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Response of Thompson seedless grapevines (h4 strain) grown on sandy soil to foliar application of some antioxidants and seaweed extract

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Abstract

The present study was carried out during 2021 and 2022 growing seasons to examine the effect of individual or combined applications of some organic acids and seaweed extract. The treatments included on Thompson seedless grapevines (H4 strain) yield and its quality. Citric and ascorbic acids each at 250 to 1000 ppm, salicylic acid at 50 to 200 ppm and seaweed extract at 0.05 to 0.2%. The individual or combined applications of the antioxidants was very effective on improving the vegetative growth characteristics, vine nutritional status, yield and berry quality during both seasons of study. The best individual treatment was seaweed extract followed by salicylic acid and then ascorbic acid and finally citric acid. The combined application of these materials was more effective than individual use of each antioxidant on promoting growth characteristics. Also, the stimulation was proportional to concentration increases of each material. To promote yield and berry quality of Thompson seedless grapevines (H4 strain) grown on sandy soil, it is recommended to spray the grapevines three times at growth start, just after berry setting and one month later with a mixture consists of citric acid at 1000 ppm, ascorbic acid at 1000 ppm, salicylic acid at 200 ppm and seaweed extracts at 0.2%.

Keywords: antioxidants, citric acid, ascorbic acid, salicylic acid, Thompson seedless grapevines (H4 strain).

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1. Introduction

There are many modern strains of Thompson seedless grapevines (Thompson 2A, H4 and H5). Rapidly, they are becoming the preferred seedless grape for consumers and markets worldwide due to their exceptional shelf life, a very distinctive sweet and juicy flavour and a crisp firm skin as well as high sugar content (glucose and fructose). Also, they produce dietary fiber and vitamin A and C and contain adequate amounts of potassium and low sodium content (Possingham, 2003). It is a prime and popular grape cv. successfully grown under Egyptian conditions. It prunes as cane long pruning system. The drawback of such grape cv. is the small berries on the clusters that leading lowering its marketing. In the local markets, it widely spreads in recent few years due to high yield of vine and clusters weight. Antioxidant compounds have auxinic action, since they have synergistic effect on growth, productivity and fruit quality of most fruit trees. Also, they are safe to human, animal and environment. They are very beneficial for avoiding free oxygen and reducing cell senescence. They are important in the cell division and the biosynthesis of organic foods and controlling the incidence of fungal attack (Galal and El- Sayed, 1996; Raskin, 1990). Seaweed extracts have long been recognized as excellent natural fertilizer and sources of organic matter. Commercial growers around the world have been using these extracts as a soil conditioner and slow-release fertilizer for over century (regular use of cyano-bacteria as blue green Algae). Seaweed extract contributes to more vigours plant growth healthier root system and greater marketable yield potential for fruit crops as well as some horticultural plants. The benefits associated with using seaweed extract were increased over time when an application program is followed during years. These extracts increase nutrients content such as C, N, P, K, Mg, Ca, Fe, Zn, S, Mn, B, Cu and Mo (Ho *et al.*, 2003). Therefor current study aims to highlights the effect of different concentrations of some antioxidants (citric, ascorbic and salicylic acids) and seaweed extracts on some vegetative growth characteristics, vine nutritional status, yield and quality of Thompson seedless grapes (H4 strains).

2. Materials and methods

2.1 Experimental site and treatments description

The study was executed through two growing seasons of 2021 and 2022 on ninety-six vigour of 6 years old Thompson Seedless grapevines (H4 strain) grafted on freedom rootstock grown in a private vineyard located in the west of Abo Qurqas district, Minia governorate, Egypt. The soil texture is sandy and well drained (water table depth > 2 meters). The vines are spaced at 3.0 m between nows and 2.0 m apart between vines (700 vines/feddan) (feddan = 4200 m² = 0.420 hectares = 1.037 acres). The 96 selected vines were nearly uniform in vigor. The chosen vines were trained by a cane pruning system leaving 96 eyes/vine (eight fruiting canes × 10 eyes plus eight renewal spurs × two eyes) using Barun supported method. Winter pruning was done in the 1st week of January during both seasons. The well was the main source of irrigation water (1046 ppm) using drip irrigation system and all fertilizers were added with irrigation water (fertigation). Some physical and chemical properties of the tested soil form 0.0 up to 90.0 cm depth were carried out as initial state according to the procedures of Wild *et al.* (1973) which are shown in Table (1).

Table (1): Some physical and chemical properties of the tested soil.

