Journal of Horticultural Science & Ornamental Plants 9 (3): 138-143, 2017
ISSN 2079-2158

DOI: 10.5829/idosi.jhsop.2017.138.143

Promoting the Productivity of Early Sweet Grapevines Grown under Sandy Soil Conditions by Using Glutamic Acid and Potassium Silicate

Haitham Mohamed Allam Mohamed

Viticulture Research Department, Hort. Res. Instit. A.R.C., Giza, Egypt

Abstract: This study was carried out during 2016 and 2017 seasons to assess the effect of single and combined application of glutamic acid and potassium silicate at 0.0125 to 0.1 % on growth, nutritional status, yield and quality of the berries in Early sweet grapevine cv. Subjecting the vines to glutamic acid and/or potassium silicate each at 0.0125 up to 0.1 % was accompanied with enhancing main shoot length, leaf area, N, P, K, yield and quality of the berries over the control treatment. The promotion was related to the increase in concentration without significant effect among the higher two concentrations namely 0.05 and 0.1 %. using potassium silicate was superior than using glutamic acid in this respect. using a mixture of glutamic acid and potassium silicate each at 0.05 % three times recorded the best results with regard to yield and quality of Early sweet grapevines grown in sandy soil under Minia region conditions.

Key words: Early sweet grapevines · Glutamic acid · Potassium silicate · Growth · Nutritional status · Yield · Berries quality

INTRODUCTION

Many attempts were accomplish for promoting the yield and quality of berries in grapevine cv. Early sweet grown under sandy soil by using untraditional methods namely application of glutamic acid and silicon.

Amino acids as antioxidants are responsible for building natural hormones, proteins, enzymes, plant pigments, vitamins, antioxidants and most organic foods in the plants [1, 2]. Also, they are essential in enhancing the tolerance of plant to biotic and abiotic stresses [3].

Silicon as an important antioxidant is responsible in enhancing the tolerance of plants to biotic and abiotic stresses, photosynthesis, water economy, leaf water potential, water transport and reducing different disorders especially powdery mildew in grapes [2, 4] .

Ahmed and Abd El-Hameed [5], Amin [6], Ahmed *et al*. [7] on Red Roomy grapevines; Seleem-Basma and Abd El-Hameed [8], Sayed-Heba [9], Ahmed *et al*. [10] on Thompson Seedless grapevines; El-Khawaga [11], Mohamed [12] on Superior grapevines; Uwakiem [13] on Early Sweet grapevines; Mohamed [14] on Flame Seedless grapevines where they found that applications with different amino acids at 0.025 to 0.1 % was favourable for enhancing growth, nutritional status yield and quality compared with the control treatment.

Using silicon at 0.0125 to 0.1 % in most fruit crops was supported by the results of Abd El-Hameed [15] on Early Superior grapevines; Akl *et al.* [16] on Superior grapevines; Nagy-Dina [17] on Flame Seedless grapevines; Farhat [18] on Early Sweet grapevines; Masoud [19] on Superior grapevines to promote growth, vine nutritional status, yield and fruit quality over the check treatment.

The target of this study was examining the effect of spraying glutamic acid and/or potassium silicate at various concentrations on growth, yield and berries quality of Early sweet grapevines grown under sandy soil.

MATERIALS AND METHODS

This study was carried out during 2016 and 2017 seasons on 5 years old Early sweet grapevines on Polsen grapevine rootstock and grown in a private vineyard located at West Matay, Matay district, Minia Governorate where the texture of the soil is sandy, well drained and

Corresponding Author: Haitham Mohamed Allam Mohamed, Viticulture Research Department, Hort. Res. Instit. A.R.C., Giza, Egypt.

Table 1: Analysis of the tested soil

Constituents	Values	Constituents	Values
	Particle size distribution		
Sand%	81.0	O.M. %	0.5
Silt%	10.0	$CaCO_3$ %	4.9
Clay%	9.0	Total N%	0.02
Texture%	Sandy	Available P (Olsen method, ppm)	1.3
PH(1:2.5 extract)	8.01	Available K (ammonium acetate, ppm)	101.3
E. C.(1: 2.5 extract) ppm	1.9	-----	------
EDTA extractable micronutrients(ppm)			
Fe	0.4	Zn	0.4
Mn	0.3	Cu	0.1

with water table depth not less than two meters. Vines are spaced at 3.0 m. (between rows) and 2.0 m (between vines) (700 vines per /fed.)78 vines were chosen as uniform in vigour as possible. Pruning was done on the first week of Jan. during both seasons and the vine load for all the selected vines was adjusted to 72 eyes/vine (30 fruiting spurs x two eyes plus six replacement spurs x two eyes). Gable supporting system was followed. Surface irrigation system was formed.

