Journal of Sohag Agriscience (JSAS) 2024, 9(1): 183-195

ISSN 2357-0725
https://jsasj.journals.ekb.eg
JSAS 2024; 9(1): 183-195

Received: 14-06-2024
Accepted: 09-09-2024

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The Impact of Using Micronutrients and Amino Acids on Growth, Yield, and Quality of "Early Sweet" Grapevines

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Abstract

"Early Sweet" grapevine is one of the most popular and delicious grape varieties in Egypt. However, it is known for its low yield, which may be attributed to the adverse effects of unfavorable environmental conditions. Micronutrients, like iron, zinc, manganese, molybdenum, and amino acids, have been shown to mitigate the negative effects of unfavorable environmental conditions. A study was conducted in the 2021 and 2022 seasons to assess the impact of applying single and combined treatments of molybdenum (Mo) at 30 ppm, mixed micronutrients (MM) at 150 ppm, and amino acids (AA) at 500 ppm on the growth, yield, and quality of "Early Sweet" grapevines. The results revealed that both individual and combined applications of Mo, MM, and AA significantly enhanced leaf area, increased the concentrations of total chlorophylls, total carotenoids, N, P, K, Mg, Fe Zn, and Mn in the leaves, and improved both yield and grape quality compared to untreated vines. Among the treatments, amino acids (AA) showed the most pronounced effect. The combination of Mo, MM, and AA was more effective compared to applying each component individually. Three sprays of a combination including molybdenum at 30 ppm, mixed micronutrients (Fe, Zn, and Mn) at 150 ppm, and amino acids at 500 ppm were significantly boosted in enhancing the quantitative and qualitative yield of "Early Sweet" grapevines.

Key words: micronutrients, amino acids, grapevine

INTRODUCTION

Grapevine is one of the most significant horticultural crops worldwide, with numerous cultivars of *Vitis vinifera* L. having been commercialized over the past centuries, including popular seedless varieties. Among these, the Early Sweet grapevine cultivar stands out as a prime and widely favored variety, particularly well-suited to Egyptian conditions, despite the introduction of many new seedless grapevine cultivars. In the past, efforts to enhance the yield and improve the physical and chemical properties of this cultivar have largely relied on synthetic chemicals and certain micronutrients aimed at increasing berry weight and dimensions. Recent studies have highlighted the potential role of amino acids in indirectly supporting plant growth and development by boosting the naturally occurring levels of important growth regulators like cytokinins and gibberellins, which are produced in the leaves and transported via the phloem. Amino acids are crucial in both primary and secondary plant metabolism, playing a vital role in the synthesis of compounds essential for fruit quality and production. For example, phenylalanine is integral to producing anthocyanin, the primary pigment responsible for fruit coloration, while asparagine and glutamate link the carbon and nitrogen metabolic cycles, affecting both sugar and protein levels. Additionally, glycine enhances photosynthesis efficiency, leading to increased sugar content and yield. These functions have been well-documented by researchers such as Taiz and Zeiger (2002), Ahmed, *et al.,* (2007), Amin, (2007), Seleem-Basma and Abd El-Hameed, (2008), Mosa, *et al,.* (2015), Wassel *et al.,* (2015), Khattab *et al.,* (2016), Ali *et al.,* (2019), and Hussein (2023). It is a well-known fact that sandy soils are poor of its content of nutrients especially the micro-nutrients. So, trees grown in sandy soil require more intensive cultural practices like fertilization and foliar spraying with macro and micronutrients. Micronutrients are crucial for the proper functioning of enzyme systems and play a vital role in various biological processes that contribute to tree productivity and fruit quality. Elements such as iron, zinc, and boron are particularly essential. Iron is vital for chlorophyll biosynthesis, and its deficiency can significantly reduce photosynthesis and, consequently, yield. Zinc influences the synthesis of tryptophan, a precursor to indole acetic acid, which is important for growth, and also plays a role in starch metabolism. Manganese is a crucial mineral for plant growth and development as well as the control of metabolic processes in several plant cell compartments. It participates in the oxidation or breakdown of indole-3-acetic acid (IAA), which is necessary for respiration Sekhon, (2003). Molybdenum (Mo) is an important micronutrient for plant growth and occurs in several enzymes catalyzing diverse oxidation–reduction reactions in plants Mengel and Kirkby, (2001). Molybdenum is component of the nitrate reductase, nitrogenase, xanthine dehydrogenase, aldehyde oxidase, and sulfite oxidase enzymes. Because of its involvement in the nitrate assimilation, nitrogen fixation processes, and transport of nitrogen compounds in plants, molybdenum plays a crucial role in nitrogen metabolism of plants (Li *et al.,* 2013). Applying micronutrients (Abada, 2002, Abd El-Wahab, 2010, Sayed-Heba, 2010, and Abdelaal *et al*., 2012) demonstrated a clear improvement on various grapevine cvs growth, production, and berries quality. The primary goal of this research was to examine the effects of molybdenum at 30 ppm, mixed micronutrients (Fe, Zn, and Mn) at 150 ppm, and amino acids at 500 ppm either utilized individual or combined applications on yield and quality of “Early Sweet” grapevines.