Property	Values	Property	Values
Sand (%)	83.5	Total N (%)	0.035
Silt (%)	12.5	Available P (ppm) (Olsen method)	1.8
Clay (%)	4.0	Available K (ppm) (ammonium acetate)	41.0
Texture class	Sandy	Fe (ppm)	1.11
Organic carbon (%)	0.35	Zn (ppm)	0.98
Organic matter (%)	0.60	Mn (ppm)	0.95
pH (1: 2.5 extract)	7.98		
EC (1: 2.5 ex. dS/m)	1.65		
$CaCO_3$ (%)	4.96		

The selected vines (96 vines) received the usual horticultural practices that are commonly used in the vineyard, in addition to treatment with organic acids and seaweed extract. The experiment included sixteen treatments individual or combined of the antioxidants' applications and seaweed extracts. Randomized complete block design (RCBD) was adopted and the sixteen treatments were replicated three times with two vines per each (Rangaswamy, 1995). The treatments were spraying citric, ascorbic and salicylic acids at 250, 500, 1000 ppm from each, as well as seaweed extract at 0.05, 0.1 and 0.2 %. Moreover, combination with the previous compound at low, mid and high combination, while the untreated vines were sprayed with water.

2.2 Data collection

During both seasons of 2021 and 2022, the following parameters were carried out.

2.2.1 Vegetative growth

The following *vegetative growth* parameters were measured:

- Shoot length (cm), in the last week of May.
- Leaves number/shoot.
- Leaf area (cm), on twenty leaves opposite to the based clusters according to Ahmed and Morsy (1999).

- Wood ripening coefficient, in the last week of October according to Bouard (1966).
- Cane thickness (cm).
- Wood pruning weight (kg/vine).

2.2.2 Chemical constituents of leaves

Leaf pigments (chlorophyll a & b, total chlorophylls and total carotenoids (mg/g F.W.) were measured according to Von Wettstein (1957). Percentages of N, P and K and contents of Fe, Zn and Mn (ppm) were measured in the leaf petioles corresponding to the basal clusters (1st week of July) according to Sumner (1986), and Chapman and Pratt (1962).

2.2.3 Yield components

Yield components are expressed as number of clusters per vine and weight (kg/ vine). In the 1st week of July for both seasons, harvesting was done when TSS/ acid ratio parameter in the untreated berries reached 25:1. Cluster weight (g), and cluster dimensions (length and width, cm) were measured.

2.2.4 Physical and chemical characteristics of the berries

The following physical and chemical characteristics of the berries were measured:

- Berry weight (g), dimensions (length and diameter in cm) and berry shape index.
- Total soluble sugars (TSS %) in the juice using hand refractometer.
- Reducing sugars (%) according to (Lane and Eynon, 1923).
- Total acidity (%) as a tartaric acid/100 ml juice), T.S.S/acid ratio (A.O.A.C., 2000).

2.8 Statistical analysis

All the obtained data were tabulated and statistically analyzed according to Anderson-Cook *et al.* (2003). The difference between means were tested using New LSD values at 5% level of the probability for comparing the significance between different treatments.

3. Results

3.1 Some vegetative growth aspects

The obtained data in Table (2) clearly showed that individual or combined applications of citric acid, ascorbic acid, salicylic acid and seaweed extract were significantly accompanied with stimulating the growth characteristics (shoot length, number of leaves/shoots, leaf area, wood ripening coefficient, pruning wood weight per vine and cane diameter) compared to untreated vines. The promotion of growth characteristics was significantly arranged in ascending order of citric acid < ascorbic acid < salicylic acid < seaweed extract. Increasing antioxidants concentrations showed insignificant promotion for growth aspects. However, combined application of antioxidants and seaweed extract were significantly positive than individual use. On average basis of both seasons, the maximum values of shoot length (143.0 cm), leaves number/shoot (27.75), leaf area (148.6 cm^2), wood ripening coefficient (0.95), pruning wood weight/vine (2.09 kg) and cane diameter (1.55 cm) were recorded on the vines received a mixture of 1000 ppm citric acid plus 1000 ppm ascorbic acid plus 200 ppm salicylic acid plus 0.2% seaweed extract. The minimum values of growth parameters were observed on the untreated treatment.