Mechanical, physical and chemical analysis of the tested soil at 0.0 – 90.0 cm depth were carried out at the start of the experiment (Table 1) according to the procedures of Chapman and Pratt [20].

Except those dealing with the present treatments (application of Glutamic amino acids and Potassium silicate), all the selected vines (78 vines) received the usual horticultural practices which commonly used in the vineyard.

This experimental included the following thirteen treatments:

Control; spraying Glutamic acid 0.0125%, 0.025% .0.05%. 0.1%; spraying potassium silicate at .0125%, 0.025%, 0.05%, .0.1% spraying both Glutamic acid and potassium silicate at 0.0125%, 0.025%, 0.05% and 0.1%.

Each treatment was replicated three times, on two vines per each. Therefore, seventy-eight uniform in vigour of Early sweet grapevines were devoted for achieving of this experiment. Glutamic acid and potassium silicate (25 % Si + 10 % K_2O were sprayed three times at beginning of growth (last week of Feb.), just after berry setting (1st week of Apr.) and at one month later (1st week of May). Triton B as a wetting agent was used at 0.05% for all solutions of glutamic acid and potassium silicate extract and the spray was done till runoff (1-2 liter).

The present experiment was set up in a randomized complete block design (RCBD) with three replicates each consisted from two Early sweet grapevines.

During both seasons, the following measurements were recorded:

Average shoot length (cm):Was recorded during last week of may.

Average leaf area (cm^2): Twenty mature leaves per vine were picked form those leaves opposite to the first clusters on each shoot and the leaf area was estimated according to by using the following equation reported by Ahmed and Morsy [21] La = 0.45 (0.79 x w^2) +17.77.

Vine nutritional status: Twenty leaves from those opposite to the basal clusters were taken at first week of June and dried then the leaf N, P and K content were determined. N (%) was determined by the modified Micro kejldahel method as described by Wild *et al.* [22]. P (%) was determined by using olsen method as reported by Chapman and Pratt [23]. K (%) was flame photometrically determined using the method outlined by Chapman and Pratt [23].

Yield and berries quality: At harvest time the following parameters were determined. yield/ vine was expressed as number of clusters/ vine and weight (kg.). Clusters weight (g.) and dimensions (length & shoulder, in cm). Percentage of shot berries. Physical and chemical characteristics of the berries namely berry weight (g.), longitudinal and equatorial (cm), T.S.S.%, reducing sugars % [24], total acidity as g tartaric acid/100 ml juice according to A.O.A.C. [24] and T.S.S./ acid ratio was calculated.

All the obtained data were tabulated and statistically analyzed using New L.S.D. at 5% for made all comparisons among the investigated treatment means according to Snedecor and Cochran [25].

RESULTS AND DISCUSSION

Average Shoot Length and Leaf Area: Data in Table (2) clearly show that treating Early sweet grapevines with glutamic acid and/or potassium silicate each at 0.0125 to 0.1 % significantly stimulated the main shoot length and leaf area over the control treatment. There was a gradual stimulation on such two growth aspects with increasing

Table 2: Effect of spraying glutamic acid and potassium silicate on main shoot length, leaf area and percentages of nitrogen, phosphorus and potassium in the leaves of Early sweet grapevines during 2016 & 2017 seasons

	Main shoot length (cm)		Leaf area $(cm)^2$		Leaf N %		Leaf P %		Leaf K %	
Treatment	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	119.8	120.0	101.0	101.9	1.57	1.64	0.119	0.121	1.11	1.14
Glutamic acid at 0.0125 %	122.0	122.2	102.1	103.0	1.64	1.71	0.129	0.131	1.16	1.19
Glutamic acid at 0.025 %	124.3	124.5	103.4	104.3	1.71	1.76	0.140	0.140	1.21	1.24
Glutamic acid at 0.05 %	126.1	126.3	103.7	104.6	1.80	1.82	0.149	0.149	1.27	1.28
Glutamic acid at 0.1 %	126.3	126.4	105.0	106.0	1.81	1.83	0.151	0.150	1.28	1.29
Potassium silicate at 0.0125 %	128.9	129.1	108.0	109.0	1.89	1.90	0.161	0.164	1.33	1.34
Potassium silicate at 0.025 %	131.0	132.4	109.4	110.5	1.97	1.96	0.172	0.174	1.40	1.41
Potassium silicate at 0.05 %	133.3	134.7	110.9	112.0	2.04	2.04	0.183	0.185	1.47	1.46
Potassium silicate at 0.1 %	133.8	135.0	111.2	112.3	2.06	2.05	0.184	0.186	1.48	1.47
Both at 0.0125 %	136.9	138.0	112.4	113.6	2.15	2.15	0.195	0.199	1.59	1.57
Both at 0.025 %	140.0	141.0	114.5	115.6	2.24	2.23	0.211	0.210	1.70	1.69
Both at 0.05 %	142.0	144.0	116.7	117.8	2.33	2.34	0.231	0.219	1.76	1.77
Both at 0.1 %	142.4	144.5	116.9	117.9	2.34	2.36	0.233	0.222	1.77	1.78
New L.S.D at 5%	1.4	1.6	0.9	1.1	0.06	0.05	0.006	0.008	0.04	0.03