MATERIALS AND METHODS

Plant material and experimental work:

This study was conducted during 2021 and 2022 seasons on a 48-uniform in vigour 10-years old “Early Sweet” grapevines in a private vineyard located at Tema district, Sohag Governorate, Egypt. This area is characterized by a very hot climate and high solar radiation in summer. Early sweet grapevines spaced 2 m x 3 m grown in sandy soil were used in this investigation. Vines were spur pruned, trellised by a Spanish Parron system with a bud load of 72 buds/ vine {(12 fruiting spur x 5 eyes) + (6 replacements spurs x 2 eye)}. Drip irrigation system was used to supply water and fertilizers to the vines. All of the carefully chosen vines were given the standard horticultural treatments previously used in the vineyard, with the exception of those including the application of molybdenum, mixed micronutrients (Fe, Zn and Mn), and amino acids.

Eight treatments used in this experiment were as follows:

1. Control (untreated vines)
2. Spraying molybdenum (Mo) at 30 ppm.
3. Spraying mixed micronutrients (MM) at 150 ppm.
4. Spraying amino acid (AA) at 500 ppm.
5. Spraying mixed micronutrients (MM) at 150 ppm + molybdenum (Mo) at 30 ppm.
6. Spraying amino acid (AA) at 500 ppm + molybdenum (Mo) at 30 ppm.
7. Spraying Amino acid at 500 ppm (AA) + mixed micronutrients (MM) at 150 ppm.
8. Spraying amino acid (AA) at 500 ppm + mixed micronutrients (MM) at 150 ppm + molybdenum (Mo) at 30 ppm

The vines under investigation were sprayed with Bioflow (a commercial compound containing 27.3% amino acids) at 500 ppm. Mixtures of micronutrients (Fe 3%, Zn 2%, and Mn 2%) at 150 ppm in a chelated on EDTA form, and molybdenum were added as a solution from Folia Stim (a commercial product produced by Queisna Company, containing 15% Mo) at 30 ppm. Each treatment was replicated three times, two vines per treatment. Molybdenum, mixtures of micronutrients, and amino acids were applied by spraying two times Throughout each season: one time when growth was just getting started, (mid-March.) and after berry setting (last week of April). Triton B as a wetting agent was added at 0.05% to all the treatments, including the control treatment. Spraying was done till runoff. Utilizing three replications and two vines per replication, the experiment was designed via a randomized complete block design (RCBD).

