid and silicon on the leaf content of Mg and Ca (as %) and Zn, Fe, Mn and Cu (as ppm) as well as percentage of berry setting, yield per vine and cluster weight of Superior grapevines during 2013 & 2014 seasons.

Treatments	Leaf Mg %		Leaf Ca %		Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	0.61	0.59	2.91	3.00	41.2	42.0	50.5	51.0	40.0	40.9
Vitamins B + C	0.68	0.64	3.01	3.11	42.3	43.1	51.7	52.3	41.0	42.3
Glutamic acid	0.75	0.69	3.11	3.22	44.1	44.9	52.5	53.4	41.9	44.0
Vitamins B + C + glutamic	0.80	0.75	3.24	3.31	45.2	46.0	53.5	55.0	43.3	46.0
Vitamins B + C + silicon	0.86	0.80	3.39	3.40	46.3	47.1	54.9	56.3	44.3	48.3
Glutamic acid + silicon	0.92	0.85	3.50	3.51	48.3	49.1	55.9	57.5	46.0	50.5
Vitamins B + C + glutamic + silicon	0.98	0.90	3.61	3.64	50.0	51.2	57.3	59.9	47.9	1.6
New L.S.D. at 5%	0.06	0.05	0.09	0.08	0.6	0.7	0.6	0.6	0.5	0.5
Character	Leaf Cu (ppm)		Berry setting %		No. of clusters per vine		Yield/ vine (kg.)		Cluster weight (g.)	
Control	1.11	1.10	8.0	7.3	18.0	18.0	6.1	5.8	341.0	343.0
Vitamins B + C	1.12	1.11	8.4	8.0	19.0	19.0	6.8	6.8	357.0	357.0
Glutamic acid	1.12	1.11	8.8	8.9	19.0	21.0	7.1	7.5	375.0	359.0
Vitamins B + C + glutamic	1.12	1.11	9.4	9.5	19.0	23.0	7.4	8.4	391.0	361.0
Vitamins B + C + silicon	1.13	1.11	10.0	10.1	19.0	24.0	7.8	8.9	410.0	369.0
Glutamic acid + silicon	1.14	1.11	10.4	10.5	19.0	25.0	7.9	9.4	415.0	375.0
Vitamins B + C + glutamic + silicon	1.14	1.11	10.9	11.0	19.0	27.0	8.5	10.9	430.0	400.0
New L.S.D. at 5%	NS	NS	0.3	0.3	NS	2.0	0.3	0.3	15.0	13.9

Table (3): Effect of single and combined application of vitamins B& C, glutamic acid and silicon on cluster dimensions, percentage of shot berries, berry weight and dimensions (longitudinal & equatorial), T.S.S. %, total acidity %, T.S.S. /acid and reducing sugars % in the berries of Superior grapevines during 2013 & 2014 seasons.

Treatments	Cluster (length cm)		Cluster width (cm.)		Shot berries %		Berry weight (g.)		Berry equatorial (cm.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	21.5	22.4	13.0	12.9	8.6	8.3	3.33	3.40	1.90	1.89
Vitamins B + C	22.3	23.2	13.7	13.8	8.0	7.7	3.51	3.59	1.99	2.00
Glutamic acid	23.0	24.0	14.5	14.4	7.4	7.1	3.65	3.73	2.11	2.12
Vitamins B + C + glutamic	23.9	25.0	15.5	15.6	6.8	6.5	3.89	3.99	2.25	2.25
Vitamins B + C + silicon	24.7	25.8	16.6	16.7	5.0	4.7	4.11	4.18	2.40	2.41
Glutamic acid + silicon	25.9	27.0	17.2	17.3	4.1	3.7	4.41	4.51	2.55	2.56
Vitamins B + C + glutamic + silicon	27.0	27.9	18.0	18.1	3.2	2.9	4.74	4.80	2.69	2.70
New L.S.D. at 5%	0.6	0.6	0.5	0.5	0.4	0.4	0.11	0.12	0.07	0.06
Character	Berry longitudinal (cm)		T.S.S. %		Total acidity %		T.S.S. /a cid		Reducing sugars %	
Control	2.11	2.07	18.0	17.9	0.721	0.717	25.0	25.0	15.9	16.0
Vitamins B + C	2.22	2.25	18.4	18.3	0.680	0.691	27.1	26.5	16.3	16.2
Glutamic acid	2.33	2.35	18.9	18.8	0.655	0.660	28.9	28.5	16.6	16.5
Vitamins B + C + glutamic	2.50	2.52	19.3	19.4	0.630	0.640	30.6	30.3	16.8	16.7
Vitamins B + C + silicon	2.80	2.81	19.7	19.7	0.610	0.611	32.3	32.3	17.1	17.0
Glutamic acid + silicon	3.00	3.01	20.0	20.1	0.580	0.582	34.5	34.5	17.4	17.3
Vitamins B + C + glutamic + silicon	3.06	3.07	20.4	20.5	0.560	0.559	36.4	36.7	17.6	17.7
New L.S.D. at 5%	0.04	0.04	0.3	0.3	0.020	0.018	1.2	1.3	0.2	0.2

These results regarding the promoting effect of amino acids on fruiting of Superior grapevines are in concordance with those obtained by **Ahmed and Abd El Hameed (2003); Madian and Refaai (2011) and Abdelaal (2012)**.

Conclusion:

The best results with regard to yield and berries quality of Superior grapevines were obtained by spraying the vines four times with a mixture of vitamins B complex ($B_1+B_2+B_6+B_{12}$) at 50 ppm vitamin, C at 1000 ppm glutamic acid at 1000 ppm & potassium silicate at 0.1%.

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