

Growth and Vine Nutrients of Status of Superior Grapevines As Affected By Application of Silicon and Vitamin B

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Abstract: During 2016 and 2017 seasons Superior grapevines were subjected to three sprays of potassium silicate at 0.05 to 0.2 % and/or vitamins B (B₁+ B₂+B₆+B₁₂) at 25 to 100 ppm. The merit was examining the effect of these treatments on main shoot length, number of leaves/shoot, leaf area, wood ripening coefficient, cane thickness and pruning wood weight, photosynthetic pigments, leaf content of N, P, K, Mg, Ca, Zn, Fe, Mn and Cu. Single and combined applications of potassium silicate at 0.05 to 0.2 % and vitamin B at 25 to 100 ppm were responsible for stimulating all growth aspects and all chemical components except Cu over the control. The promotion on these growth and chemical parameters was associated with increasing concentrations of each material without material promotion among the higher two concentrations. Using potassium silicate was superior than using vitamins B in this respect. Combined applications were favourable than using each material alone in this connection. Carrying out three sprays at growth start, just after berry setting and 21 days later with a mixture of potassium silicate at 0.1 % and vitamins B (B₁+ B₂+B₆+B₁₂) at 50 ppm was suggested to be beneficial for producing vigour Superior grapevines.

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Keywords: Silicon, vitamins B, Superior grapevines, growth, leaf chemical components.

1. Introduction

Many attempts were carried out for enhancing growth and vine nutritional status of Superior grapevines by using silicon and vitamins B (Samiullahet *al.*, 1988 and Ma, 2004). Using silicon (Al-Wasfy, 2014; Aklet *al.*, 2016; Farahat, 2017 and Metwally, 2017) and vitamins B (El-Kady-Hanaa, 2011; Mohamed-Ebtesam, 2012; Abdelaal, 2012 and Al-Wasfy, 2014) was very essential for enhancing growth and vine nutritional status of different grapevine cvs.

The target of this study was examining the effect of single and combined applications of silicon and vitamins B on growth and vine nutritional status of Superior grapevines.

2. Materials and Methods

This study was carried out during 2016 and 2017 seasons on 60 uniform in vigour 12 years old Superior grapevines grown in a private vineyard located at Kom Wally village, Matay district, Minia 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 x 3 m apart. The chosen vines (60 vines) were pruned during the first week of January in the two seasons using cane pruning method with the assistance of Gable 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. Surface irrigation system was followed using Nile water.

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

Table (1): Analysis of the tested soil:

Constituents	Values
Particle size distribution:	
Sand %	11.0
Silt %	22.5
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

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

This study included the following ten treatments from application of single and combined sprays of

silicon and vitamins B, in addition to the control treatment:

- 1- Control (untreated vines).
- 2- Spraying potassium silicate at 0.05 %
- 3- Spraying potassium silicate at 0.1 %
- 4- Spraying potassium silicate at 0.2 %
- 5- Spraying vitamins B (B1, B6, B12) at 25 ppm
- 6- Spraying vitamins B (B1, B6, B12) at 50 ppm
- 7- Spraying vitamins B (B1, B6, B12) at 100 ppm
- 8- Spraying potassium silicate and vitamins B at low concentrations
- 9- Spraying potassium silicate and vitamins B at medium concentrations
- 10- Spraying potassium silicate and vitamins B at high concentrations

Each treatment was replicated three times, two vines per each (60 vines). Silicon (pure %) and the four vitamins (Vit B: Vitamin B complex (B1: Thiamine; B2: Riboflavin; B6: Pyridoxine; B12: Cyanocobalamin); were sprayed three times at growth start (1st week of March, just after berry setting (mid. of April) and at three weeks later (1st week of May).

Triton B as a wetting agent was used with all vitamins treatments 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 (0.05%).

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

The following measurements were recorded during the two experimental seasons:

I Measurements of vegetative growth characters:

At the middle of June, the following growth aspects were recorded:

1-Average main shoot length (cm.) as a result of measuring the length of the ten labeled main shoots per vine and then the average was estimated.

1. Average leaf area (cm²) as a result of measuring the diameter of twenty mature leaves from those opposite to the basal clusters on the main shoots (**Baloet et al., 1985**).

Leaf area (cm²) was measured using the following equation as outlined by **Ahmed and Morsy (1999)**.

Leaf area (cm²) = 0.45 (0.79 × d²) + 17.77, where d is the maximum diameter of leaf, then the average leaf area was registered.

