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Effect of Foliar Application with Seaweed Extract and Different Amino Acids on Vegetative Growth and Chemical Composition of Superior Grapevines

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Abstract: This study was executed during two growing seasons in 2021 and 2022 at a private vineyard located in Al Hawartah, East El-Nile, Minia Governorate. The study investigated the impact of foliar spraying with seaweed extract at concentrations of (0.05%, 0.1% & 0.2%) and three amino acids (methionine, tryptophan, and cystine) at concentrations of (50, 100 & 200 ppm). These treatments were administered three times during the vegetative growth stage, after set, and at one-month intervals. The study aimed to assess the effects on vegetative growth parameters, leaves pigments and leaves nutrient status in ten-year-old "Superior seedless" grapevines. The 30 vines selected for the experiment have as similar vigor as feasible and planted in clay soil. Result of the present work suggested that spraying with seaweed extract was more effective than the amino acids. Combining applications enhanced the parameters more than utilizing each material alone especially at amino acids (200 ppm) + seaweed extract (0.2%), which scored the highest values of primary shoot length, number of leaves per plant, leaf area, pruning wood weight, cane thickness, leaves (chlorophyll, carotenoid content, N, P, K, Fe, Mn and Zn concentration). Lower concentrations had no effect. Based on the current work's findings, it is recommended for economic reasons to spray Superior grapevines with amino acids (100 ppm) + seaweed extract (0.1%), which gave the best vegetative growth and good nutrient content of leaves.

Key words: Superior grapevines, amino acids, tryptophan, cystine, methionine, seaweed extract and chemical content.

1. Introduction

The grapevine (*Vitis vinifera* L.) is widely recognized as the foremost economically significant crop globally, and holds the second position in Egypt. It is widely regarded as one of the most renowned and popular fruits globally due to its exceptional flavor, pleasing taste, and significant nutritional content. The majority of grape varieties grown in

Egypt are table grapes, all of which are European grape cultivars (**Mohamed *et al.*, 2019**). The Superior Seedless grapevine is a highly favored variety of table grape that has been successfully cultivated in Egypt. In the El-Minia region of Egypt, there are certain issues that arise, including low crop productivity and a high incidence of shot berries in grape clusters. These problems have a detrimental impact on the marketing of this particular grape variety. Multiple experiments were conducted to discover alternative approaches to address these issues while simultaneously safeguarding the environment against pollution (**Ali *et al.*, 2023**).

The elevated weather temperatures in Egypt have adverse impacts on the pigmentation and quality of berries. Hence, grape producers in this region, as well as in other climatically similar regions, employ diverse techniques to enhance the quality of their grapes. The methodologies employed in the management of vineyards significantly impact the quality of the grape harvest. Organic bio-stimulants have shown promise in improving plant growth, vigor, crop output, and quality by enhancing the essential nutrients absorption (**Sharma *et al.*, 2023**).

Amino acids, including tryptophan, cysteine, and methionine, perform an essential function in the metabolism of plants. They serve as transporters of organic nitrogen within the plant's organs and act as precursors for essential secondary metabolites in cells of plant (**Dinkeloo *et al.*, 2018**). Several studies on grapevines have demonstrated that the foliar spray of amino acids to the leaves is crucial for promoting development, improving the nutritional state of the vines, increasing output, and improving the quality of the berries **(Hussein, 2017; Mohamed, 2017**). The aromatic amino acid tryptophan is produced by the shikimate pathway, which is started by chorismite (**Tzin and Galili, 2010**). According to **Maeda and Dudareva (2012**), a key role for tryptophan acid in plant development promotion and auxin production regulation has been uncovered. **Abd-Elkader *et al*. (2020)** discovered that the utilize of tryptophan acid through spraying resulted in enhanced vegetative growth and higher production. Applying tryptophan to the leaves resulted in a raise in the overall levels of carotenoids and chlorophyll in the plants. Tryptophan has a crucial role in preventing premature flower and berry drop. It is essential for the development of an enzyme that facilitates the synthesis of auxin, hence enhancing berry set (**Saburi *et al.*, 2014**). Another important amino acid that is involved in many biological reactions is methionine. Proteins and carbon metabolism rely on it, and its sulfur-bound methyl group activates S-adenosylmethionine to produce methane (**Lenhart *et al.*, 2015**). It's also essential for chlorophyll biosynthesis, cellular energy glucosinolates, polyamines, cell wall biosynthesis, and a plethora of secondary metabolites; and DNA methylation relies on it (**Mekawy, 2019**). In addition, Cysteine is a crucial amino acid that includes an amino group, a thiol group, and a carboxylic acid group as reactive centers. The unique configuration of Cysteine allows it to function as a powerful antioxidant and effective scavenger for ROS. A thiol side chain protects against oxidative damage from biotic and abiotic stimuli by facilitating smooth oxidation (**Álvarez *et al.*, 2012; Genisel *et al.*, 2015**). Because S-adenosylmethionine and/or methionine are building blocks for important phytohormones including polyamines and ethylene, these interactions can affect how plants grow and develop (**Sauter *et al.*, 2012; Elkelish *et al.*, 2021**).