Table (2): Effect of some antioxidants and seaweed extract on some vegetative growth characteristics of Thompson seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	Shoot length (cm)		leaves number/shoot		Leaf area (cm^2)		Wood ripening coefficient		Pruning wood weight/vine (kg)		Cane diameter (cm)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	101.0	102.0	14.0	14.0	118.5	121.0	0.71	0.70	1.61	1.63	1.00	1.00
Citric acid at 250 ppm	103.5	105.0	15.0	16.0	122.5	124.0	0.73	0.74	1.66	1.67	1.11	1.13
Citric acid at 500 ppm	107.0	108.0	16.0	16.0	126.0	126.5	0.75	0.76	1.71	1.72	1.16	1.18
Citric acid at 1000 ppm	111.0	112.0	17.0	17.0	128.0	128.8	0.77	0.78	1.72	1.73	1.21	1.22
Ascorbic acid at 250 ppm	108.0	108.5	16.5	16.8	126.8	127.0	0.75	0.76	1.71	1.72	1.18	1.19
Ascorbic acid at 500 ppm	111.5	112.5	17.5	18.0	129.2	130.5	0.78	0.78	1.74	1.75	1.22	1.23
Ascorbic acid at 1000 ppm	114.0	115.0	19.0	19.2	131.0	132.2	0.79	0.80	1.77	1.78	1.26	1.28
Salicylic acid at 50 ppm	112.5	113.0	18.5	18.8	129.0	130.2	0.78	0.79	1.76	1.77	1.25	1.26
Salicylic acid at 100 ppm	119.0	120.0	20.0	20.0	133.0	133.5	0.81	0.82	1.81	1.82	1.29	1.30
Salicylic acid at 200 ppm	121.0	121.5	20.5	20.8	134.5	135.0	0.83	0.84	1.85	1.86	1.31	1.33
Seaweed extract at 0.05 %	120.0	120.5	20.2	20.9	133.2	133.4	0.82	0.83	1.83	1.48	1.30	1.32
Seaweed extract at 0.1 %	126.0	127.0	22.5	23.0	135.5	136.2	0.85	0.86	1.87	1.90	1.36	1.37
Seaweed extract at 0.2 %	128.0	129.0	23.2	24.0	137.0	138.5	0.88	0.89	1.91	1.92	1.38	1.39
Spraying four materials in low concentration	130.0	131.0	24.0	24.5	141.0	143.0	0.90	0.91	1.95	1.96	1.40	1.41
Spraying four materials in mid concentration	139.0	140.0	26.0	26.2	146.8	147.5	0.94	0.94	1.99	2.01	1.46	1.48
Spraying four materials in high concentration	142.0	144.0	27.5	28.0	148.0	149.2	0.95	0.96	2.08	2.10	1.50	1.55
LSD. at 5%	1.2	1.3	0.9	1.0	1.4	1.5	0.04	0.05	0.17	0.19	0.02	0.03

3.2 Leaf chemical components

Data presented in Tables (3 and 4) realized that treating the vines three times with different antioxidants either individual or in combinations was significantly augmented leaf chemical components; chlorophyll a, and b, total chlorophylls, total carotenoids, N, P, K, Fe, Zn and Mn compared to untreated treatment. The enhancing of these pigments could be arranged in ascending order of citric acid < ascorbic acid < salicylic acid < seaweed extract. There were a gradual promotion of these pigment and some nutrients by increasing antioxidant concentrations then lowered with the higher two concentrations. Two seasons average data revealed that the maximum values of chlorophyll a (3.65 mg/g FW) chlorophyll b (1.78 mg/g FW), total chlorophylls (5.42 mg/g FW), N (2.00%) , P (0.48%) , K (1.49%), Fe (67.0 ppm), Zn (57.0 ppm) and Mn (61.0 ppm) were recorded on the vines that received 1000 ppm citric acid, 1000 ppm ascorbic acid, 200 ppm salicylic acid and 0.2% seaweed extract. During both seasons, the untreated vines produced the lowest values of leaf chemical components.

Table (3): Effect of some antioxidants and seaweed extract on chlorophylls a, b, total chlorophylls, total carotenoids (mg/g FW), N and P (%) in the leaves of Thompson seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	Chlorophyll a (mg/1.0g FW)		Chlorophyll b (mg/1.0gFW)		Total chlorophylls (mg/1.0g FW)		Total carotenoids (mg/1.0g FW)		Leaf N (%)		Leaf P (%)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	2.25	2.28	1.05	1.07	3.30	3.35	1.24	1.26	1.55	1.58	0.11	0.12
Citric acid at 250 ppm	2.41	2.45	1.13	1.14	3.54	3.59	1.32	1.33	1.60	1.61	0.17	0.18
Citric acid at 500 ppm	2.62	2.66	1.20	1.23	3.82	3.89	1.39	1.41	1.63	1.64	0.19	0.20
Citric acid at 1000 ppm	2.71	2.75	1.23	1.26	3.94	4.01	1.42	1.45	1.65	1.66	0.22	0.23
Ascorbic acid at 250 ppm	2.68	2.71	1.21	1.25	3.89	3.95	1.40	1.44	1.64	1.65	0.21	0.22
Ascorbic acid at 500 ppm	2.79	2.81	1.31	1.33	4.10	4.13	1.50	1.52	1.67	1.68	0.24	0.25
Ascorbic acid at 1000 ppm	2.88	2.91	1.34	1.36	4.22	4.25	1.53	1.55	1.69	1.70	0.26	0.27
Salicylic acid at 50 ppm	2.85	2.88	1.35	1.36	4.20	4.24	1.54	1.56	1.68	1.69	0.25	0.28
Salicylic acid at 100 ppm	2.93	2.99	1.41	1.42	4.34	4.41	1.59	1.61	1.72	1.73	0.29	0.30
Salicylic acid at 200 ppm	3.11	3.15	1.46	1.48	4.57	4.63	1.65	1.67	1.74	1.75	0.34	0.35
Seaweed extract at 0.05 %	3.06	3.12	1.45	1.46	4.51	4.58	1.64	1.66	1.74	1.75	0.36	0.37
Seaweed extract at 0.1 %	3.18	3.22	1.51	1.53	4.69	4.75	1.70	1.72	1.81	1.82	0.39	0.41
Seaweed extract at 0.2 %	3.30	3.35	1.55	1.58	4.85	4.93	1.74	1.77	1.83	1.85	0.41	0.43
Spraying four materials in low concentration	3.35	3.41	1.58	1.60	4.93	5.01	1.78	1.80	1.90	1.91	0.42	0.44
Spraying four materials in mid concentration	3.50	3.55	1.66	1.71	5.16	5.26	1.85	1.90	1.95	1.96	0.45	0.46
Spraying four materials in high concentration	3.61	3.68	1.75	1.80	5.36	5.48	1.94	1.98	1.99	2.00	0.47	0.48
LSD. at 5%	**0.08**	**0.09**	**0.04**	**0.05**	**0.22**	**0.24**	**0.05**	**0.07**	**0.06**	**0.08**	**0.03**	**0.03**