2. Wood ripening coefficient was measured by dividing the length of brownish part of the cane by the total length of cane just before pruning date (1st week of January) (**Bourad, 1966**).

3. Just after carrying out winter pruning, the weight removal of 1-year old pruning wood per each vine was recorded (kg/ vine).

4. For each vine five canes were selected just before Winter pruning (1st week of January) for measuring the cane thickness (mm) by using Vernier caliper.

2- Number of leaves/ shoot.

3- Average leaf area (cm²) as a result of measuring the diameter of twenty mature leaves from those opposite to the basal clusters on the main shoot/ vine.

Leaf area (cm²) was measured using the following equation that outlined by **Ahmed and Morsy (1999)**.

Leaf area (cm²) = 0.45 (0.79 × maximum diameter of leaf) + 17.77 then average leaf area was registered.

3 Measurements of plant pigments:

Samples of five mature and fresh leaves from those leaves opposite to the basal clusters on each shoot were taken at the middle of June during the three seasons and cut into small pieces and 0.05 g weight from each sample was taken, homogenized and extracted by 25% acetone in the presence of little amounts of Na₂CO₃ then filtered. The residue was washed several times with acetone until the filtrate became colourless. The extract was completed to a known volume (20 ml) with acetone 85%. A portion of this extract was taken for the determination of chlorophylls A and B colourimetrically and acetone (85 % V/V) was used as a blank (as mg/ 100 g F.W). The optical density of the filtrate was determined at the wave length of 662 and 664 nm to determine chlorophylls A and B, respectively. Concentration of each pigment was calculated by using the following equations according to **Von-Wettstein (1957) and Hiscox and Isralstam (1979)**.

Cl. A = (9.784 × E 662) – (0.99 × E 644) = mg / 100 g FW

Cl. B = (21.426 × E 644) – (4.65 × E 622) = mg /100 g FW

Where E = optical density at a given wavelength. Total chlorophylls was estimated by summation of chlorophyll a plus chlorophyll b (mg/ 100 g. F.W)

Total carotenoids = (4.965 × E440- 0.268 (chl.a + chl.b)

Where E = optical density at a given wave length. Total chlorophylls was calculated by summation of chl. a and chl. b. These plant pigments were calculated as (mg/100 g F.W.).

4 Measurements of leaf chemical composition:

Twenty leaves picked from the main shoots opposite to the basal clusters (according to **Balo et al., 1988**) for each vine were taken at the middle of June during the three seasons. Blades of the leaves were discarded and petioles were saved for determining different nutrients. Petioles were oven dried at 70°C and grind then 0.5 g weight of each sample was digested using H₂SO₄ and H₂O₂ until clear solution was obtained (according to **Wilde et al. 1985**). The digested solutions were quantitatively transfer to 100 ml volumetric flask and completed to 100 ml by distilled water. Thereafter, leaf contents of N, P, K, Mg, Ca, Zn, Fe, Mn and Cu were determined as follows:

1-N % by the modified micro Kejldahl method as described by **Chapman and Pratt (1965)**.

2- P % by using Olsen method as reported by **Wilde et al., (1985)**.

3- K % by using flame photometer as outlined by (**Chapman and Pratt (1965)**).

4- Mg and Ca by titration against EDTA (Versene method)

5- Micronutrients namely Zn, Fe and Mn (as ppm) by using atomic absorption spectrophotometer according to **Wilde et al., (1985)**.

5- Statistical analysis:

The obtained data were tabulated and significantly analyzed according to **Mead et al., (1993)**. Differences between treatment means were compared during new L.S.D. test at 5% level of probability.

6. Results and Discussion

1- Effect of single and combined applications of silicon and vitamins B on some growth aspects:-

It is clear from the obtained data in Table (2) that single and combined applications of potassium silicate at 0.05 to 0.2 % and vitamins B at 25 to 100 ppm significantly was followed by stimulating the six growth traits namely main shoot length, number of leaves/shoot, leaf area, wood ripening coefficient, cane

thickness and pruning wood weight relative to the control. Using potassium silicate was significantly superior than using vitamins B in enhancing these growth aspects. There was a gradual promotion on these growth aspects with increasing concentrations of each material. Significant differences on these growth aspects were detected among the ten treatments except among the higher two concentrations of each material (0.1 and 0.4 % for potassium silicate and 50 and 100 ppm for vitamins B). Combined applications were significantly superior than using each material alone in this respect. The maximum values were recorded on the vines that received potassium silicate at 0.1 % plus vitamins B at 100 ppm. The lowest values were recorded on the untreated vines. Similar results were announced during both seasons.

