Response of Flame Seedless Grapevines to Foliar Application of some Micronutrients and Glutathione

Mubarak Abdelall Shoug
Hort. Dept. Fac. Agric. El- Azhar Univ. (Assiut branch) Egypt

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Abstract: This study was carried out during 2020 and 2021 seasons to examine the effect of spraying glutathione at 0.025 to 0.1% and/ or citrine compound (2% Zn + 2% Fe + 2% Mn) at 0.05 to 0.2% were sprayed three times from growth start (first week of March), just after berry setting (first week of Apr.) and three weeks later (last week of Apr.). on growth aspects, vine nutritional status, yield , berries colouration % as well as physical and chemical characteristics of Flame seedless grapes, Subjecting the vines to glutathione at 0.025 to 0.1% and or citrine compound at 0.05 to 0.2% was very effective in enhancing main shoot length, number of leaves/ shoot, leaf area, wood ripening coefficient, cane thickness, pruning wood weight, as well as leaf photosynthesis pigments, N, p, K , Fe, Zn and Mn in the leaves, yield, cluster weight and dimensions, berries colouration % and both physical and chemical characteristics compared to the control treatment. Using citrine compound was favourable than using glutathione in this respect Combined application of glutathione and citrine compound obviously surpassed the application of each alone in this respect, The best results with regard to yield berries colouration % and quality of the berries were recorded on the vines that received three sprays (at growth start, just after berry setting and three weeks later) of glutathione at 0.05% and citrine compound (2% Zn + 2% Fe + 2% Mn) at 0.1%.

Keywords*:* Flame seedless grapevines, glutathione, citrine compound, yield, berry quality

INTRODUCTION

Grape is considered the third fruit crop after citrus and mangoes in terms of area in Egypt. The fruiting area and total production of grapes in Egypt during 2019 reached 190486 feddans and 174715 tons respectively. Minia occupied the second position after Noubaria in grape plantation and production. Fruiting area of grapevines reached 24324 feddans produced 24086 tons (Egyptian Ministry of Agriculture and reclamation Statistics, 2019)

Such grapevines cv. has great potentially for export to foreign markets, since it ripens early in the first week of June. Yield decline, irregular colouration of berries as well as inferior of fruit quality of Flame seedless grapevines grown under Minia region conditions are considered serious problems facing such grapevine cv.

Nowadays, foliar fertilization has been increased in nutrition of fruit trees, especially in Egyptian soils where the loss through leaching or fixation of the applied fertilizers seemed higher. Therefore, foliar application of nutrients to fruit trees in new reclaimed soils is suggested to be of more efficient than that of soil dressing.

Foliar application are used to overcome the problems resulted from the alkalinity of the Egyptian soils. Moreover, micronutrients play an important role in flowering and fruiting processes, movement of the natural hormones and the encouragement of both cells division and cell enlargement. Also, application of them lessened at the lower extent the different disorders in fruit crops (Nijjar, 1985). Glutathione is the most important non-protein thiol present in plants. It is essential in sulfur metabolism and defense against most stresses. It is important pool of reduced sulfur and regulated sulfur uptake at root level. Reduced glutathione, the major water soluble antioxidant in photosynthetic and non-photosynthetic tissues, reacting directly or indirectly with reactive of cell structure and the proper functions of various metabolic pathways. In addition to its effects on expression of defense genes glutathione may also be involved in redox control of cell division and enhanced growth of plants (Levitt, 1980; Rennenberg, 1982; Meister and Andreson, 1983; Dekok and Stulen, 1993; Jorge *et al.,* 1993; Foyer *et al.,* 1997; Noctor and Foyer, 1998; Tausz and Grill, 2000; Kocsy *et al.,* 2001 and Mullineaux and Rausch, 2005).

The target of this study was examining the effect of glutathione and/ or citrine compound on improving yield, berries colouration and quality of Flame seedless grapevines grown under Minia region conditions

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2020 and 2021 on 15-years old Flame seedless grapevines grown in a private vineyard located at Tanda village, Mallawy district, Minia Governorate. Where the soil texture is (Table 1) clay (Chapman and Pratt, 1965) and water table is not less than two meters deep. Vines are spaced at 1.5 meters (between vine) x 3.0 meters (between rows). The selected vines (60 vines) were chosen as uniform in vigour as possible and devoted to achieve this study. The chosen vines were pruned the last week of December in both seasons. Super pruning system using gable shape supporting method was followed vine load for all the selected vines was adjusted (15 fruiting spurs x 4 eyes) + (6 replacement spurs x 2 eye).