Seaweed extract is an organic compound obtained from several marine plant sources and has the capacity to offer multiple advantages as a plant growth regulator. This extract contains a variety of bioactive components, including phytohormones and antioxidants, that have positively impact on the plant growth and development. Seaweed extract has shown promise as a plant growth regulator by animating root growth, improving blooming and fruiting, and boosting yields (**Prajapati *et al.*, 2023**). Seaweed extracts include auxins, cytokinins, gibberellins, antioxidants and trace elements (**Gupta *et al.*, 2021**). It has the potential to increase a plant's resistance to drought, salt, and high temperatures. Seaweed extract, when used as a plant growth regulator, enhances the nutritional content and overall quality of crops, rendering them more appealing to both consumers and producers. An important benefit of utilizing seaweed extract as a plant growth regulator is its environmentally friendly nature. Due to its natural composition, it has no detrimental effects on the environment and is completely safe for human health (**Prajapati *et al.*, 2023**).

The objective of this study was to investigate the possibility of reducing the use of mineral fertilizers by using environmentally friendly fertilizers, specifically seaweed extract and a mixture of three amino acids, as a foliar spray. The study aimed to assess the impact of different concentrations of

these applications on the growth of the Superior grapevine cultivar and the nutritional status of its leaves in the El-Minia Region, Egypt.

2. Materials and Methods

2.1. Experimental grapevines and their growing conditions

Ten-years-old "Superior seedless" grapevines (*Vitis vinifera* L.) grown on their own roots in a private vineyard in Al Hawartah, East El-Nile, Minia Governorate, during 2021 and 2022 seasons were selected to investigate the impact of applying seaweed extract and amino acids on growth, chemical content of leaves, berry yield and quality.

The 30 vines selected for the experiment were intended to have as similar vigour as feasible and planted in clay soil at 3 x 2 m spacing. The grapevines were watered using a surface irrigation system sourced from the Nile River. During each experimental season, the vines were subjected to standard horticultural methods. Pruning was performed in winter during both seasons in the first week of January by using the Gable supporting method was employed for the cane pruning system. Pruning was conducted, resulting in the retention of 84 eyes (6 fruiting canes, each with 12 buds plus six replacement spurs x two eyes) on each vine.

The initial examination of the soil's physical and chemical properties, as outlined by **Wilde *et al.* (1985)**, is presented in Table (A).

Table (A). Mechanical and Physio-chemical analysis during both seasons of selected vineyard soil.

Soil characters		2021/2022
Particle size distribution (%)	Sand	2.31
	Silt	36.83
	Clay	60.86
	Texture class	Clayey
EC ppm (1:2.5 extract)		294
pH (1:2.5 extract)		7.43
Organic matter %		2.11
$CaCO_3$ %		2.31
Soil nutrients	Total N (%)	0.16
	Available P (ppm)	5.24
	Available K (ppm)	496.5
	Zn (ppm)	2.8
	Fe (ppm)	3.1
	Mn (ppm)	3.9
	Cu (ppm)	0.10

2.2. Examined designs and treatments

Ten treatments in a fully randomized block design, and each treatment has three replicates individual or combined of the seaweed extract and combination of three amino acids (methionine, cysteine, and tryptophan) as follows:

1- Control (spray with tap water).