Table (4): Effect of some antioxidants and seaweed extract on K (%), Fe, Zn and Mn (ppm) in the leaves of Thompson Seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	Leaf K (%)		Leaf Fe (ppm)		Leaf Zn (ppm)		Leaf Mn (ppm)		Leaf K (%)		Leaf Fe (ppm)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	1.11	1.13	51.0	52.5	41.1	42.2	46.0	46.3	1.11	1.13	51.0	52.5
Citric acid at 250 ppm	1.15	1.16	53.5	54.0	43.4	44.0	48.2	48.8	1.15	1.16	53.5	54.0
Citric acid at 500 ppm	1.18	1.19	55.0	56.5	45.0	46.3	49.8	51.1	1.18	1.19	55.0	56.5
Citric acid at 1000 ppm	1.20	1.21	56.5	57.0	46.4	46.8	51.2	51.6	1.20	1.21	56.5	57.0
Ascorbic acid at 250 ppm	1.19	1.20	56.0	56.5	46.0	46.4	51.0	51.2	1.19	1.20	56.0	56.5
Ascorbic acid at 500 ppm	1.25	1.26	57.5	57.8	47.3	47.5	52.2	52.4	1.25	1.26	57.5	57.8
Ascorbic acid at 1000 ppm	1.27	1.28	58.2	59.0	48.1	49.0	53.0	53.8	1.27	1.28	58.2	59.0
Salicylic acid at 50 ppm	1.26	1.27	57.8	58.0	47.7	48.0	52.6	52.9	1.26	1.27	57.8	58.0
Salicylic acid at 100 ppm	1.31	1.33	58.8	59.0	48.7	49.0	53.5	53.9	1.31	1.33	58.8	59.0
Salicylic acid at 200 ppm	1.33	1.34	59.2	60.0	49.1	49.9	54.0	54.8	1.33	1.34	59.2	60.0
Seaweed extract at 0.05 %	1.32	1.34	59.5	60.3	49.4	50.2	54.3	55.0	1.32	1.34	59.5	60.3
Seaweed extract at 0.1 %	1.37	1.38	60.0	60.8	50.0	50.7	55.0	55.6	1.37	1.38	60.0	60.8
Seaweed extract at 0.2 %	1.39	1.40	61.2	61.7	51.0	51.6	55.9	56.5	1.39	1.40	61.2	61.7
Spraying four materials in low concentration	1.39	1.41	61.0	61.5	51.0	51.4	56.0	56.3	1.39	1.41	61.0	61.5
Spraying four materials in mid concentration	1.46	1.47	64.0	65.0	54.0	55.0	59.0	59.8	1.46	1.47	64.0	65.0
Spraying four materials in high concentration	1.48	1.49	66.0	68.0	56.0	58.0	59.9	61.0	1.48	1.49	66.0	68.0
LSD. at 5%	0.04	0.06	1.4	1.5	1.1	1.2	1.3	1.4	0.04	0.06	1.4	1.5

3.3 Yield and cluster characteristics

Data in Table (5) showed that individual or combined application of different antioxidants were significantly improved yield, clusters number/ vine as well as weight, length and width of cluster over the untreated treatment. The promotion could be arranged in ascending order of citric acid < ascorbic acid < salicylic acid < seaweed extract. The combined application of antioxidants and seaweed extract was significantly superior comparing to the individual use on improving yield and cluster characteristics. The highest yield was attained by using a mixture consists of 1000 ppm citric acid, 1000 ppm ascorbic acid, 200 ppm salicylic acid and 0.2% seaweed extract. For such promised treatment, the yield per vine reached 20.01 and 27.30 kg while the yield of the control vines recorded 15.40 and 16.24 kg during 2021 and 2022 seasons, respectively. The increment percentage of yield weight was 30.52 and 68.1% over the untreated treatment for the 1st and 2nd seasons, respectively.