Surface irrigation system was followed using Nile water.

Corresponding author e-mail: mubarakabdelall000@gmail.com

Table (1): Analysis of the tested vineyard soil

Constituents	Values
Partical size distribution	
Sand %	11.7
Silt %	10.5
Clay %	77.8
Texture	Clay
pH (1: 2.5 extract)	7.6
E.C. (1: 2.5 extract) ppm	246
O.M. %	1.9
$CaCO_3$ %	2.3
Total N %	0.11
Available P (Olsen method, ppm)	4.9
Available K (ammonium acetate ppm)	491.0
EDTA extractable micronutrients (ppm)	
Fe (ppm)	3.6
Mn (ppm)	3.1
Zn (ppm)	4.1

Except those dealing with the present treatments (application of glutathione and citrine compound) all the selected vines received the usual horticultural practices which are commonly used in the vineyard. This experiment included the following ten treatments from various glutathione and citrine compound concentrations:

1- Control (vines sprayed with tap water).
2- Spraying glutathione at 0.025%.
3- Spraying glutathione at 0.05%.
4- Spraying glutathione at 0.1%.
5- Spraying citrine compound at 0.05%.
6- Spraying citrine compound at 0.1%.
7- Spraying citrine compound at 0.2%.
8- Spraying glutathione at 0.025% + citrine compound at 0.05%.
9- Spraying glutathione at 0.05% + citrine compound at 0.1%.
10- Spraying glutathione at 0.1% + citrine compound at 0.2%.

Each treatment was replicated three times with two vines per tree. The total vines selected for achieving this experiment was 60 vines.

Glutathione (cystein + glycine + glutamic acid) and citrine compound (2% Zn + 2% Fe + 2% Mn) were sprayed three times at growth start (first week of March), just after berry setting (first week of Apr.) and three weeks later (last week of Apr.)

Triton B as agent was added to all praying solutions and was done till runoff.

Randomized complete block design (RCBD) was followed where the experiment consisted of the treatments and each treatment was replicated three times with two vines per each replicate.

The following measurements were recorded during the two experimental seasons.

1- Vegetative growth characters:

At the first week of June, the following growth aspects were recorded:

a) Average main shoot length (cm.)
b) Number of leaves/ shoot.
c) Average leaf area $(cm)^2$ was measured using the following equation as outlined by (Ahmed and Morsy, 1999).

Leaf area = $0.45\ (0.79 \times d^2) + 17.77 = (cm)^2$

Where d is the maximum diameter of leaf

d) Wood ripening coefficient (Bourad, 1966).
e) Pruning wood weight (kg.)
f) Can thickness (mm).

2- Leaf pigments:

Samples of ten mature and fresh leaves from those leaves opposite to the basal clusters on each shoot were taken at the first of June during the two seasons and cut into small pieces and 0.5 g weight from each sample was taken, homogenized and extracted by 25.0 % acetone in the presence of little amounts of Na_2CO_3 then filtered. The residue was washed several times with acetone until the filtrate became coulorless. The extract was completed to a known volume (15 ml) with acetone 85%. A portion of this extract was taken for the determination of chlorophylls a, b, total chlorophylls and total carotenoids colormetically and acetone 85% v/v was used as a blank as (mg/1.0 g F.W.) The optical density of the filtrate was determined at the wave length of 662, 644 and 440.5 nm to determine chlorophyll a, b, and total carotenoids, respectively and total chlorophylls were calculated (Hiscox and Isralstam, 1979).Concentration of each pigment was calculated by using the following equation according to (Von-Wettstein, 1957).

Ch.A = (9.784 x E662) – (0.99 x E 644) = mg/1.0 g F.W.

Ch.B = (21.426 x E644) – (4.65 x E 662) = mg/1.0 g F.W.

Total ch. = chlorophyll a + chlorophyll b = mg/1.0 g F.W.

Total carotenoids = (4.965 x E 440.5) – 0.268 (total chlorophylls) mg/1.9 F.W.

Where E = optical density at given wave length.

3- Leaf chemical composition:

Twenty leaves picked from the main shoots opposite to the basal clusters according to (Summer, 1985). For each vine were taken at the first of June during seasons 2020 and 2021, blades of the leaves were discovered and petioles were oven dried at 70^oC

and grind than 0.5 g weight of each sample was digested using H_2SO_4 and H_2O_2 until clear solution as 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 content of N, P, K, Zn, Fe and Mn were determined as follows.

a) N % by the modified microkejldahl method as described by (Chapman and Pratt, 1965).

b) K % by using Flame photometer was outlined by (Chapman and Pratt, 1965).