2- Amino acid (50 ppm).

3- Amino acid (100 ppm).

4- Amino acid (200 ppm).

5- Seaweed extract (0.05%).

6- Seaweed extract (0.1%).

7- Seaweed extract (0.2%).

8- Amino acid (50 ppm) + seaweed extract (0.05%).

9- Amino acid (100 ppm) + seaweed extract (0.1%)

10- Amino acid (200 ppm) + seaweed extract (0.2%)

The treatments were administered thrice over the season: first during the vegetative stage, second immediately after fruit set, and third at a one-month interval. The application was done using a hand sprayer, ensuring that the vines were sprayed until the run off.

The analysis of the seaweed extract reported in Table (B) is derived from the work of **James (1994).**

Table (B): Seaweed extract analysis

Characters	Value
Moisture%	6.0
O.M%	45-60
Inorganic matter%	45-60
Protein%	6-8
Carbohydrates %	35-50
Aliginic acid%	10-20
Mannitol%	4-7
Total N%	1.0-1.5
P%	0.02-0.09
K%	1.0-1.2
Ca%	0.2-1.5
S%	3-9
Mg%	0.5-0.9
Cu (ppm)	1.0-6.0
Fe (ppm)	50-200
Mn (ppm)	5-12
Zn (ppm)	10-100
B (ppm)	20-100
Mo (ppm)	1-5
Cytokinin %	0.02
IAA %	0.03
ABA%	0.01

The following characteristics were determined:

Vegetative growth factors

Primary shoot length, number of leaves/shoot, pruning wood weight/vine (kg), cane thickness (mm) and leaf area cm^2: according to **Ahmed and Morsy (1999**)

$$\textbf{Leaf area} = 0.56\ (0.79 \times w^2) + 20.01$$

where, W = the maximum leaf width

Leaves chemical content

At two weeks following fruit set, the 6th and 7th leaves from the growing shoot tips were used to measure the pigments as chlorophyll a, b mg/100 g FW, and total carotenoid mg/100 g FW in leaves using the method of **Von Wettstein (1957**).

N, P, K (%) Zn, Fe, and Mn (ppm) were measured in 20 leaf basal cluster leaf petioles after berry set in the first week of July using the methods mentioned by (**Cottenie *et al.*, 1982 and Balo *et al.*, 1988**).

2.3. Statistical analysis

To compare the means of the studied treatments according to **Mead *et al.* (1993)** by utilizing the new L.S.D. technique at 5%.

3. Results and Discussion

3.1. Characteristics linked to vegetative growth:

The impact of a combination of three amino acids and seaweed extract at varying concentrations in solo or combined way on the vegetative characteristics of Superior grapevines, including primary shoot length, number of leaves per plant, leaf area, pruning wood weight, and cane thickness, during the 2021 and 2022 growing seasons is displayed in Tables (1).

The data presented in Table 1 demonstrate that treating Superior grapevines with a combination of three amino acids and seaweed extract at different dosages, either individually or in conjunction, significantly increased primary shoot length, number of leaves per plant, leaf area, pruning wood weight, and cane thickness compared to untreated vines.

Concerning the impact, a mix of amino acids and seaweed extract individually, after comparing the results with the check treatment, it is clear that all of the treatments significantly increased the vegetative growth parameters of the Superior grapevine. Seaweed extract (SWE) was effective than the amino acids (AA) in enhancement the traits and the most suitable treatment which produced the highest values was the solo treatment of SWE at 0.2% followed by 0.1% without significant difference between them. The two growing seasons followed a similar pattern.

Over the course of the two study seasons, there was a notable interaction between the treatments including amino acids and seaweed extract. Spraying with AA (200 ppm) + SWE (0.2%) resulted in the highest vegetative parameters in both seasons and scored (99.7 & 101.1 cm) for primary shoot length, (23.5 & 23.9) for number of leaves/vine, (101.2 & 101.5 cm^2) for leaf area, (2.45 & 2.54 kg) for pruning wood weight (kg)/vine and (1.67 & 1.72 cm) for can thickness, followed by AA (100 ppm) + SWE (0.1%), neither of the two treatments was significantly different from the other. In contrast, the untreated vines had the lowest mean value (92.0 & 92.8 cm) for primary shoot length, (17.0 & 17.8) for number of leaves/vine, (93.1 & 93.5 cm^2) for leaf area, (1.82 & 1.88 kg) for pruning wood weight (kg)/vine and (1.22 & 1.28 cm) for can thickness in both seasons.