Table (5): Effect of some antioxidants and seaweed extract on yield (kg) and cluster number/ vine as well as cluster weight and dimensions of Thompson Seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	Clusters No. / vine		Yield/ vine (kg)		Cluster weight (g)		Cluster length (cm)		Cluster width (cm)		Clusters No. / vine	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	28.0	29.0	15.40	16.24	550.0	560.0	24.5	25.0	10.0	10.5	28.0	29.0
Citric acid at 250 ppm	28.0	29.0	15.82	16.53	565.0	570.0	26.0	26.5	11.0	11.5	28.0	29.0
Citric acid at 500 ppm	28.0	30.0	16.24	17.55	580.0	585.0	27.5	28.0	12.5	13.0	28.0	30.0
Citric acid at 1000 ppm	29.0	31.0	17.11	18.44	590.0	595.0	28.0	28.5	13.0	13.5	29.0	31.0
Ascorbic acid at 250 ppm	27.0	30.0	15.80	17.70	585.0	590.0	27.5	28.0	12.0	12.5	27.0	30.0
Ascorbic acid at 500 ppm	28.0	31.0	16.80	18.91	600.0	610.0	29.0	29.5	14.5	15.0	28.0	31.0
Ascorbic acid at 1000 ppm	28.0	33.0	17.22	20.46	615.0	620.0	30.0	30.5	15.0	15.0	28.0	33.0
Salicylic acid at 50 ppm	28.0	32.0	17.08	19.68	610.0	615.0	29.0	29.5	14.0	14.5	28.0	32.0
Salicylic acid at 100 ppm	28.0	34.0	17.64	21.59	630.0	635.0	31.0	31.5	16.0	16.5	28.0	34.0
Salicylic acid at 200 ppm	28.0	35.0	18.20	23.10	650.0	660.0	32.0	33.0	17.0	17.0	28.0	35.0
Seaweed extract at 0.05 %	28.0	34.0	17.92	22.10	640.0	650.0	31.5	32.0	15.0	16.5	28.0	34.0
Seaweed extract at 0.1 %	29.0	36.0	19.14	23.94	660.0	665.0	33.5	34.0	16.5	17.0	29.0	36.0
Seaweed extract at 0.2 %	29.0	37.0	19.43	24.97	670.0	675.0	34.5	35.0	17.5	18.0	29.0	37.0
Spraying four materials in low concentration	29.0	36.0	19.29	24.12	665.0	670.0	34.0	34.5	17.0	17.5	29.0	36.0
Spraying four materials in mid concentration	29.0	38.0	19.72	26.22	680.0	690.0	35.5	36.0	18.5	19.0	29.0	38.0
Spraying four materials in high concentration	29.0	39.0	20.01	27.30	690.0	700.0	36.0	36.5	19.0	19.5	29.0	39.0
LSD. at 5%	NS	1.2	0.6	0.8	8.2	8.4	0.6	0.7	0.3	0.4	NS	1.2

3.4 Physical and chemical characteristics of the berries

Data in Tables (6 and 7) showed that treating the vines three times with different antioxidants either individual or in combinations significantly increased berry weight, dimensions and berry shape index, TSS%, TSS/acid ratio, reducing sugars % and decreasing total acidity (%) compared to the untreated treatment. The promotion of berry quality could be arranged in ascending order of citric acid < ascorbic acid < salicylic acid < seaweed extract. The promotion on berry quality was more obvious with increasing antioxidant concentrations. The combined application of various antioxidants was significantly more effective on improving berries quality than using individual one. Treating the vines with foliar application by a mixture of 1000 ppm citric acid,1000 ppm ascorbic acid, 200 ppm salicylic acid and 0.2% seaweed extract realized the maximum values of berry weight (2.35 and 2.40 g), TSS% (21.5 and 21.7%) and reducing sugars (19.2 and 19.5%) during 2021 and 2022 growing seasons, respectively. The untreated vines produced the lowest values of berry quality. On the other hand, treating Thompson seedless grapevines (H4 stain) with different antioxidants attained the lowest total acidity (%) (0.495 and 490%) in both seasons, respectively. The untreated vines produced berry with the highest total acidity values (0.688 and 0.680%).