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

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

4- Yield and physical characteristics of berries:

At the harvesting time (the first week of June) when T.S.S/ acid in the juice of the berries reached at least 25:1 (Winkler *et al.,* 1974 and Weaver, 1976). The number of cluster per vine was calculated, then three clusters per vine were collected, one from each direction then transferred to laboratory where the following physical aspects were done:

a) cluster Weight (g)

b) Yield/vine (calculated by multiplying cluster weight x number of clusters/vine).

c) Cluster dimensions (length and width) (cm)

d) Weight of berries (g)

e) Berry dimensions (longitudinal and equatorial) (cm)

5- Chemical characteristics of berries:

a) Percentage of total soluble solids, in the juice by using a hand refractometer.

b) Percentage of total acidity in the juice (as tartaric acid/100 ml/juice) by titration with 0.1 N NaOH using phenophthaleine as an indicator (A.O.A.C. 2000).

c) The ratio between of T.S.S. and acid was estimated.

d) The percentage of reducing sugars in juice was done according to (Lane and Eynon, 1965). Volumetric method as outlined by (AOAC, 2000).

Statistical analysis:

All the obtained data were tabulated and statistically analyzed using New L.S.D. at 5% for made all comparison among the investigated treatment means according to (Mead *et al.,* 1993).

RESULTS AND DISCUSSION

1- Effect of single and combined applications of glutathione and some micronutrients on some vegetative growth characteristics:

It is clear from obtained data in Table (2) that treating the vines three times with glutathione at 0.025 to 0.1% and/ or citrine compound (2% Zn + 2% Fe + 2% Mn) at 0.05 to 0.2% significantly enhanced the six growth aspects namely the main shoot length, number of leaves/shoot, leaf area, wood ripening coefficient, pruning wood weight/vine and cane thickness relative to the control. The promotion was associated with increasing concentration of glutathione from 0.025 to 0.1% and citrine compound from 0.05 to 0.2%. Combined applications of glutathione and citrine compound significantly increased these growth aspects than using each material alone.

Using citrine compound was significantly superior than using glutathione in stimulating these growth traits. Increasing concentrations of glutathione from 0.05 to 0.1% and citrine compound from 0.1 to 0.2% had no significant promotion on these growth traits.

The maximum values of main shoot length (130.0 & 131.0 cm), number of leaves/ shoot (24.5 & 25.5 leaf), leaf area (129.0 & 129.3 cm^2), wood ripening coefficient (0.92 & 0.93) cane thickness (1.24 & 1.26 cm) and pruning wood weight (2.42 & 2.45 kg) were recorded on the vines that received three sprays of a mixture of glutathione at 0.1% and citrine compound at 0.2 % during both seasons, respectively. The untreated vines produced the minimum values of main shoot length (106.0 & 107.0 cm), number of leaves/shoot (14.0 & 15.0 leaf), leaf area (102.0 & 106.3 cm^2) wood ripening (0.66 & 0.68), cane thickness (0.96 & 0.99 cm) and pruning wood weight (1.88 & 1.92 kg/vine) during both seasons, respectively.

The beneficial effects of Fe, Zn, and Mn on growth characters clearly show spraying these micronutrients on flame seedless grapevines three times were significantly effective in enhancing leaf area, shoot length and cane thickness and resulted the maximum values. The stimulating effect of Zn in enhancing the biosynthesis of IAA and the effect of Zn, Fe and Mn in activating cell division and building organic foods (Nijjar, 1985) could explain the present results. The beneficial effect of micronutrients on growth in harmony with these obtained by Kabeel *et al.* (1993) on white Banaty, Abada (2002), Abdel-Salam Maha (2016).

The higher content of glutathione from glycine, cycteine and glutamic as well as its action on enhancing sulfur metabolism and defense gene and reducing reactive oxygen species (ROS) could explain the present results (Mullineaux and Raush, 2005). These results concerning the positive action of glutathione on growth are in harmony with Abdelaal *et al.* (2012), Gad El- Kareem (2012), Ahmed *et al.* (2012), (2013), El- Khawaga and Mansour (2014) and Madany (2017) they emphasized the beneficial effects of glutathione on growth , tree nutritional status, yield and fruit quality of fruit crops.