The enhancements mentioned are mostly linked to amino acid compounds found in applied bio-stimulants, which have crucial functions in plant development and the manufacture of chlorophyll (**Sowmya *et al.*, 2023**). **Mohammadipour and Souri (2019a**) asserted that amino acids play a crucial role in protein biosynthesis, which is essential for various aspects of plant growth, including stem and root development, also the expansion of leaf area and number. In addition, amino acids such as alanine, lysine and serine have a role in the production of chlorophyll and carotenoids. Multiple investigations demonstrated that the utilization of amino acids can influence plant growth by stimulating many physiological processes, including protein synthesis, glucose metabolism, and the production of hormone precursors (**El-Beltagi *et al.*, 2023**). It has been suggested that applying certain amino acids (methionine, tryptophan, and cysteine) directly to the leaves will enhance the growth of Superior grapevines as indicated by **Mekawy (2019)**, **El-Kenawy (2022), Sayed (2022) and Waseel *et al.*, (2024)** they all stated that foliar spraying with various amino acids increased the growth aspects of grapevines varieties.

Researchers unanimously concur that utilizing natural plant extracts is advantageous for promoting growth. Possible explanations for the improved growth could be the existence of chemicals that stimulate growth, such as vitamins B complex (**Cabrera *et al*., 2003**) and cytokinin, amino acids, IAA, and GA3 as natural hormones present in seaweed extract (**Blunden, 1991**). Furthermore, the increased concentration of macro and micro elements in the seaweed extract may also contribute to its capacity to stimulate growth. Polyamines, a class of growth regulators, have a pivotal function in stimulating division and elongation of cell, leading to enhanced leaf area and shoot length. These polyamines can be synthesized through various substances such as laminarin, enzymes, alginates, 1.3-1.6 D glucan and polysaccharides (**Colavita *et al*., 2011**). Studies undertaken by several researchers yielded comparable results as **Ahmed (2022), Al-Sagheer *et al*., (2023), Abd El-Moatamed (2024) and Ali *et al*. (2024)**.

Table (1). Impact of applying amino acids and seaweed extract on Superior grapevines vegetative growth aspects in 2021 and 2022 growing seasons

Characteristics / Treatments	Primary shoots length (cm)		Number of leaves/shoot		Leaf area (cm^2)		Pruning wood weight (kg)/vine		Cane thickness (cm)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Control	92.0	92.8	17.0	17.8	93.1	93.5	1.82	1.88	1.22	1.28
AA (50 ppm)	93.5	94.4	18.2	19.1	95.0	95.5	1.93	2.00	1.30	1.38
AA (100 ppm)	95.0	96.0	19.2	20.2	96.5	97.1	2.03	2.12	1.37	1.45
AA (200 ppm)	96.2	97.4	20.0	21.1	97.7	98.4	2.10	2.20	1.41	1.50
SWE (0.05%)	95.4	96.4	20.0	20.7	96.4	96.9	2.13	2.18	1.42	1.47
SWE (0.1%)	97.0	98.1	21.2	22.4	97.8	98.4	2.22	2.28	1.50	1.54
SWE (0.2%)	98.3	99.4	21.9	23.2	98.9	99.7	2.28	2.36	1.53	1.58
AA (50 ppm) + SWE	96.9	98.1	21.4	21.9	98.5	98.6	2.28	2.34	1.57	1.59
AA (100 ppm) + SWE	98.5	99.7	22.7	23.0	100.0	100.2	2.38	2.46	1.63	1.67
AA (200 ppm) + SWE	99.7	101.1	23.5	23.9	101.2	101.5	2.45	2.54	1.67	1.72
New LSD at 5%	**1.4**	**1.5**	**0.9**	**1.0**	**1.3**	**1.4**	**0.08**	**0.09**	**0.05**	**0.06**
AA: Amino acids			**SWE: seaweed extract**							

3.2. Photosynthetic pigments mg/100 g F.W

The average values of photosynthetic pigments (chlorophyll a, b, total chlorophyll, total carotenoid mg/100 g FW) in Superior grapevines were analyzed in relation to foliar spraying with various concentrations of 3 amino acids (tryptophan, cystine and methionine,) and seaweed extract, either individually or in combination, during the winter seasons of 2021 and 2022. The results are presented in Table 2.