The following data were recorded:

Various measurements:

Leaf area (cm^2) according to Ahmed and Morsy, (1999), Average main shoot length (cm), number of leaves per shoot was also recorded. Ten leaves opposite the first basal clusters on the current shoots according to Balo *et al.,* (1988) were taken in the first week of May for determining chlorophylls a and b, total chlorophylls, and total carotenoids (mg/100g F.W.). Percentages of N, P, K, and Mg in the leaves according to (Chapman and Pratt, 1965, and Balo *et al*., 1988) were measured, micronutrients like Fe, Zn, and Mn (as ppm) utilizing atomic absorption spectrophotometer In the work of Jones *et al.*, (1991). Percentage of berry setting was predestined from dividing number of attached berries by total number of flowers per cluster and multiplying the product by 100. In mid-June, when harvesting takes place, the number of clusters on each vine and the yield, measured in kilograms per vine, were noted. Using the volumetric technique referred to by Lane and Eynon, (1965), and explained by A.O.A.C, (2000), five clusters/ vine were obtained in order to measure the following: cluster weight (g), berry weight (g), berry length (cm), berry width (cm), total soluble solids%, reducing sugars%, and total acidity% expressed as g tartaric acid/100 ml juice.

Statistical analysis

Data were analyzed with the analysis of variance (ANOVA) procedure of the XLSTAT program version 2020.5: XLSTAT 2020.5.1. Treatment means were compared by Duncan's multiple range tests at a 5% level of probability in the average of two seasons of study {means with a different letter (s) are significantly different} Steel and Torrie, (1984)

RESULTS

1- Effect of molybdenum, mixed micronutrients, and amino acids on some vegetative growth characteristics:

Data shown in Table 1 demonstrates evident that both singular and combination uses of molybdenum (Mo), mixed micronutrients

(MM), and amino acids (AA) significantly stimulated the three growth aspects, namely main shoot length, number of leaves/shoots, and leaf area, relative to the control. Spraying Mo, MM, and AA was significantly greater than ~~to~~ applying any Mo, MM, and AA individually in promoting these growth features. Using AA was significantly greater than ~~t r9o~~ using Mo, MM, in promoting these growth characteristics. Notable variations in these growth features were revealed between the eight treatments. These materials' combination applications were in this case far more advantageous than their individual uses. The highest results were obtained by using all of the components at the same concentrations: 500 ppm of AA, 150 ppm of MM, and 30 ppm of Mo. The vines without treatment yielded the least amount of value. Throughout both seasons, these outcomes held true. The results discussed above correspond with those attained by Abada, (2002); Ahmed and Abd El-Hameed, (2003); Ahmed *et al*., (2007); Amin, 2007; El- Kady-Hanaa, (2011) ; Ahmed *et al*., (2011a), (2011b), & (2012) and Abdel-Salam-Maha, (2016) on various grapevines cvs.

2- Effect of molybdenum, mixed micronutrients, and amino acids on the leaf chemical components:

It is quite clear from the obtained data in Tables 2 to 4 that single and combined applications of molybdenum (Mo), mixed micronutrients (MM), and amino acids (AA) led to a notable increase in the levels of chlorophylls a and b, total chlorophylls, carotenoids, N, P, K, Mg, Fe, Zn, and Mn in the leaves compared to the control treatment. Applying AA at 500 ppm, MM at 150 ppm, and Mo at 30 ppm, in that decreasing order, significantly increased all leaf chemical components. Applying amino acids or combined micronutrients greatly outperformed the use of a single dose of molybdenum in activating these chemical components. In this regard, applying these materials together was substantially more advantageous than utilizing them separately. The vines that got all amino acids, a mixture of micronutrients, and molybdenum together showed the highest results. The vines without treatment yielded the least amount of value. Throughout both seasons, these outcomes held true. The remarkable capacity of amino acids along with micronutrients to improve plant pigments and facilitate nutrient absorption and translocation N, P, K, Mg, Fe Zn, and Mn in the leaves El- Kady-Hanaa, (2011); Abdelaal *et al.,* (2012), Ahmed *et al.,* (2012) & (2013), Madany, (2017) and Shoug, (2022). unequivocally indicated increased fruit quality and maturation.