2- Effect of single and combined applications of glutathione and some micronutrients on leaf pigments:

Data in Table (3) obviously reveal that varying glutathione and citrine compound treatments significantly altered the leaf pigments namely chlorophylls a & b, total chlorophylls and total

carotenoids rather single and combined applications significantly were responsible for enhancing these plant pigments relative to the control. There was a gradual promotion on these leaf pigments with increasing concentrations of glutathione from 0.025 to 0.1% and citrine compound from 0.05 to 0.2%. Using citrine compound was significantly preferable than using glutathione in enhancing these plant pigments. Using both materials together significantly increased these leaf pigments combined to using material alone in enhancing these leaf pigments. No significant differences were observed among the higher two concentrations of glutathione namely 0.05 and 0.1% and citrine compound from 0.1 to 0.2 %. Treating the vines with glutathione at 0.1% and citrine at 0.2% gave the maximum values of chlorophyll a (5.3 & 5.4 mg/ 1 g F.W.), b (2.9 & 3.0 mg/ 1 g F.W.)), total chlorophylls (8.2 & 8.4 mg/ 1 g F.W.) and total carotenoids (3.4 & 3.5 mg/ 1 g F.W.) during both seasons, respectively. The lowest values were recorded on untreated vines. Similar results were announced during 2020 and 2021 seasons.

These results are in agreement with those obtained by Kishk *et al.* (1983) on Red Roomy and El-Qazzar *et al.* (1990) on Thompson grape. The results of chlorophylls a & b, total chlorophylls and total carotenoids.

The increase in amino acids/ photosynthetic processes (Mullineaux and Rausch, 2005) could explain the promoting effect of glutathione on the biosynthesis of plant pigments. These results are in agreement with those obtained by Abdelaal *et al.* (2012), Gad El- Kareem (2012), Ahmed *et al.* (2012) and (2013), El-Khawaga and Mansour (2014), Madany (2017).

3- Effect of single and combined applications of glutathione and some micronutrients on the leaf content of N, P and K (as %) and Zn, Fe and Mn (as ppm).

Table (4) show the effect of single and combined application of glutathione and citrine compound on the leaf content of N, P and K (as %) and Zn, Fe and Mn (as ppm) of Flame seedless grapevines during 2020 and 2021 seasons.

It can be stated from the obtained data that subjecting Flame seedless grapevines three times with glutathione and/ or citrine compound was significantly followed by stimulating N, P, K, Zn, Fe and Mn relative to the control treatment. The stimulation on these nutrients was in proportional to the increase in concentrations of each material. Employing citrine compound at 0.05 to 0.2% significantly was accompanied with enhancing these nutrients than using glutathione. Combined applications were significantly superior than using material alone. Negligible promotion on these nutrients were observed among the higher two concentrations of each material. Using the higher concentrations of glutathione namely 0.1 and citrine compound namely 0.2% gave the highest values of N (2.01 & 2.08%), P (0.43 & 0.44 %), K (1.96 & 1.99%), Zn (52.0 & 52.5 ppm) Fe (64.1 & 64.2 ppm) and Mn (61.6 & 61.9 ppm) during both seasons, respectively. The untreated vines produced the lowest values. The results were true during both seasons.

The positive action of glutathione and micronutrients on enhancing root development and up take of nutrients could explain the present results of El-Kady (2011), El- Kady-Hanaa (2011) and Abdelaal *et al.* (2012), Gad El- Kareem (2012), Ahmed *et al.* (2012) and (2013), El- Khawaga and Masnsour (2014), Madany (2017) and Ahmed *et al.* (2018).

4- Effect of single and combined applications of glutathione and some micronutrients on the yield as well as cluster weight and dimensions:

Data concerning the effect of single and combine applications of glutathione and citrine compound on the yield as well as cluster weight and dimensions (length & shoulder) of Flame seedless grapevines during 2020 and 2021 seasons are shown in Table (5).

The obtained data cleared that supplying the vines with glutathione at 0.025 to 0.1% and / or citrine compound at 0.05 to 0.2% significantly improved the yield expressing in weight (kg) and number of clusters per vine and weight, length and cluster relative to the control treatment. There was a progressive promotion on these parameters with increasing concentrations of each material. Significant differences on these parameters were observed between all concentrations and materials except among the higher two concentrations of each material, therefore, from economical point of view it in necessary to use the material. Combined were favorable than using each material alone in this respect. Using citrine compound significantly preferable than using glutathione in improving yield and cluster characteristics.