Table (2) showed that amino acids and seaweed extract increased photosynthetic pigments in superior grapevine fresh leaves compared to the untreated vines in two growth seasons. As treatment concentrations increased, chlorophyll a, b, total and carotenoid levels rose gradually. The findings revealed that multiple foliar spraying on Superior grapevines with amino acids or seaweed extract at various doses improved leaf photosynthetic pigments relative to the untreated treatment. The examined applications' concentrations improved these characteristics gradually. No change in photosynthetic pigments (a, b, total, and carotenoid) was seen with amino acid or seaweed extract addition under the highest concentrations. Instead of using amino acids, 0.2% seaweed extract topically increased photosynthetic pigments more than the lower dose without significant difference. Both seasons followed the same trend.

Combining applications enhanced the parameters more than utilizing each material alone. The highest mean photosynthetic pigments were found in vines treated with AA (200 ppm) + SWE (0.2%).

Lower concentrations had no effect. A lower AA (100 ppm) + SWE (0.1%) concentration on vines provided the most cost-effective leaves photosynthetic pigments. Under the highest treatment, chlorophyll a achieved 2.64 and 2.733 mg/100g FW, chlorophyll b 1.38 and 1.44 mg/100g FW, total chlorophyll 4.03 and 4.17 mg/100g FW, and total carotenoid 4.2 and 4.6 mg/100g FW during the two seasons. The untreated vines' leaves had 2.21 and 2.17 mg/100g FW of chlorophyll a, 0.99 and 1.00 mg/100g FW of chlorophyll b, 3.20 and 3.27 mg/100g FW of total chlorophyll, and 2.10 and 2.30 mg/100g FW of total carotenoid across the two seasons.

When amino acids are applied to the leaves of vines, they can enhance the rates of photosynthesis and the generation of chlorophyll. This leads to improved plant development, particularly in cases where the climate is unfavorable (**Ertani *et al.*, 2009; Garcia *et al.*, 2011**). Plants that receive amino acids as a supplement generally exhibit elevated amounts of sugar, protein, and other nutrients, indicating their superior nutritional value. Moreover, plants possessing this characteristic exhibit enhanced resilience towards temperature fluctuations, high salt levels, and water scarcity (**Tantawy *et al.*, 2009; Cerdán *et al.*, 2013**). The increase in leaf photosynthesis pigments content may be attributed to the beneficial properties of amino acids, including major and minor elements, vitamins and growth regulators. These components enhance metabolism, cell division, and other biological reactions. Additionally, they activate photosynthesis and promote the formation of essential cellular components such as RNA and DNA, which are crucial for cell division (**Attoa *et al.*, 2002; EL-Naggar *et al.*, 2013; Souri, 2016). El-Kenawy (2022)** discovered that applying amino acids to the leaves three times led to a significant rise in the chlorophyll content of the leaves. The findings about the impact of amino acids on the augmentation of pigment content are in agreement the findings reported by **Ahmed (2022); Zagzog and Qaoud (2023) and Waseel *et al.*, (2024)**.

The elevated levels of seaweed extract likely played a role in the rise of chlorophyll content by inhibiting the degradation of chlorophyll, thereby leading to a raise in chlorophyll levels (**Whapham *et al.*, 1993 and Blunden *et al.*, 1997**). **Salvi *et al.* (2019)** revealed that vines sprayed with seaweed extract enhanced pigment levels due to higher photosynthesis and stomatal conductance. Prior studies demonstrated that applying seaweed extract at elevated quantities yields the most significant pigment levels. The current beneficial outcomes of the seaweed extract product align with the results of **El-Senosy (2022), Belal *et al.* (2023), Abada *et al.* (2023), and Ali *et al.* (2024).**