2- Effect of single and combined applications of silicon and vitamins B on the leaf chemical components:-

It is evident from the obtained data in Tables (3 and 4) that subjecting Superior grapevines three times to potassium silicate at 0.05 to 0.2 % and vitamins B at 25 to 100 ppm either alone or in combinations had significant promotion on all chemical components namely chlorophylls a & b, total chlorophylls, total carotenoids, N, P, K, Mg, Ca, Zn, Fe and Mn relative to the control. The promotion was associated with increasing concentrations of each material. Using potassium silicate was significantly superior than using vitamins B in enhancing these leaf chemical components. Combined applications were favourable than using each material alone in enhancing these leaf chemical components. Increasing concentrations of each material from the medium to the high had no significant stimulation on these leaf components. The highest values were recorded on the vines that received both materials together at the higher concentrations. The untreated vines produced the lowest values. Leaf content of Cu was significantly unaffected with the present treatments. These results were true during both seasons.

Table (2): Effect of spraying silicon and/or vitamins B on some vegetative growth characteristics of Superior grapevines during 2016 and 2017 seasons

Treatments	Main shoot length (cm)		No. of leaves / shoot		Leaf area (cm) ²		Wood ripening coefficient		Cane thickness (cm)		Pruning wood weight (kg)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	109.1	109.4	16.0	16.0	106.3	107.0	0.66	0.65	1.14	1.14	1.61	1.59
K. Silicate at 0.05 %	111.1	111.4	20.0	22.0	112.0	112.7	0.80	0.81	1.30	1.29	1.91	1.90
K. Silicate at 0.1 %	113.0	113.3	22.0	23.0	114.0	114.8	0.83	0.85	1.35	1.34	2.01	2.00
K. Silicate at 0.2%	113.3	113.8	22.0	23.0	114.4	115.0	0.84	0.84	1.36	1.35	2.03	2.03
Vitamins B at 25 ppm	110.1	110.4	18.0	18.0	108.0	109.0	0.70	0.70	1.19	1.18	1.71	1.71
Vitamins B at 50 ppm	111.1	111.5	19.0	20.0	110.0	111.0	0.74	0.75	1.24	1.23	1.80	1.81
Vitamins B at 100 ppm	111.4	111.6	19.0	21.0	110.3	111.3	0.75	0.76	1.25	1.24	1.81	1.82
Both at low conc.	113.0	113.5	24.0	25.0	116.6	118.0	0.87	0.88	1.41	1.41	2.14	2.16
Both at medium conc.	115.0	115.3	26.0	26.0	118.9	120.0	0.90	0.92	1.46	1.47	2.24	2.27
Both at high conc.	115.2	115.5	26.0	26.0	119.0	120.3	0.91	0.93	1.47	1.48	2.25	2.28
New L.S.D. at 5%	1.0	1.1	1.0	1.0	1.4	1.3	0.03	0.03	0.03	0.02	0.04	0.05

Vitamins B = (B₁+B₂+B₆+B₁₂)

Table (3): Effect of spraying silicon and/or vitamins B on some photosynthetic pigments and percentages of N and P in the leaves of Superior grapevines during 2016 and 2017 seasons

Treatments	Chlorophyll a (mg/g F.W)		Chlorophyll b (mg/g F.W)		Total Chlorophylls (mg/g F.W)		Total carotenoids (mg/g F.W)		Leaf N %		Leaf P %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	4.90	4.81	1.00	1.02	5.90	5.83	1.03	1.07	1.57	1.59	0.117	0.119
K. Silicate at 0.05 %	5.19	5.09	1.21	1.24	6.40	6.33	1.24	1.29	1.83	1.88	0.147	0.150
K. Silicate at 0.1 %	5.30	5.20	1.27	1.30	6.57	6.50	1.30	1.35	1.90	1.95	0.155	0.158
K. Silicate at 0.2%	5.31	5.21	1.28	1.31	6.59	6.52	1.32	1.36	1.91	1.96	0.156	0.159
Vitamins B at 25 ppm	4.97	4.96	1.07	1.10	6.04	6.06	1.11	1.15	1.68	1.68	0.127	0.130
Vitamins B at 50 ppm	5.05	4.95	1.14	1.18	6.19	6.13	1.18	1.23	1.75	1.76	0.137	0.140
Vitamins B at 100 ppm	5.06	4.96	1.15	1.19	6.21	6.15	1.19	1.24	1.76	1.77	0.138	0.141
Both at low conc.	5.41	5.44	1.38	1.41	6.79	6.85	1.42	1.46	2.00	2.05	0.166	0.176
Both at medium conc.	5.52	5.55	1.45	1.48	6.97	7.03	1.53	1.55	2.06	2.12	0.175	0.185
Both at high conc.	5.53	5.56	1.46	1.49	6.99	7.05	1.54	1.56	2.07	2.13	0.176	0.186
New L.S.D. at 5%	0.05	0.06	0.05	0.04	0.05	0.07	0.05	0.04	0.05	0.07	0.008	0.007