From economical point of view, using glutathione at 0.05 plus citrine compound at 0.1% resulted in the highest yield. Under such promised treatment, yield per vine reached 12.0 and 15.0 kg during both seasons, respectively. The untreated vine produced 9.5 and 9.7 kg during both seasons, respectively. The percentage of increment on the yield due to application of the previous treatment over the check treatment reached 26.3 and 54.6% during both seasons, respectively. These results were nearly the same during both seasons.

The beneficial effect of glutathione and micronutrients on berry yield might be attributed to their positive effect on growth, vine nutritional status and pigments reflecting on berry setting and cluster weight and dimensions. These results are in concordance with the results of the promoting effect of glutathione on berry setting; yield and cluster weight was emphasized by Abdelaal *et al.* (2012), Gad El-Kareem (2012), Ahmed *et al.* (2012) and (2013), El-Khawaga and Mansour (2014), Madany (2017), Ahmed *et al.* (2018).

Table (2): Effect of single and combined applications of glutathione and some micronutrients on some growth characteristics of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	Main shoot length (cm)		No. of leaves/ shoot		Leaf area $(cm)^2$		Wood ripening coefficient		Can thickness (cm)		Pruning wood weight/ vine kg	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	106.0	107.0	14.0	15.0	102.0	106.3	0.66	0.68	0.96	0.99	1.88	1.92
Spraying glutathione at 0.025%	111.0	113.5	15.5	16.0	108.5	109.6	0.69	0.70	1.00	1.02	1.94	2.00
Spraying glutathione at 0.05%	115.5	116.5	16.0	17.0	111.6	112.7	0.73	0.74	1.08	1.10	2.00	2.10
Spraying glutathione at 0.1%	117.0	118.5	16.5	17.5	112.8	113.5	0.74	0.75	1.10	1.11	2.05	2.13
Spraying citrine compound at 0.05%	117.5	119.0	18.0	19.0	112.9	114.0	0.75	0.76	1.11	1.13	2.07	2.15
Spraying citrine compound at 0.1%	120.5	122.0	19.2	20.0	118.5	119.0	0.78	0.79	1.16	1.17	2.16	2.20
Spraying citrine compound at 0.2%	122.6	124.0	20.5	21.2	119.3	120.0	0.80	0.82	1.18	1.19	2.20	2.24
Spraying glutathione at and 0.025%+citrine compound at 0.05%	123.0	125.0	21.0	22.0	121.0	121.6	0.83	0.85	1.20	1.21	2.22	2.26
Spraying glutathione at and 0.05% +citrine compound at 0.1%	128.0	129.0	23.0	24.0	127.0	128.0	0.89	0.91	1.23	1.24	2.38	2.40
Spraying glutathione at and 0.1% +citrine compound at 0.2%	130.0	131.0	24.5	25.5	129.0	129.3	0.92	0.93	1.24	1.26	2.42	2.45
New L.S.D. at 5%	1.4	1.3	1.9	1.9	1.3	1.4	0.03	0.04	0.04	0.04	0.08	0.09

Table (3): Effect of single and combined applications of glutathione and some micronutrients on some leaf pigments of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	Chlorophyll a (mg/ 1.0 g F.W.)		Chlorophyll b (mg/ 1.0 g F.W.)		Total chlorophylls (mg/ 1.0 g F.W.)		Total carotenoids (mg/ 1.0 g F.W.)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	2.9	3.0	1.0	1.0	3.9	4.0	1.1	1.1
Spraying glutathione at 0.025%	3.3	3.4	1.3	1.4	4.6	4.8	1.4	1.6
Spraying glutathione at 0.05%	3.8	3.9	1.6	1.7	5.4	5.6	1.8	1.9
Spraying glutathione at 0.1%	3.9	4.0	1.7	1.8	5.6	5.8	1.9	1.9
Spraying citrine compound at 0.05%	4.0	4.1	1.8	1.9	5.8	6.0	2.1	2.2
Spraying citrine compound at 0.1%	4.4	4.6	2.2	2.3	6.6	6.9	2.6	2.7
Spraying citrine compound at 0.2%	4.6	4.8	2.4	2.5	7.0	7.1	2.7	2.8
Spraying glutathione at and 0.025%+citrine compound at 0.05%	4.7	4.9	2.5	2.6	7.2	7.5	2.9	3.0
Spraying glutathione at and 0.05% +citrine compound at 0.1%	5.2	5.3	2.8	2.9	8.0	8.2	3.3	3.4
PSpraying glutathione at and 0.1% +citrine compound at 0.2%	5.3	5.4	2.9	3.0	8.2	8.4	3.4	3.5
New L.S.D. at 5%	0.2	0.2	0.1	0.2	0.5	0.4	0.2	0.2

