

Berries Colouration, Yield and Fruit Quality Parameters As Influenced With Some Silicon and Summer Pruning Treatments

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Abstract: Berries colouration %, yield as well as physical and chemical characteristics of Red Globe grapes in response to spraying the vines with K-Silicate at 0.1 % and/or three summer pruning practices (pinching the main shoots, removing all leaves under clusters and removing all laterals on the main shoots) were investigated during 2016 and 2017 seasons. Summer pruning was carried out once just after berry setting. Potassium silicate was sprayed thrice at growth start, just after berry setting and one month later. Treating the vines with K-Silicate at 0.1 % either alone or with any summer pruning treatments (pinching the main shoots, removing all leaves under clusters and removing all laterals on the main shoots) considerably stimulated number of clusters per vine and yield expressed in weight (kg.), weight, length and shoulder of cluster, percentage of berries colouration, berry weight and dimensions, T.S.S. %, reducing sugars %, total anthocyanins (mg/g F.W) and decreased total acidity % in the berries relative to the control treatment. The promotion on these parameters was associated with removing laterals on the main shoots, removing all leaves under clusters and pinching the main shoots, in descending order. Using silicon besides any summer pruning treatments was measurably superior than using silicon alone in enhancing these parameters. Using more summer pruning treatments was obviously superior than using one summer pruning practice in this respect. The maximum values were obtained on the vines treated with silicon and subjected to all summer pruning treatments. Carrying out three sprays of K-Silicate at 0.1 % besides (pinching the main shoots, removing all leaves under clusters and removing all laterals on the main shoots) gave on acceptable yield and good berries quality of Red Globe grapevines.

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Keywords: Silicon, summer pruning practices, yield, berries colouration, physical and chemical characteristics of the berries.

1. Introduction

The outstanding effect of silicon on yield and berries quality in 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 ((Melo *et al.*, 2003; Ma, 2004 and Tahir *et al.*, 2006).

Using silicon was found by many authors to improve yield, berries colouration % and berries quality in different grapevine cvs (Abd El- Hameed, 2012; Al-Wasfy, 2014; El- Khawaga, 2014; Uwakiem, 2015; Wassel *et al.*, 2015; Nagy-Dina, 2016; Akl *et al.*, 2016; Farahat, 2017 and Masoud, 2017).

It is worth mentioning that, the majority of grape growers in Egypt either do not apply summer pruning practices in their vineyards or carry out them incorrectly or at the improper time with the result of which most of the current season shoots do not ripen well, perhaps due to the consumption of assimilates manufactured in the leaves for the continuity of shoot growth instead of being stored in the shoots possibly required as canes for the subsequent winter pruning (Silvestroni *et al.*, 1994).

Light plays an exceptionally important role in the life of fruit trees. Light is indispensable for the

synthesis of organic substances in leaves, acts as an activator and determines the speed of the growth and development of plant organs. Light is an important ecological factor. As light intensity increases photosynthesis rate in fruit trees considerably increases. Most fruit trees are light-lovers. With inadequate light their growth and bearing are impaired. The aim of summer pruning is principally arranged as follows to according to **Campostrini and Seriana (2003)**.

These results might be attributed to the following merits of summer pruning.

- 1- Reducing competition on mineral and organic nutrients for the remaining shoots.
- 2- The promotion on the growth of the remaining shoots.
- 3- Obtaining the highest reserved of organic foods.
- 4- The stimulation in the assimilation in the remaining leaves.
- 5- The improvement in the distribute on of photosynthesis products.
- 6- The great control of fungal and disease attack.
- 7- The reduction of shade during growth.
- 8- The increase in light intensities or penetration within the canopy.

Carrying out summer pruning at the optimum time was responsible for enhancing yield, berries colouration % and berries quality in different grapevine cvs (**Ibrahiem-Alia et al., 2001; Ibrahiem-Asmaa 2001; Marengi, 2002; Poni et al., 2002; Valor and Bautista, 2002; Petrie et al., 2003 and Abada, 2005**).

Thus, this study aimed to examine the effect of silicon and summer pruning on yield, berries colouration and berries quality of Red Globe grapevines grown under Minia region conditions.

2. Materials and Methods

This study was carried out during 2016 and 2017 seasons on 54 uniform in vigour 10-years old own-rooted Red Globe grapevines. The selected vines are grown in a private vineyard located at Al- Kessey private vineyard located at Matay district, Minia Governorate, where the texture of the soil is clay (Table 1). Soil analysis was done according to the procedures that outlined by **Wilde et al., (1985)**.

The selected vines are planted at 1.5 x 3 meters apart. The chosen vines were trained by spur pruning method leaving 66 eyes/ vine (on basis of 18 fruiting spurs x 3 eyes plus 6 replacement spurs/ two eyes) using Gable supporting system. Winter pruning was carried out at the first week of Jan. during both seasons. Surface irrigation system was followed using Nile water.