Vitamins B = (B₁+B₂+B₆+B₁₂)

Table (4): Effect of spraying silicon and/or vitamins B on the leaf content of K, Mg and Ca (as %) and Zn, Mn, Fe and Cu (as ppm) of Superior grapevines during 2016 and 2017 seasons

Treatments	Leaf K %		Leaf Mg %		Leaf Ca %		Leaf Zn (ppm)		Leaf Mn (ppm)		Leaf Fe (ppm)		Leaf Cu (ppm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	1.10	1.14	0.49	0.51	2.00	1.99	49.1	50.0	52.9	53.0	46.1	45.1	0.89	0.91
K. Silicate at 0.05 %	1.36	1.40	0.67	0.67	2.23	2.22	57.0	57.8	60.5	60.6	51.1	50.1	0.91	0.91
K. Silicate at 0.1 %	1.44	1.48	0.74	0.73	2.30	2.29	59.5	60.4	63.0	63.9	53.3	52.5	0.91	0.91
K. Silicate at 0.2%	1.45	1.50	0.75	0.74	2.31	2.30	59.6	60.5	63.3	63.0	53.4	52.6	0.92	0.91
Vitamins B at 25 ppm	1.18	1.22	0.55	0.55	2.07	2.06	51.5	52.4	55.5	55.4	47.6	46.6	0.92	0.92
Vitamins B at 50 ppm	1.26	1.30	0.60	0.60	2.15	2.14	54.0	55.0	58.0	57.9	49.0	48.2	0.92	0.92
Vitamins B at 100 ppm	1.27	1.31	0.61	0.62	2.16	2.15	54.3	55.2	58.3	58.0	49.1	49.1	0.92	0.92
Both at low conc.	1.52	1.55	0.80	0.80	2.41	2.40	63.0	63.9	66.0	66.1	56.0	55.9	0.92	0.92
Both at medium conc.	1.60	1.63	0.84	0.85	2.48	2.47	65.6	66.5	68.9	96.0	58.0	57.9	0.92	0.92
Both at high conc.	1.61	1.64	0.85	0.86	2.49	2.48	65.7	66.6	68.9	69.1	58.3	58.0	0.92	0.92
New L.S.D. at 5%	0.05	0.06	0.03	0.04	0.06	0.07	2.0	2.1	1.9	2.0	1.3	1.4	NS	NS

Vitamins B = (B₁+B₂+B₆+B₁₂)

4. Discussion

The outstanding effect of silicon on growth and fruiting of the various fruit crops is mainly attributed to its essential roles in enhancing the tolerance of fruit crops to biotic (pests) and abiotic (climatic and soil environmental conditions) stresses, the biosynthesis of organic foods (proteins, fats and carbohydrates), uptake of water and essential nutrients, plant organ strength, plant development, enzyme activities and the retained water. The beneficial effects of silicon on forming double layers on plant tissues could explain its effect on protecting the trees from higher transpiration rate and the incidence of different disorders. Previous studies supported the important roles of silicon as antioxidant on protecting the plant cells from aging and senescence through chelating free radicals namely OH and O₃ as well as preventing the formation of reactive oxygen species (ROS) from destroying the permeability of cell walls. Consequently, oxidation process is stopped (Ma, 2004).

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 favour of enhancing yield and fruit quality. (Samiullah *et al.*, 1988).

These results are agreement with those obtained by Al-Wasfy, 2014; Akl *et al.*, 2016; Farahat, 2017 and Metwally, 2017) worked in silicon and (El-Kady-Hanaa, 2011; Mohamed-Ebtesam, 2012; Abdelaal, 2012 and Al-Wasfy, 2014) worked on vitamins.

Conclusion

Carrying out three sprays at growth start, just after berry setting and at 21 days later with a mixture of potassium silicate at 0.1 % and vitamins B (B₁+B₂+B₆+B₁₂) at 50 ppm was suggested to be beneficial for producing vigour Superior grapevines.

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