concentrations of each material. Increasing concentrations of glutamic acid and potassium silicate from 0.05 to 0.1 % failed to show was significantly Early sweet than using glutamic acid in promoting such two aspects.

Combined application surpassed the application of each material alone in this respect. The maximum values were recorded on the vines that treated three times with a mixture of glutamic acid and potassium silicate each at 0.1 %. The lowest values were recorded on untreated vines. These results were true during both seasons. The stimulating effect of amino acids on growth and fruiting of the Early sweet grapevines might be ascribed to the important of these amino acids on enhancing the biosynthesis of all types of prevented proteins, DNA, RNA, different enzymes, antioxidants, vitamins, cell division, building and movement of sugars and their roles as an important antioxidants the formation of ROS (reactive oxygen species).Their important roles in the biosynthesis of natural hormone namely tryptophane and methionene did not neglect in this respect [1, 2].

These results are in harmony with those obtained by Ahmed and Abd El-Hameed [5] on Red Roomy grapevines; El-Khawaga [11] on Superior grapevines; Uwakiem [13] on Early Sweet grapevines Mohamed [14] on Flame seedless grapevines. The effects of silicon on enhancing the tolerance of plants to biotic and abiotic stresses, photosynthesis and water uptake could result in stimulating growth aspects [4].

Vine Nutritional Status: Data in Table (2) obviously reveal that treating the vines three times with glutamic acid and/or potassium silicate each at 0.0125 to 0.1 % significantly was accompanied with enhancing N, P and K in the leaves rather than non-application. The promotion was associated with the increase in concentrations of both materials. Using potassium silicate was significantly superior than using glutamic acid in this respect. Using both materials together was significantly favourable than using each material alone in enhancing these nutrients. A slight promotion on these nutrients was observed with increasing concentrations of such two materials from 0.05 to 0.1 %. The maximum values of N (2.34 & 2.36 %), P (0.233 & 0.222 %) and K (1.77 & 1.78 %) were recorded on the vines that applied with both materials at 0.1 % during both seasons, respectively. The untreated vines produced the lowest values. These results were true during both seasons.

The promoting effect of glutamic acid on the tolerance of plants to biotic and abiotic stresses as well as uptake of nutrients could results in enhancing different nutrients [1]. Similar results were announced by Amin [6] on Red Roomy grapevines; Sayed-Heba [9] on Thompson seedless grapevines; Mohamed [12] on Superior grapevines and Uwakiem [13] on Early Sweet grapevines. Also, the effect of silicon on enhancing the uptake of water and nutrients could explain the present results [4]. Moreover, our results are in accordance with those obtained by Nage-Dina [17] on Flame Seedless grapevines; Farahat [18] on Early Sweet grapevines and Masoud [19] on Superior grapevines.

Yield as Well as Cluster Weight and Dimensions: It is worth to mention from the data in Table (3) that yield expressed in weight and number of clusters/vine (2^{nd} season) as well as cluster weight and dimensions

Table 3: Effect of spraying glutamic acid and potassium silicate on yield vine, cluster weight, dimensions and shot berries percentage of Early sweet grapevines during 2016 & 2017 seasons