Table (6): Effect of some antioxidants and seaweed extract on berry weight, length, diameter and berry shape index of Thompson seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	Berry weight (g)		Berry length (cm)		Berry diameter (cm)		Berry shape index	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	1.70	1.75	1.5	1.6	1.1	1.2	1.36	1.33
Citric acid at 250 ppm	1.77	1.78	1.7	1.8	1.3	1.4	1.31	1.29
Citric acid at 500 ppm	1.83	1.84	1.9	2.0	1.4	1.5	1.35	1.33
Citric acid at 1000 ppm	1.85	1.86	2.0	2.1	1.4	1.5	1.43	1.40
Ascorbic acid at 250 ppm	1.84	1.85	1.9	2.0	1.3	1.4	1.46	1.43
Ascorbic acid at 500 ppm	1.88	1.89	2.2	2.3	1.5	1.5	1.47	1.53
Ascorbic acid at 1000 ppm	1.90	1.91	2.3	2.4	1.6	1.7	1.44	1.41
Salicylic acid at 50 ppm	1.89	1.90	2.1	2.2	1.4	1.5	1.50	1.47
Salicylic acid at 100 ppm	1.95	1.97	2.3	2.3	1.5	1.5	1.53	1.53
Salicylic acid at 200 ppm	2.03	2.05	2.4	2.4	1.6	1.7	1.50	1.41
Seaweed extract at 0.05 %	2.00	2.03	2.2	2.3	1.5	1.6	1.47	1.44
Seaweed extract at 0.1 %	2.11	2.15	2.4	2.4	1.7	1.7	1.41	1.41
Seaweed extract at 0.2 %	2.18	2.20	2.5	2.5	1.8	1.8	1.39	1.39
Spraying four materials in low concentration	2.20	2.23	2.4	2.5	1.6	1.7	1.50	1.47
Spraying four materials in mid concentration	2.32	2.34	2.6	2.7	1.7	1.8	1.53	1.50
Spraying four materials in high concentration	2.35	2.40	2.7	2.8	1.8	1.9	1.50	1.47
LSD. at 5%	0.03	0.04	0.02	0.04	0.01	0.02	0.02	0.02

Table (7): Effect of some antioxidants and seaweed extract on some berry chemical parameters of Thompson seedless grapevines (H4 strain) during 2021 and 2022 seasons.

Treatments	TSS (%)		Reducing sugars (%)		Total acidity (%)		TSS/acid ratio	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	17.5	17.8	15.2	15.6	0.688	0.680	25.4	26.2
Citric acid at 250 ppm	17.9	18.0	15.7	16.0	0.670	0.665	26.7	27.1
Citric acid at 500 ppm	18.3	18.4	16.1	16.3	0.655	0.650	27.9	28.3
Citric acid at 1000 ppm	18.5	18.6	16.3	16.4	0.645	0.640	28.7	29.1
Ascorbic acid at 250 ppm	18.4	18.5	16.2	16.3	0.650	0.645	28.3	28.7
Ascorbic acid at 500 ppm	18.8	18.9	16.6	16.7	0.630	0.620	29.8	30.5
Ascorbic acid at 1000 ppm	19.0	19.1	16.8	16.9	0.615	0.610	30.9	31.3
Salicylic acid at 50 ppm	18.9	19.0	16.7	16.8	0.620	0.615	30.5	30.9
Salicylic acid at 100 ppm	19.4	19.5	17.1	17.2	0.590	0.585	32.9	33.3
Salicylic acid at 200 ppm	19.5	19.6	17.3	17.4	0.580	0.575	33.6	34.1
Seaweed extract at 0.05 %	19.4	19.5	17.2	17.3	0.585	0.580	33.2	33.6
Seaweed extract at 0.1 %	19.8	19.9	17.6	17.7	0.560	0.550	35.4	36.2
Seaweed extract at 0.2 %	20.0	20.2	17.8	17.9	0.530	0.525	37.7	38.5
Spraying four materials in low concentration	20.0	20.2	17.9	18.0	0.525	0.520	38.1	38.8
Spraying four materials in mid concentration	21.0	21.2	18.8	19.0	0.505	0.500	41.6	42.4
Spraying four materials in high concentration	21.5	21.7	19.2	19.5	0.495	0.490	43.4	44.3
LSD. at 5%	0.4	0.5	0.2	0.3	0.022	0.024	0.9	1.1

4. Discussion

4.1 Effect of spraying some antioxidants

The positive action of antioxidants in catching or chelating the free radicals which could result in extending the shelf life of plant cells and stimulating growth aspects is reported by Rao *et al*. (2003). In the meantime, ascorbic acid is considered plant growth as regulator. Also, citric acid plays essential role in single transduction system, membrane stability and functions, activating transporter enzymes metabolism and translocation of carbohydrates (Smirnoff, 1996). The positive action of salicylic acid is adjusting the balance between promoters and inhibitors within plant tissues as well as it improves the tolerance of plants to all stresses and stimulates cell division (Gunes *et al.*, 2007; Hayat *et al.*, 2010; Joseph *et al.*, 2010). The foliar application of different antioxidants causes positive effect in plant growth by enhancing the natural hormones (gibberellins and cytokinins) that stimulate growth factors and various physiological processes such as nutrient uptake, photosynthesis plant pigments respiration as well as protein and hormones biosynthesis that depend on antioxidants availability (Elade, 1992; Oretili, 1987). The obtained results of the current study are agreed with those reported by Bondok-Sawsan *et al.* (2011), Abdelaal and Aly (2013), Abada (2014), Mohamed-Attiat (2016), Gomaa-Marwa (2018), and Mohamed-Attiat (2021). They found that spraying ascorbic, citric and salicylic acids were favourable to enhance the growth and fruiting of grape cvs.