Table (4): Effect of single and combined applications of glutathione and some micronutrients on the leaf content of N, P and K (as %) and Fe, Zn and Mn (as ppm) of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	Leaf N %		Leaf P %		Leaf K %		Leaf Fe (ppm)		Leaf Zn (ppm)		Leaf Mn (ppm)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	1.68	1.70	0.19	0.21	1.56	1.58	51.1	51.2	41.3	42.0	48.1	48.3
Spraying glutathione at 0.025%	1.71	1.72	0.23	0.24	1.63	1.65	53.0	53.1	44.0	44.3	49.9	50.2
Spraying glutathione at 0.05%	1.76	1.78	0.27	0.28	1.68	1.68	56.0	56.2	45.2	45.6	50.8	51.0
Spraying glutathione at 0.1%	1.79	1.80	0.28	0.29	1.69	1.70	56.7	56.8	46.0	46.5	51.3	51.5
Spraying citrine compound at 0.05%	1.79	1.81	0.29	0.30	1.70	1.72	59.2	59.8	47.0	47.3	52.5	52.8
Spraying citrine compound at 0.1%	1.84	1.85	0.33	0.35	1.79	1.80	61.9	62.0	48.2	48.8	56.3	56.6
Spraying citrine compound at 0.2%	1.86	1.87	0.38	0.39	1.81	1.82	62.2	62.8	48.8	49.2	58.5	58.9
Spraying glutathione at and 0.025%+citrine compound at 0.05%	1.87	1.88	0.39	0.39	1.82	1.83	62.8	63.1	48.5	49.2	58.6	59.1
Spraying glutathione at and 0.05% +citrine compound at 0.1%	1.96	1.99	0.42	0.43	1.92	1.93	63.9	64.0	51.3	51.8	61.0	61.2
Spraying glutathione at and 0.1% +citrine compound at 0.2%	2.01	2.08	0.43	0.44	1.96	1.99	64.1	64.2	52.0	52.5	61.6	61.9
New L.S.D. at 5%	0.06	0.07	0.02	0.03	0.05	0.06	1.8	1.7	1.9	1.8	1.9	2.0

Table (5): Effect of single and combined applications of glutathione and some micronutrients on yield as well as weight, length and shoulder of cluster of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	No. of clusters / vine		Yield / vine (kg.)		Cluster weight (g.)		Cluster length (cm)		Cluster width (cm)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	28.0	28.0	9.5	9.7	340.0	345.0	17.0	17.3	10.5	10.9
Spraying glutathione at 0.025%	28.0	29.0	9.8	10.4	350.0	360.0	17.8	18.0	10.8	11.3
Spraying glutathione at 0.05%	28.0	31.0	10.1	11.3	360.0	365.0	18.3	18.4	11.0	11.5
Spraying glutathione at 0.1%	28.0	32.0	10.2	11.8	365.0	370.0	19.5	19.7	11.2	11.7
Spraying citrine compound at 0.05%	29.0	32.0	10.6	11.9	368.0	372.0	19.6	19.9	11.3	11.9
Spraying citrine compound at 0.1%	29.0	33.0	10.9	12.6	378.0	382.0	21.6	21.9	11.9	12.2
Spraying citrine compound at 0.2%	29.0	34.0	11.2	13.1	385.0	288.0	22.0	22.4	12.5	13.1
Spraying glutathione at and 0.025%+citrine compound at 0.05%	29.0	35.0	11.4	14.1	395.0	400.0	22.2	22.6	12.9	13.7
Spraying glutathione at and 0.05% +citrine compound at 0.1%	29.0	36.0	12.0	15.0	415.0	418.0	23.9	24.5	14.2	14.3
Spraying glutathione at and 0.1% +citrine compound at 0.2%	29.0	37.0	12.1	15.7	420.0	425.0	24.3	24.8	14.3	14.4
New L.S.D. at 5%	NS	1.8	0.4	0.7	8.3	9.1	0.9	1.0	0.4	0.5

5- Effect of single and combined applications of glutathione and some micronutrients on the percentage of berries colouration:

Table (6) show the effect of single and combined applications of glutathione and citrine compound on the percentage of berries colouration of Flame seedless grapevines during 2020 and 2021 seasons.