Table (2). Impact of applying amino acids and seaweed extract on Superior grapevines chlorophyll a, b, total chlorophyll and total carotenoid in 2021 and 2022 growing seasons

Characteristics / Treatments	Chlorophyll a mg/100 g FW		Chlorophyll b mg/100 g FW		Total chlorophyll mg/100 g FW		Total carotenoid mg/100 g FW	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Control	2.21	2.27	0.99	1.00	3.20	3.27	2.1	2.3
AA (50 ppm)	2.30	2.37	1.07	1.08	3.37	3.45	2.7	2.8
AA (100 ppm)	2.39	2.45	1.13	1.15	3.52	3.60	3.2	3.2
AA (200 ppm)	2.43	2.48	1.16	1.19	3.59	3.67	3.4	3.5
SWE (0.05%)	2.40	2.49	1.24	1.26	3.64	3.75	3.1	3.2
SWE (0.1%)	2.47	2.55	1.30	1.31	3.77	3.86	3.4	3.7
SWE (0.2%)	2.50	2.59	1.32	1.35	3.82	3.94	3.5	3.9
AA (50 ppm) + SWE (0.05%)	2.55	2.62	1.30	1.33	3.85	3.95	3.6	3.9
AA (100 ppm) + SWE (0.1%)	2.61	2.69	1.35	1.40	3.96	4.09	4.0	4.3
AA (200 ppm) + SWE (0.2%)	2.64	2.73	1.38	1.44	4.03	4.17	4.2	4.6
New LSD at 5%	**0.05**	**0.05**	**0.04**	**0.05**	**0.08**	**0.09**	**0.3**	**0.4**
AA: Amino acids	**SWE: seaweed extract**							

3.3. Nutrient status of leaves

The data presented in Tables 3 and 4, illustrate the impacts of applying various concentrations of three amino acids (methionine, tryptophan, and cystine) and seaweed extract on the leaves content nutrient (N, P, and K %, as well as Zn, Fe, and Mn ppm) in Superior grapevines across the winter seasons of 2021 and 2022.

3.3.1. N, P and K%

Bio-stimulant treatments as amino acids and seaweed extract, and their interactions significantly affected concentration of nitrogen, phosphorus and potassium in Superior grapevines leaves during both seasons (Table 3). Treatments with either amino acids or seaweed extract alone considerably raised the N, P and K concentration percentage in leaves when contrasted with the control. At greater dosages of the two applications, no statistically significant changes were seen. Utilizing seaweed extract proved to be a superior alternative to employing a combination of amino acids in this regard. The greatest average values of N, P and K% were observed at a concentration of 0.2% for seaweed extract, followed by 0.1%. These levels were far greater than those of the control treatment and the other treatments. Additionally, no notable disparity existed between the two concentrations. The rate of growth over the control was highest for N% at 18.02% and 14.44% for the 0.2% treatment, and at 16.86% and 12.77% for the 0.1% treatment. The concentration of P and K take the same trend across two seasons.

The findings revealed that the addition of dual different levels of amino acids and seaweed extract to the vines resulted in an elevated nitrogen, phosphorus and potassium percentage. The greatest nutrient content was obtained when AA (200 ppm) plus SWE (0.2%), followed by lower concentrations of AA (100 ppm) combined with SWE (0.1%), which failed to demonstrate any discernible variation ($P \leq 0.05$). The scores for the other treatments fell within the average range for both seasons.

Table (3). Impact of applying amino acids and seaweed extract on Superior grapevines leaf N, P and K% in 2021 and 2022 growing seasons

Characteristics / Treatments	Leaf N%		Leaf P%		Leaf K%	
	2021	2022	2021	2022	2021	2022
Control	1.72	1.80	0.15	0.17	1.18	1.20
AA (50 ppm)	1.86	1.88	0.19	0.22	1.23	1.26
AA (100 ppm)	1.94	1.95	0.24	0.26	1.28	1.32
AA (200 ppm)	1.97	1.99	0.26	0.27	1.30	1.35
SWE (0.05%)	1.95	1.97	0.25	0.26	1.27	1.31
SWE (0.1%)	2.01	2.03	0.28	0.31	1.31	1.35
SWE (0.2%)	2.03	2.06	0.30	0.33	1.32	1.38
AA (50 ppm) + SWE (0.05%)	2.00	2.04	0.31	0.32	1.32	1.35
AA (100 ppm) + SWE (0.1%)	2.04	2.10	0.36	0.37	1.36	1.39
AA (200 ppm) + SWE (0.2%)	2.07	2.14	0.37	0.40	1.38	1.42
New LSD at 5%	**0.04**	**0.05**	**0.03**	**0.03**	**0.03**	**0.04**
AA: Amino acids **SWE: seaweed extract**						