Table (1): Analysis of the tested soil

constituent	Values
Sand %	5.9
Silt %	15.0
Clay %	79.1
Texture	clay
O.M. %	2.49
pH (1: 2.5 extract)	7.95
EC (1:2.5 extract) (mmhos/cm/25°C)	0.89
CaCO ₃ %	2.11
Total N %	0.09
Available P (Olsen method, ppm)	4.90
Available K (ammonium acetate, ppm)	480

Except those dealing with the present treatments (application of potassium silicate and Summer pruning practices), the selected vines (54 vines) received the usual horticultural practices that are commonly applied in the vineyard.

This study consisted from the following nine treatments:

- 1- Control treatment.
- 2- Spraying potassium silicate at 0.1% (g/l)
- 3- Spraying potassium silicate at 0.1%+ pinching the main shoots.
- 4- Spraying potassium silicate at 0.1%+ removing all leaves under clusters.
- 5- Spraying potassium silicate at 0.1%+ removing all lateral shoots on the main shoots.
- 6- Spraying potassium silicate at 0.1%+ pinching the main shoots + removing all leaves under clusters.
- 7- Spraying potassium silicate at 0.1%+ pinching the main shoots+ removing all lateral shoots on the main shoots.
- 8- Spraying potassium silicate at 0.1%+ removing all leaves under clusters+ removing all lateral shoots on the main shoots.
- 9- Spraying potassium silicate at 0.1%+ all summer pruning practices (pinching the main shoots, removing all leaves under clusters and removing all lateral shoots on the main shoots)

Each treatment was replicated three times, two vines per each. The total vines selected for achieving of this experiment were 54 vines. Pinching the main shoots was carried once by cutting 3 cm from shoot tips. Summer pruning practices were conducted once just after berry setting (middle of May). Potassium silicate (25% Si+ 10% K₂O) was sprayed three times at growth start (middle of April), just after berry setting (middle of May) and at one month later (middle of June). Triton B as a wetting agent at 0.1% was added to silicon solutions and spraying was done till runoff.

Randomized complete block design (RCBD) was adopted for carrying out statistical analysis of the obtained data (**Rangaswamy, 1995 and Rao, 2007**), where the present experiment contained nine treatments and each treatment was replicated three times two vines per each.

Harvesting took place when T.S.S./ acid in the berries of the check treatment reached at least 25: 1 (according to **Winkler et al., 1974 and Weaver, 1976**). The yield of each vine was recorded in terms of weight (in kg.) and number of clusters per vine, then the average weight of cluster (g.) was recorded. Five clusters per each vine were taken at random for determinations of the following physical and chemical characteristics of the berries:

1- Cluster dimensions (length and shoulder, cm).

2- Berries colouration % was estimated by counting the number of red berries and dividing this number by the total number of berries per cluster and multiplying the product x 100.

3- Average berry weight (g.) and dimensions (longitudinal and equatorial, cm)

4- Percentage of total soluble solids in the juice by using a hand refractometer.

5- Percentage of total titratable acidity (as gram tartaric acid / 100 ml juice) by titration against 0.1 N NaOH using phenolphthalein as indicator (**A.O.A.C, 2000**).

6- Percentage of reducing sugars in the juice by using **Lane and Eynon (1965)** volumetric method as described in **A.O.A.C. (2000)**.

7- Total anthocyanins in the berries by using ethyl alcohol and HCL method (mg / 100 g F.W.) (**Fulcki and Francis, 1968**).

Statistical analysis:

The proper statistical analysis was done. Treatment means were compared using new L.S.D. at 5% (according to **Mead et al., 1993**).

3. Results and Discussion

Effect of silicon and summer pruning treatments on yield:

Data in Table (2) show the effect of silicon and summer pruning treatments on yield expressed in number of clusters per vine and weight (kg.) of Red Globe grapevines during 2016 and 2017 seasons.

Treating the vines with K-silicate at 0.1 % alone or with any summer pruning treatments significantly was accompanied with improving yield expressed in number of clusters/vine and weight (kg.) relative to the control. Combined application of silicon and summer pruning treatments was significantly preferable than using silicon alone in improving the yield / vine. The best summer pruning practice was the removal of lateral on the main shoots followed by the removal of

leaves under clusters. Pinching the main shoots occupied the last position in this respect. Using more than one practice of summer pruning with silicon was significantly favourable than using one practice in improving the yield per vine. Using all summer pruning practice in (removal of laterals on main shoots and cutting leaves under clusters and pinching the main shoots) besides spraying K-silicate at 0.1 % gave the best results with regard to the yield. Under such promised treatment yield/vine reached (26.2 & 31.3 kg) during both seasons, respectively compared with the yield of untreated vines that reached (18.6 & 18.9 kg) during both seasons. The percentage of increment on the yield due to using the previous promised treatment above the control treatment reached 40.9 & 65.6 % during both seasons, respectively. Number of clusters in 2016 season was unaffected by the present treatment.