It is revealed from the obtained data that subjecting Flame seedless grapevines to glutathione at 0.025 to 0.1% and/or citrine compound at 0.05 to 0.2% significantly enhanced berries colouration relative to the control treatment. Using citrine compound was significantly superior than using glutathione in enhancing berries colouration. A mixture of glutathione and citrine compound was significantly preferable in enhancing berries colouration than using material alone. Meaningless promotion on berries colouration was observed among the higher two concentrations of each material. A progressive promotion was noticed with increasing concentrations of each material. Economically point of view and for solving the irregular berries colouration problem; it is useful to use the two materials together at the medium concentrations. The berries coloration reached the highest values (85.0 & 86.0%) in the vines that received both materials together at the higher concentration. The lowest berries colouration (65.8 & 66.5%) was occurred on the untreated vines during both seasons, respectively. These results were true during both seasons.

The enhancing effect of glutathione and micronutrients on berries colouration might be attributed to their positive action on enhancing the leaf area and photosynthesis (Mullineaux and Rausch, 2002).

These results regarding the promoting effect of glutathione on berries colouration are in harmony with those obtained by Abdelaal *et al.* (2012), Gad El-Kareem (2012), Ahmed *et al.* (2012), (2013), El-Khawaga and Mansour (2014), Madany (2017).

The results of berries colouration are in the same line with that obtained by Abdel-Hameed (2003) on red Roomy grapevines and Gobara (1999) on Flame seedless.

Table (6): Effect of single and combined applications of glutathione and some micronutrients on some physical characteristics of the berries of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	Berries colouration %		Berry weight (g)		Berry longitudinal (cm)		Berry equatorial (cm)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	65.8	66.5	3.35	3.40	1.80	1.79	1.58	1.57
Spraying glutathione at 0.025%	67.2	67.7	3.40	3.45	1.83	1.84	1.60	1.60
Spraying glutathione at 0.05%	68.5	69.0	3.50	3.60	1.89	1.90	1.66	1.67
Spraying glutathione at 0.1%	69.0	69.3	3.55	3.65	1.91	1.93	1.67	1.68
Spraying citrine compound at 0.05%	69.2	69.5	3.70	3.75	1.93	1.94	1.68	1.69
Spraying citrine compound at 0.1%	71.9	72.5	3.85	3.90	1.97	1.98	1.73	1.74
Spraying citrine compound at 0.2%	73.0	74.0	3.90	3.95	1.98	1.99	1.75	1.76
Spraying glutathione at and 0.025%+citrine compound at 0.05%	77.2	78.0	3.95	4.00	1.99	2.00	1.75	1.77
Spraying glutathione at and 0.05% +citrine compound at 0.1%	83.2	84.5	4.15	4.20	2.03	2.04	1.79	1.80
Spraying glutathione at and 0.1% +citrine compound at 0.2%	85.0	86.0	4.20	4.25	2.04	2.05	1.80	1.81
New L.S.D. at 5%	1.0	1.1	0.18	0.19	0.04	0.05	0.03	0.04

6- Effect of single and combined applications of glutathione and some micronutrients on some physical and chemical characteristics of the berries:

Data in Tables (6 & 7) show the effect of single and combined applications of glutathione and citrine compound on berry weight and dimensions (longitudinal and equatorial), TSS%, Reducing sugars %, total acidity % and TSS/acid ratio in the berries of Flame seedless grapevines during 2020 and 2021 seasons.

It is clear from the obtained data that treating Flame seedless grapevines three times with glutathione at 0.025 to 0.1% and/or citrine compound at 0.05 to 0.2% significantly was favorable than the control treatment in improving quality of the berries in terms of increasing weight, longitudinal and equatorial of berry, T.S.S. %, Reducing sugars %, and T.S.S./acid ratio and decreasing total acidity % relative to the check treatment. The promotion on quality of the berries was related to the increase in concentrations of glutathione and citrine compound without significant promotion among the higher two concentrations of glutathione and citrine compound. Using citrine compound significantly was preferable than using glutathione in enhancing physical and chemical properties of the berries.

These results regarding the effect of glutathione and citrine compound on promoting berries quality might be ascribed to their positive action on enhancing leaf pigments and total anthocyanins in the berries (Mullineaux and Rausch, 2005).

The results of Abdelaal *et al.* (2012), Gad El-Kareem (2012), Ahmed *et al.* (2012) and (2013), El-Khawaga and Mansour (2014), Madany (2017) supported the beneficial effects of glutathione on berries quality.