3.3.2. Zn, Fe, and Mn (ppm)

The zinc, iron and manganese concentration were significantly increased during both seasons when different forms of amino acids (methionine, tryptophan, and cysteine) and seaweed extract were used solo or in combination, compared to the control (spray with tap water). This information is reported in Table 4 4. The increase in levels of amino acids and/or seaweed extract was found to have a direct correlation with the increase in Zn, Fe and Mn (ppm), as compared to the control group. The micro nutrient content of the vines increased after being sprayed with high doses. Regardless of the season,

there was no discernible variation in the Zn, Fe and Mn (ppm levels at the greatest concentration of the two treatments. During the 2021 and 2022 seasons, a nearest level was observed with either 0.1% or 0.2% seaweed extract. However, the treatment using 0.2% seaweed extract yielded the greatest levels of Zn, Fe and Mn (ppm among all individual treatments.

The amalgamation of seaweed extract and amino acids resulted in an increase in the studied trait. The treatment with the highest traits concentration were associated with AA (200 ppm) plus SWE (0.2%). This treatment recorded zinc concentrations of 60.4 ppm and 60.6 ppm during the 2021 and 2022 seasons, respectively. The treatment with AA (100 ppm) plus SWE (0.1%) recorded zinc concentrations of 58.8 ppm and 59.0 ppm during the same seasons. These two treatments no appreciable difference between them. The same pattern was happened with the concentrations of Fe and Mn (ppm) during two seasons.

Mohammadipour and Souri (2019a and 2019b) found that applying amino acids to the leaves can enhance the uptake and levels of nutrients in the leaves. The effects of micronutrients, particularly zinc and iron, have been well demonstrated (**Zhou *et al.,* 2007; Souri *et al.,* 2018**). Certain amino acids have a specific attraction to several nutrients, and some of these amino acids can even create chelates with other nutrients. **Souri and Hatamian (2019)** noted that this attribute has been extensively employed to enhance the uptake and translocation of micronutrients in plants, such as iron. The advantages of amino acid-bound nutrients are amplified in plants **(Sadak *et al*., 2015; Pranckietienė *et al.,* 2015)**. Furthermore, as mentioned earlier, enhanced photosynthesis can result in higher production of assimilates, improved plant growth, and increased yield as a result of improved nutritional condition of the leaves (**Galili and Amir, 2013; Ma *et al.,* 2017**). A study conducted by **Belal *et al.* (2016**) revealed that applying amino acids to the leaves of Flame Seedless grapevines boosted the levels of N, P, K and Mg in the leaves. The increase in these quantities can be attributed to changes in the levels of certain proteins and amino acids, which promote cell elongation and division. These results align with the findings of **El-Kenawy (2022), Zagzog and Qaoud (2023) and Waseel *et al.,* (2024)**.

The seaweed extract contains hormones that have the ability to augment plant vigour and growth by stimulating root formation and enhancing nutrient absorption. Multiple studies have shown that seaweed extract possesses distinct properties that promote growth. These characteristics have the potential to affect not just the composition of plant roots, but also the chemical, biological, and physical attributes of the soil (**Taskos *et al.,* 2019**). The ability of the seaweed extract to improve nutritional status may be due, in part, to the fact that it contains both macro and micronutrients (**Cabrera *et al.,* 2003**). Consistent with previous research, seaweed extract improves the nutritional value of grapevine leaves are in line with the findings of **El-Senosy (2022), Belal *et al.* (2023), Abada *et al.* (2023**), and **Ali *et al.* (2024)**. These studies showed that when seaweed extract is added to grapevine leaves at higher levels, the content of macro and micro nutrients in the leaves are elevated.