Effect of silicon and summer pruning treatments on weight, length and shoulder of cluster

Data in Table (2) show the effect of silicon and summer pruning treatments on weight, length and shoulder of cluster of Red Globe grapevines during 2016 and 2017 seasons.

It is evident from the obtained data that weight, length and shoulder of cluster were significantly promoted due to using silicon alone or with any summer pruning practices over the control treatment. Using silicon with any summer pruning practice significantly succeeded in improving weight and dimensions of clusters than using silicon alone. Carrying out summer pruning by removing laterals on the shoots considered the prime method followed by removing the leaves under clusters and pinching the main shoots ranked the last position in this respect. Combined application of summer pruning was significantly preferable than single summer in enhancing weight, length and shoulder of cluster. The heaviest clusters (819 & 824 g) were borne on the vines that received all summer pruning treatments besides the spray of silicon during both seasons, respectively. The lowest weight of clusters and dimensions was recorded on untreated vines. These results were true during both seasons.

Effect of silicon and summer pruning treatments on the percentage of berries colouration:

Data in Table (2) show the effect of silicon and summer pruning treatments on the percentage of berries colouration of Red Globe grapevines during 2016 and 2017 seasons.

Percentage of berries colouration was significantly hastened with treating the vines with silicon alone or with any summer pruning practices relative to the control. Using silicon besides any summer pruning practices significantly was superior than using silicon alone in advancing berries

colouration. The beneficial effects of the three summer pruning practices on enhancing berries colouration could be arranged as follows, in descending order, removal of laterals and leaves under clusters and pinching the main shoots. Using more than one practice of summer pruning was significantly favourable than using one practice in improving berries colouration %. The best berries colouration (89.9 & 91.0 %) was recorded during both seasons, respectively in the vines that treated with silicon and all summer pruning practices. The value of berries colouration in the untreated vines reached (67.1 & 68.1 %) during both seasons, respectively. These results were true during both seasons.

Effect of silicon and summer pruning treatments on some physical and chemical characteristics of the berries:

Data in Table (3) show the effect of silicon and summer pruning treatments on berry weight, longitudinal and equatorial, T.S.S. %, reducing sugars %, total anthocyanins (mg/g F.W) and total acidity % in the berries of Red Globe grapevines during 2016 and 2017 seasons.

It is noticed from the obtained data that treating the vines with K-silicate at 0.1 % with or without summer pruning practices had significant promotion on fruit quality in terms of increasing berry weight, longitudinal and equatorial, T.S.S. %, reducing sugars %, total anthocyanins (mg/g F.W) and decreasing total acidity % relative to the control. The promotion on berries quality was significantly related to the use of silicon with any summer pruning practice relative to the use of silicon alone. The best practice of summer pruning responsible for enhancing quality of the berries were removal of laterals on the main shoots and leaves under clusters and pinching the main shoots, in descending order. Combined summer pruning removing practice with silicon was significantly preferable than using and practice of summer pruning. The best results with regard to quality of the berries were obtained due to treating the vines with K-silicate at 0.1 % besides. Carrying out all summer pruning practices (removal laterals and leaves under clusters and pinching the main shoots). The untreated vines produced unfavourable effects on quality of the berries. These results were true during both seasons.

Table (2): Effect of spraying Silicon and some summer pruning treatments Yield, cluster aspects and berries colouration % of Red Globe grapevines during 2016 & 2017 seasons

Treatment	No of clusters /vine		Yield /vine (kg.)		Cluster weight (g.)		Cluster length (cm)		Cluster shoulder (cm)		Berries colouration %	
	2016	2017	2016	2017	2016	2017			2016	2017	2016	2017
Control	31.0	31.0	18.6	18.9	600	610	28	27.9	14.0	13.9	67.1	68.1
K-Silicate at 0.1 %	31.0	33.0	19.8	21.2	640	641.0	29.1	29.0	14.4	14.5	68.9	70.0
K-Silicate + pinching main shoots	32.0	35.0	21.8	23.8	680	681.0	30.5	30.6	15.0	14.9	70.4	71.5
K-Silicate + removal of leaves	32.0	37.0	22.7	26.3	710	711.0	31.8	31.7	15.4	15.3	71.9	73.0
K-Silicate + removal of laterals	32.0	37.0	23.7	27.4	740	741	33.0	32.9	15.8	15.7	74.0	75.0
K-Silicate + removal of leaves+ pinching	32.0	37.0	24.3	28.3	760	764	35.3	35.3	16.6	16.5	76.0	77.0
K-Silicate + removal of laterals+ pinching	32.0	37.0	25.0	29.0	780	785	37.1	37.1	17.2	17.1	79.9	81.0
K-Silicate + removal of laterals and leaves	32.0	38.0	25.6	30.6	800	805	39	38.9	17.7	17.6	84	85.0
K-Silicate + removal of laterals and leaves and pinching	32.0	38.0	26.2	33.1	819	824	41	40.9	18.9	18.9	89.9	91.0
New L.S.D. at 5%	Ns	2.0	0.5	0.7	17.0	18.5	1.0	1.0	0.5	0.4	0.9	0.7