4.2 Effect of spraying seaweed extract

The positive action of seaweed extract application was attributed to the seaweed extract has higher content to some nutrients (N, P, K, Mg, S, Ca, Fe, Zn and Mn) as well as natural hormones, such as IAA, GA_3, cytokinins, amino acids, peptides and some vitamins (B_1, B_2, B_6, and B_{12}) as mentioned by Kannaiyan (2002), and Cabrera and Medina (2003). Seaweed extract eliminates the plant enemies such as insect weeds and microbial passogenes (Planes-Ienyva *et al.*, 2003). It is considered as soil conditions and slow-release fertilizers. These effects of seaweed extract on promoting growth, and fruiting of Thompson seedless grapevines are in according with those obtained by Saleh *et al.* (2006), and Seleem-Basma and Ahmed (2008) on Thompson seedless grapevines, El-Kareem and Abd El-Rahman (2013) on Ruby seedless grapevines, Abd El-Hameed *et al.* (2010) and El-Saman (2010) on Flame seedless grapevines, Abd El-Wahab (2010) on early Superior grapevines, Tony (2016) on Superior grapevines, and Amin Sarah (2020) on Early Sweet grapevines.

5. Conclusion

For promoting the yield and quality of the berry Thompson seedless grapevines (H4 strain) grown on sandy soil under Minia conditions at Egypt, it is advised to spray the vines with a mixture of 1000 ppm citric acid, 1000 pm ascorbic acid, 200 ppm salicylic acid and 0.2% seaweed extract three times on growth start, just after berry setting and one month later.

References

A.O.A.C. (2000), *Official Methods of Analysis*, 17th Ed., The Association of Official Analytical Chemists, Washington D.C, USA.

Abada, M. A. M. and Ahmad, M. (2014), "A comparative study for the effect of green tea extract and some antioxidants on Thompson seedless grapevines", *International Journal of Plant & Soil Science*, Vol. 3 No. 10, pp. 1333–1342.

Abd El-Hameed, H. M., Abada, M. A. and Seleem-Basma, M. (2010), *Reducing inorganic N fertilizer partially by using yeast, seaweed and farmyard manure extracts in Flame seedless grapevines*, 2nd Conference on Agriculture and Environmental Sciences, Minia, Egypt, pp. 81–89.

Abd El-Wahab, M. H. H. (2010), *Relation of fruiting in Superior grapevines with spraying sulphur, magnesium, zinc and boron*, M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

Abdelaal, A. H. M. and Aly, M. M. (2013), "The synergistic effects of using turmeric with some antioxidants on growth, vine nutritional status and productivity of Ruby Seedless grapevines", *Science Journal of Suez Canal*, Vol. 1, pp. 305–308.

Ahmed, F. F. and Morsy, M. H. (1999), "A new method for measuring leaf area in different fruit species", *Minia Journal of Agricultural Research and Development*, Vol. 19, pp. 97¬105.

Amin-Sarah, M. (2020), *Effect of spraying algae extract and selenium on productivity of Early sweet grapevines grown in sandy soil*, M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

Anderson-Cook, C. M. and Alley, M. M. (2003), "Statistical Methods in Agricultural and Experimental Biology", *The American Statistician*, Vol. 57 No. 4, pp. 317–318.

Bondok-Sawsan, A., Shoeib, M. M. and Abada, M. A. (2011), "Effect of ascorbic and salicylic acids on growth and fruiting of Ruby seedless grapevines", *Minia Journal of Agricultural Research and Development*, Vol. 30 No. 1, pp. 85–95.

Bouard, J. (1966), *Recharches, physiologiques sur la vigen at en particulier sur laoudment des serments (in French)*, Thesis Sci. Nat., Bardeux, France.

Cabrera, O., Garza, J. V. and Medina, J. A. (2003), "Use of biofertilizers in agricultural crops in the central region of Mexico", *Agricultura técnica en México*, Vol. 2, pp. 213–225.

Chapman, H. D. and Pratt, P. F. (1961), *Methods of analysis for soil, plant and water*, Division of Agricultural Sciences, University of California, Oakland, USA.

Elade, Y. (1992), "The use of antioxidants to control gray mould (*Botrytic cibera*) and white mould (*Sclerotinia Aclerotiorum*) in various crops", *Plant Pathology*, Vol. 141, pp. 417–426.

El-Kareem, G. M. and El-Rahman, A. M. (2013), "Response of Ruby Seedless grapevines to foliar application of seaweed extract, salicylic acid and roselle extract", *Hortscience Journal of Suez Canal University*, Vol. 1, pp. 294–303.

El-Saman, A. Y. E. (2010), *Response of Flame seedless grapevines growing under El-Mataana conditions to spraying seaweed extract*, M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

Galal, A. A. and Abdou, E. S. (1996), "Antioxidants for the control of fusarial diseases in cowpea", *Egyptian Journal of Phytopathology*, Vol. 24, pp. 1–12.