These results regarding the promoting effect of micronutrients on berries quality are in harmony with those obtained by Abada (2002) on Red Roomy grapevines, El- Kady-Hanaa (2011) on Thompson seedless grapevines and Ahmed *et al.* (2012) and Abdel-Salam-Maha (2016) on Bez El-Nakag.

Table (7): Effect of single and combined applications of glutathione and some micronutrients on some chemical characteristics of the berries of Flame seedless grapevines in 2020 and 2021 seasons

Treatments	TSS %		Total acidity %		TSS/ acid		Reducing sugars %	
	2020	2021	2020	2021	2020	2021	2020	2021
Control (untreated vines)	17.8	17.9	0.710	0.715	25.1	25.0	14.8	14.9
Spraying glutathione at 0.025%	18.2	18.3	0.695	0.690	26.2	26.5	15.1	15.3
Spraying glutathione at 0.05%	19.0	19.1	0.680	0.675	27.9	28.2	16.0	16.1
Spraying glutathione at 0.1%	19.2	19.3	0.675	0.670	28.4	28.8	16.2	16.3
Spraying citrine compound at 0.05%	19.3	19.4	0.660	0.655	29.2	29.6	16.4	16.5
Spraying citrine compound at 0.1%	19.9	20.0	0.645	0.640	30.8	31.2	16.8	16.9
Spraying citrine compound at 0.2%	20.0	20.1	0.630	0.630	31.7	31.9	17.0	17.1
Spraying glutathione at and 0.025% citrine compound at 0.05%	20.0	20.1	0.615	0.610	32.5	32.9	17.1	17.3
Spraying glutathione at and 0.05% citrine compound at 0.1%	20.6	20.7	0.600	0.595	33.3	34.7	17.5	17.6
Spraying glutathione at and 0.1% citrine compound at 0.2%	20.7	20.8	0.590	0.585	35.1	35.5	17.7	17.9
New L.S.D. at 5%	0.4	0.5	0.017	0.018	0.6	0.7	0.3	0.3

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استجابة كرمات العنب الفليم سيدلس للرش الورقى ببعض العناصر الصغرى والجلوتاثيون

مبارك عبد العال شوق

قسم البساتين- كلية الزراعة - جامعة الأزهر(فرع أسيوط) – مصر

أجريت هذه الدراسة خلال موسمي 2020، 2021 لاختبار تأثير رش الجلوتاثيون بتركيز من 0.025الى 0.1% ومركب الستيرين (زنك 2% + حديد 2% + منجنيز 2%) بتركيز من 0.05 إلى 0.2% في الصورة المنفردة أو المشتركة على صفات النمو الخضري والحالة الغذائية للكرمات وكمية المحصول والنسبة المئوية لتلوين الحبات في العنقود والخصائص الطبيعية والكيميائية لحبات العنب الفليم سيدلس. كانت معاملة الكرمات بالجلوتاثيون بتركيز ما بين 0.025–0.1% ومركب الستيرين بتركيز ما بين 0.05 و 0.2% في الصورة المنفردة أو التوليفات بينهما فعالا جدا في تحسين صفات النمو الخضري وهى (طول الفرخ الرئيسي- وعدد الأوراق عليه ومساحة الورقة ومعدل نضج الخشب وسمك القصبات ووزن خشب التقليم للكرمة) وكذلك الصفات النباتية وعناصر النتروجين والفوسفور والبوتاسيوم والحديد والزنك والمنجنيز في الورقة وكمية المحصول ووزن العنقود وأبعاده والنسبة المئوية لتلوين الحبات والخصائص الطبيعية والكيميائية للحبات وذلك مقارنة بمعاملة الكونترول. ولقد تفوق استخدام مركب الستيرين (زنك 2% + حديد 2% + منجنيز 2%) عن الجلوتاثيون في هذا الصدد كما تفوق استخدام التوليفة المشتركة بينهما عن الاستخدام الفردي. أمكن الحصول على أفضل النتائج بخصوص كمية المحصول وتلوين الحبات وخصائص الجودة للحبات عند معاملة الكرمات ثلاثة مرات (في بداية النمو وبعد عقد الحبات مباشراً وبعدها بثلاثة أسابيع) بمخلوط من الجلوتاثيون بتركيز 0.05% مع مركب الستيرين (زنك 2% + حديد 2% + منجنيز 2%) بتركيز 0.1%.

الكلمات الدالة: العنب الفليم سيدلس - الجلوتاثيون - مركب الستيرين - كمية المحصول - خصائص الجودة للحبات