Table (3): Effect of spraying Silicon and some physical and chemical characteristics of berries of Red Globe grapevines during 2016 & 2017 seasons

Treatment	Berries weight (g.)		Berries longitudinal (g.)		Berries equatorial (g.)		T.S.S %		Reducing sugars %		Total anthocyanin (mg/g F.W)		Total acidity %	
	2016	2017	2016	2017	2016	2017			2016	2017	2016	2017	2016	2017
Control	8.3	8.4	2.60	2.59	2.43	2.42	17.0	16.9	15.0	14.9	2.4	2.6	0.680	0.676
K-Silicate at 0.1 %	9.1	9.2	2.70	2.69	2.53	2.52	17.4	17.2	15.4	15.2	2.9	3.2	0.660	0.655
K-Silicate + pinching main shoots	10.1	10.1	2.81	2.79	2.63	2.61	17.8	17.5	15.8	15.6	3.9	4.0	0.640	0.634
K-Silicate + removal of leaves	10.8	11.0	2.92	2.91	2.74	2.73	18.2	17.9	16.2	16.0	4.1	4.7	0.620	0.614
K-Silicate + removal of laterals	11.8	11.9	3.00	2.99	2.85	2.85	18.6	18.3	16.5	16.3	5.0	5.5	0.599	0.594
K-Silicate + removal of leaves+ pinching	13.0	12.9	3.11	3.10	2.96	2.95	19.0	18.6	16.8	16.7	5.6	6.1	0.571	0.571
K-Silicate + removal of laterals+ pinching	14.0	13.9	3.22	3.20	3.07	3.05	19.4	18.9	17.1	17.0	6.1	6.7	0.551	0.550
K-Silicate + removal of laterals and leaves	15.0	14.9	3.32	3.31	3.18	3.17	19.8	19.2	17.5	17.4	6.6	7.3	0.531	0.534
K-Silicate + removal of laterals and leaves and pinching	16.0	15.8	3.38	3.37	3.25	3.24	20.2	19.6	17.8	17.8	7.1	7.9	0.509	0.516
New L.S.D. at 5%	0.8	0.7	0.06	0.07	0.05	0.06	0.4	0.3	0.3	0.3	0.5	0.6	0.017	0.015

4. Discussion

The outstanding effect of silicon on growth and vines nutritional status of 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 ((Melo *et al.*, 2003; Ma, 2004 and Tahir *et al.*, 2006).

These results are in agreement with those obtained by Abd El- Hameed, (2012); Al-Wasfy, (2014); El- Khawaga, (2014); Uwakiem, (2015); Wassel *et al.*, (2015); Nagy-Dina, (2016); Akl *et al.*, (2016); Farahat, (2017) and Masoud, (2017).

The beneficial effects of summer pruning on yield and fruit quality might be attributed to according to (Silvestroni *et al.*, (1994) and Campostrini and Seriana (2003).

These results might be attributed to the following merits of summer pruning.

- 1- Reducing competition on mineral and organic nutrients for the remaining shoots.
- 2- The promotion on the growth of the remaining shoots.
- 3- Obtaining the highest reserved of organic foods.
- 4- The stimulation in the assimilation in the remaining leaves.
- 5- The improvement in the distribute on of photosynthesis products.
- 6- The great control of fungal and disease attack.
- 7- The reduction of shade during growth.
- 8- The increase in light intensities or penetration within the canopy.

The results of Ibrahiem-*Alia et al.*, (2001); Ibrahiem-*Asmaa* (2001); Marengi, (2002); Poni *et al.*, (2002); Valor and Bautista, (2002); Petrie *et al.*, (2003) and Abada, (2005) confirmed the present results regarding the benefits of summer pruning on yield and fruit quality.

Conclusion:

Carrying out three sprays of K-Silicate at 0.1 % besides (pinching the main shoots, removing all leaves under clusters and removing all lateral shoots on the main shoots) gave on acceptable yield and good berries quality of Red Globe grapevines.

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