Table (5). Impact of applying amino acids and seaweed extract on Superior grapevines leaf Zn, Fe and Mn ppm in 2021 and 2022 growing seasons

Characteristics / Treatments	Leaf Zn ppm		Leaf Fe ppm		Leaf Mn ppm	
	2021	2022	2021	2022	2021	2022
Control	50.0	50.6	71.1	71.4	51.0	51.6
AA (50 ppm)	52.9	53.1	74.1	74.6	53.7	53.6
AA (100 ppm)	54.9	55.2	75.9	76.3	55.5	55.3
AA (200 ppm)	56.5	56.9	77.4	77.7	57.1	56.8
SWE (0.05%)	54.9	55.0	76.0	76.5	55.8	55.7
SWE (0.1%)	56.8	57.1	77.7	78.1	57.7	57.4
SWE (0.2%)	58.3	58.8	79.1	79.6	59.2	59.0
AA (50 ppm) + SWE (0.05%)	57.0	57.2	78.1	78.6	57.8	57.9
AA (100 ppm) + SWE (0.1%)	58.8	59.0	79.9	80.3	59.5	59.7
AA (200 ppm) + SWE (0.2%)	60.4	60.6	81.4	81.7	61.1	61.3
New LSD at 5%	**1.7**	**1.8**	**1.6**	**1.6**	**1.7**	**1.7**
AA: Amino acids SWE: seaweed extract						

4. Conclusions

Our investigation under El-Minia Governorate conditions found that applying 100 ppm amino acid and 0.1% seaweed extract to the leaves of Superior grapevines three times - during the vegetative stage, immediately after fruit set, and at a one-month interval was the most cost-effective and resulted the highest vegetative growth parameters and good nutrient content.

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تأثير الرش الورقي بمستخلص الأعشاب البحرية ومختلف الأحماض الأمينية على النمو الخضري والمحتوى الكيميائي لكروم العنب سوبريور

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الملخص العربي

أجريت الدراسة خلال موسمي النمو ٢٠٢١ و٢٠٢٢ في مزرعة خاصة بمنطقة الحوارته شرق النيل بمحافظة المنيا لدراسة تأثير الرش الورقي بمستخلص الأعشاب البحرية بتركيزات (٠,٥، ٠,١، ٠,٢%) وثلاثة أحماض أمينيه هي ميثيونين وتربتوفان وسيستين بتركيزات (٥٠، ١٠٠، ٢٠٠ جزء في المليون) ثلاث مرات خلال مرحله النمو وبعد عقد الثمار وبعدها بشهر على النمو الخضري والمحتوى الكيميائي لأوراق كروم العنب سيبريور. تم اختيار ٣٠ كرمه متقاربه في الصفات مزروعة في تربيه طيبنه. وتشير النتائج إلى أن الرش الورقي بمستخلص الأعشاب

البحرية كان أكثر تفوقا عن الأحماض الأمينية ولكن عند الجمع بين المركبين أدى إلى تحسين الصفات المدروسة أكثر من رش كل مركب بمفرده وخاصة عند الرش بمعدل ٢٠٠ جزء في المليون أحماض أمينيه + ٠,٢% مستخلص أعشاب بحريه والتي سجلت أعلى القيم لكل من طول الفرع الرئيسي(سم)، عدد الأوراق / نبات، مساحة الورقة سم^{٢}، سمك القصب سم، وزن خشب التقليم/كرمة كجم ومحتوى الأوراق من (الكلوروفيل والكاروتين، نيتروجين، فوسفور، بوتاسيوم، زنك، حديد ومنجنيز). ولم يتم ملاحظة أي فرق معنوي عند الرش بالتركيزات الأقل وبناءا على النتائج المتحصل عليها يوصى من الناحية الاقتصادية الرش بمعدل ١٠٠ جزء في المليون أحماض أمينيه + ٠,١% مستخلص أعشاب بحريه والتي أعطت أفضل نتائج للصفات الخضرية ومحتوى جيد من العناصر الغذائية للأوراق.

كلمات مفتاحيه: عنب سوبريور، أحماض أمينيه، تربتوفان، سيستين، مثيوين، أعشاب بحريه ومحتوى كيميائي

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