Gamea- Marwa, A. M. (2018), *Effect of bio- fertilization and antioxidants on vegetative growth and fruiting of Thompson seedless grapevines*, M.Sc. Thesis, Faculty of Agriculture, Assiut University, Egypt.

Gunes, A., Inal, A., Alpaslan, M., Eraslan, F., Bagci, E. G. and Cicek, N. (2007), "Salicylic acid induced changes on some physiological parameters symptomatic for oxidative stress and mineral nutrition in maize (*Zea mays* L.) grown under salinity", *Journal of Plant Physiology*, Vol. 164 No. 6, pp. 728–736.

Hayat, Q., Hayat, S., Irfan, M. and Ahmad, A. (2010), "Effect of exogenous salicylic acid under changing environment: A review ", *Environmental and Experimental Botany*, Vol. 68 No.1, pp. 14–25.

Ho, T. Y., Quigg, A., Finkel, Z. V., Milligan, A. J., Wyman, K., Falkowski, P. G. and Morel, F. M. (2003), "The elemental composition of some marine phytoplankton 1", *Journal of Phycology*, Vol. 39 No. 6, pp. 1145–1159.

Joseph, B, jini, D. and Sujatha (2010), "Insight into the role of exogenous salicylic acid on plants grown under salt environment", *Asian Journal of Crop Science*, Vol. 2 No. 4, pp. 226–235.

Kannaiyan, S. (2002), *Biotechnology of biofertilizers*, Springer, Dordrecht, Netherlands.

Lane, J. H., and Eynon, L. (1923), "Determination of reducing sugars by means of Fehlings solution with methylene blue as indicator", *Journal of the Society of Chemistry and Industry*, Vol. 42, pp. 32¬37.

Mohamed Attiat, A. (2021), *Effect of some bio and organic fertilizers and antioxidants on growth and fruiting of Flame seedless grapevines under Upper Egypt conditions*, Ph.D. Thesis, Faculty of Agriculture and Natural Resources, Aswan University, Egypt.

Mohamed Attiat, A. M. (2016), *Trials for alleviating the adverse effects of salinity on some grapevine cv transplants*, M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

Oretili, J. J. (1987), "Exogenous application of vitamins as regulators for growth and development of plants", *Pflanzenernahr Bodenk*, Vol. 150, pp. 375–391.

Planes-Ienyva, M., Tery, I. A., Figueroa, S. I. and Lores, A. (2003), "Biofertilization as a tool of biotechnology for sustainable agriculture", *Alimentari*, Vol. 40 No. 346, pp. 61–65.

Possingham, J. V. (2003), "On the growing of grapevines in the tropics", In *VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics*, Vol. 662, pp. 39–44.

Rangaswamy, R. (1995), "Randomized complete block design", *A Text Book of Agricultural Statistics*, *New Age International*, pp. 281–309.

Rao, M. V., Koch, J. R. and Davis, K. R. (2000). "Ozone: a tool for probing programmed cell death in plants", *Plant Molecular Biology*, Vol. 44 No. 3, pp. 345–358.

Raskin, I., Skubatz, H., Tang, W. and Meeuse, M. J. D. (1990), "Salicylic acid levels in thermogenic and non-thermogenic plants", *Annals of Botany*, Vol. 66, pp. 376–383.

Saleh, M. M. S., El-Ashry, S. and Gomaa, A. M. (2006), "Performance of Thompson seedless grapevine as influenced by organic fertilizer, humic acid and biofertilizers under sandy soil conditions", *Research Journal of Agriculture and Biological Sciences*, Vol. *2 No.* 6, pp. 467–471.

Seleem-Basma, M. and Ahmed, F. F. (2008), "The promotive effect of seaweed extract on fruiting of Thompson seedless grapevines", *Minia Journal of Agricultural Research and Development*, Vol. 28 No. 1, pp. 60–80.

Smirnoff, N. (1996). "Botanical briefing: the function and metabolism of ascorbic acid in plants", *Annals of Botany*, Vol. 78 No. 6, pp. 661–669.

Sumner, M. E. (1986), *Diagnosis and recommendation integrated system (DRIS) as a guide to orchard fertilization*, ASPAC, Food & Fertilizer Technology Center, Suweon, Korea.

Tony, M. S. S. (2016), *Partial replacement of inorganic N fertilizer in Superior vineyard by using compost enriched with some microorganism*, M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

von Wettstein, D. (1957), "Chlorophyll-letale und der submikroskopische Formwechsel der Plastiden", *Experimental cell Research*, Vol. 12 No.3, pp. 427–506.

Wild, S. A., Voigt, G. K., Iyer, J. G. and Voigt, G. K. (1973), "Soil and plant analysis for tree culture", *Soil Science*, Vol. 116 No. 5, pp. 390.