Treatment	No. of clusters/vine		Cluster weight (g.)		Yield/vine (kg.)		Cluster length (cm.)		Cluster width (cm.)		Shot berries %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	27.0	26.0	370.0	374.0	10.0	9.7	26.3	25.9	15.3	15.4	9.1	8.9
Glutamic acid at 0.0125 %	27.0	28.0	380.0	385.0	10.3	10.8	27.0	26.8	15.8	15.9	8.7	8.5
Glutamic acid at 0.025 %	27.0	28.0	381.0	386.0	10.3	10.9	27.7	27.5	15.9	16.0	8.4	8.0
Glutamic acid at 0.05 %	27.0	28.0	382.0	387.0	10.3	10.8	28.3	28.3	16.0	16.1	8.0	7.5
Glutamic acid at 0.1 %	27.0	28.0	382.0	388.0	10.3	10.9	29.0	28.4	16.1	16.2	7.7	7.4
Potassium silicate at 0.0125 %	27.0	30.0	395.0	401.0	10.7	12.0	29.6	29.7	16.6	16.7	7.2	7.0
Potassium silicate at 0.025 %	28.0	30.0	396.0	402.0	11.1	12.1	30.2	30.5	16.8	16.9	6.7	6.6
Potassium silicate at 0.05 %	28.0	30.0	397.0	404.0	11.1	12.1	30.8	31.2	16.9	17.0	6.2	6.2
Potassium silicate at 0.1 %	28.0	30.0	398.0	405.0	11.1	12.2	30.9	31.3	17.0	17.1	6.1	6.1
Both at 0.0125 %	28.0	32.0	410.0	419.0	11.5	13.5	31.5	32.0	17.5	17.6	5.0	5.5
Both at 0.025 %	28.0	32.0	410.0	421.0	11.5	13.5	32.5	32.7	17.6	17.7	4.5	4.8
Both at 0.05 %	28.0	32.0	411.0	422.0	11.5	13.5	33.2	33.5	17.9	18.0	4.0	4.0
Both at 0.1 %	28.0	32.0	412.0	423.0	11.5	13.5	33.3	33.6	18.0	18.1	3.9	3.6
New L.S.D at 5%	NS	2.0	10.0	9.9	0.3	0.5	0.6	0.7	0.4	0.4	0.3	0.3

Table 4: Effect of spraying glutamic acid and potassium silicate on physical and chemical characteristics of the berries of Early sweet grapevines during 2016 & 2017 seasons

Treatment	Berry weight (g.)		Berry longitudinal (cm)		Berry equatorial (cm)		T.S.S. %		Reducing sugars %		Total acidity %		T.S.S./ acid ratio	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	3.91	3.94	2.39	2.41	1.90	1.91	17.0	16.9	16.0	15.8	0.684	0.677	24.9	25.0
Glutamic acid at 0.0125 %	3.99	4.05	2.46	2.48	1.94	1.96	17.3	17.3	16.2	16.1	0.660	0.660	26.2	26.2
Glutamic acid at 0.025 %	4.10	4.16	2.53	2.55	1.99	2.01	17.5	17.6	16.5	16.3	0.640	0.641	27.3	27.5
Glutamic acid at 0.05 %	4.20	4.27	2.60	2.62	2.04	2.07	17.8	18.0	16.8	16.6	0.617	0.620	28.8	29.0
Glutamic acid at 0.1 %	4.21	4.28	2.61	2.63	2.05	2.08	17.9	18.1	16.9	16.7	0.616	0.619	29.1	29.2
Potassium silicate at 0.0125 %	4.31	4.40	2.67	2.70	2.10	2.13	18.2	18.3	17.1	17.0	0.599	0.603	30.4	30.3
Potassium silicate at 0.025 %	4.42	4.51	2.73	2.77	2.15	2.18	18.6	18.7	17.4	17.3	0.571	0.585	32.6	32.0
Potassium silicate at 0.05 %	4.53	4.61	2.80	2.84	2.20	2.23	19.0	19.0	17.8	17.6	0.555	0.568	34.2	33.5
Potassium silicate at 0.1 %	4.55	4.62	2.81	2.85	2.21	2.23	19.1	19.1	17.9	17.7	0.550	0.567	34.7	33.7
Both at 0.0125 %	4.80	4.71	2.87	2.92	2.27	2.28	19.4	19.5	18.3	18.1	0.532	0.549	36.5	35.5
Both at 0.025 %	5.01	4.85	2.93	2.99	2.32	2.33	19.7	19.9	18.5	18.4	0.516	0.530	38.2	37.5
Both at 0.05 %	5.12	4.97	2.99	3.06	2.37	2.38	20.0	20.2	18.7	18.8	0.501	0.510	39.9	39.6
Both at 0.1 %	5.13	4.99	3.00	3.06	2.38	2.39	20.1	20.3	18.8	18.9	0.508	0.509	40.2	39.9
New L.S.D at 5%	0.08	0.10	0.06	0.07	0.04	0.05	0.2	0.3	0.2	0.2	0.015	0.016	1.1	1.0

(length and shoulder) were significantly improved in response to application of glutamic acid and/or potassium silicate each at 0.0125 % to 0.1 % over the control treatment. There was a gradual promotion on these parameters with increasing concentrations. Negligible promotion was observed on these parameters among the higher two concentrations namely 0.05 and 0.1 % from each material. Using potassium silicate was significantly favourable than using glutamic acid in improving yield and cluster aspects. Using both materials together was significantly superior than using each material alone in this respect. From economical point of view, the combined application of glutamic acid and potassium silicate each at 0.05 % gave the highest yield (11.5 & 13.5 kg) during 2016 and 2017 seasons, respectively. The percentage of increment on the yield due to using the recommended treated over the control treatment reached 15 and 39.2 % during both seasons, respectively. The untreated vines produced 10.0 & 9.7 kg during both seasons, respectively. Number of clusters/vine in the first season of study was significantly unaffected. The positive action of glutamic acid and potassium silicate on enhancing growth and vine nutritional status surely reflected on promoting the yield.

The promoting effect of glutamic acid on the yield was supported by the results of Seleem-Basma and Abd El-Hameed [8] on Thompson seedless grapevines; Ahmed *et al*. [10] on Thompson Seedless grapevines; Uwakiem [13] on Early Sweet grapevines and Mohamed [12] on Flame seedless grapevines. The present results with regard to the effect of silicon on the yield are in concordance with those obtained by Akl *et al*. [16] on Superior grapevines; Farahat [18] on Early Sweet grapevines and Masoud [19] on Superior grapevines.

Percentage of Shot Berries: As shown in Table (3), shot berries was significantly controlled by using glutamic acid and/or potassium silicate relative to the control treatment. The reduction was in proportional to the increase in concentrations. A significant decline on shot berries was noticed due to using potassium silicate relative to the application of glutamic acid. Using both materials together significantly reduced shot berries than using each material alone. The lowest shot berries (3.9 & 3.6 %) was observed on the clusters harvested from vines treated with both materials together at 0.1 %. The untreated vines produced the highest values (9.1 & 8.9 %) during both seasons, respectively. These results were true during both seasons.

The effect of glutamic acid and silicon on enhancing the tolerance of plants to unfavourable conditions could explain the present results [1, 4]. These results concerning the effect of amino acids on controlling shot berries are in agreement with those obtained by Amin [6] on Red Roomy grapevines; Ahmed *et al.* [7] on Red Roomy grapevines and Uwakiem [13] on Early Sweet grapevines. The results of Farahat [18] on Early Sweet grapevines and Masoud [19] on Superior grapevines supported the present results regarding the effect of silicon on controlling shot berries.

Quality of the Berries: It is clear from the data in Table (4) that supplying the vines with glutamic acid and/or potassium silicate each at 0.0125 to 0.1 % significantly was very effective in improving quality of the berries in terms of increasing berry weight and dimensions (longitudinal and equatorial), T.S.S.% and T.S.S./acid ratio and decreasing total acidity % relative to the control. The promotion was associated with increasing concentrations of each material. using potassium silicate was significantly accompanied with promoting quality of the berries over the application of glutamic acid. Combined application was significantly favourable than using each material alone in enhancing quality of the grapes. Increasing concentrations from 0.05 to 0.1 % from each material had no significant promotion on all quality parameters. The best results with regard to quality of the berries from economical point of view were obtained with treating the vines three times with a mixture of glutamic acid and potassium silicate each at 0.05 %. Unfavourable effects on quality of the berries were recorded on untreated vines. These results are true during both seasons. The beneficial effects of amino acids and silicon on photosynthesis, plant pigments and uptake of nutrients surely reflected on improving quality of the berries. The effect of glutamic acid and silicon on enhancing the tolerance of plants to unfavourable conditions could explain the present results [1, 4]. These results concerning the effect of amino acids on improving the yield are in agreement with those obtained by Amin [6] on Red Roomy grapevines; Ahmed *et al.* [7] on Red Roomy grapevines and Uwakiem [13] on Early Sweet grapevines. The results of Farahat [18] on Early Sweet grapevines and Masoud [19] on Superior grapevines supported the present results regarding the effect of silicon on promoting the yield and cluster weight.

CONCLUSION

From the above results, it could be concluded that, using a mixture of glutamic acid and potassium silicate each at 0.05 % three times (growth stat; just after berry setting and one month later) had obvious effect on vegetative growth, leaves mineral content, yield and fruit quality of Early sweet grapevines, grown under Minia region conditions.

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