3- Effect of molybdenum, mixed micronutrients, and amino acids on the proportion of berry setting:

Table (4) displays data indicating that the proportions of berry setting increased greatly in response to both individual and combination applications of the molybdenum (Mo) at 30 ppm and mixed micronutrients (MM) at 150 ppm, namely Fe, Zn, and Mn, as well as amino acids (AA) at 500 ppm in contrast to the control. Applying AA, MM, and Mo in decreasing order was highly effective in improving the proportion of berries setting. In this regard, using amino acids or combination micronutrients was far more advantageous than just molybdenum. Mixed applications were far more advantageous than applying each material alone in this respect. There were notable variations in berry setting percentage across the eight treatments. The proportion of berry setting on the vines that received all materials combined achieved its maximum values of 14.55 and 14.62%, whereas the untreated vines throughout both seasons achieved the lowest percentages of 9.80 and 9.75%. There was a comparable pattern in both seasons. The same trend was announced by Abada (2002) on “Red Roomy” grapevines El-Kady-Hanaa (2011) on “Thompson seedless” grapevines and Ahmed *et al.*, (2012 and 2013); Abdel-Salam-Maha, (2016); Shoug, (2022) and El-Katawy *et al.*, (2024) on different grapevine cvs.

4- Effect of molybdenum, mixed micronutrients, and amino acids on the yield cluster properties:

Table 5 displays the acquired data, which indicates that treating “Early sweet” grapevines with molybdenum (Mo) at 30 ppm, mixed micronutrients (MM) at 150 ppm, and amino acids (AA) at 500 ppm was greatly followed by an increase in the weight and number of clusters/vine, along with the weight and dimensions of the clusters, in comparison to the control. The promotion very closely related to with using Mo, MM, and AA in ascending order. Applying MM and AA was far more effective in improving these characteristics than using molybdenum (Mo) alone. Combined uses of these materials were much more beneficial than applying each material individually in this regard. There were notable variations in those parameters between the eight treatments. For the vines that received all materials combined throughout the two seasons, the highest yields were observed to be 11.70 and 17.35 kg/vine, correspondingly. The lowest yields (8.38 & 8.79 kg) were obtained by the untreated vines throughout the two seasons, respectively. The results above held true throughout both seasons. The current treatments had no discernible impact on the number of clusters/vine during the study's first season. The critical role that amino acids along with micronutrients play in enhancing yield, number of clusters/vine, cluster weight, and cluster dimensions in comparison to the control can be attributed to their promotive influence on the yield cluster characteristics. The results described above correspond with those attained by Ahmed and Abd El-Hameed (2003); Gridley (2003), Williams *et al.*, (2003; 2004& 2007); Ahmed *et al.*, (2007); Amin (2007); Abdel-Salam-Maha, (2016) and Shoug, (2022) on various grapevine cvs.

5- Effect of molybdenum, mixed micronutrients, and amino acids on some physical and chemical attributes of the berries:

Data acquired and displayed in Tables 6 and 7 demonstrate that individual and combination uses for molybdenum (Mo) at 30 ppm, mixed micronutrients (MM) at 150 ppm, as well as amino acids (AA) at 500 ppm, were noticeably and highly effective in raising the berries' weight and dimensions (both longitudinal and equatorial), T.S.S.%, lowering sugar and T.S.S./acid, and lowering the overall acidity% in comparison to the control. Applying amino acids, combined micronutrients, and molybdenum in decreasing order was found to be strongly linked with increasing the quality of the berries. Quality of the berries was much improved when using amino acids or combined micronutrients, as opposed to applying materials alone. In this regard, combined uses were far more advantageous than applying each material individually. There were notable variations observed throughout the eight treatments concerning these quality measures. Aplying molybdenum, mixed micronutrients, and amino acids all together much outperformed than applied individually. Treating the vines using each of the compounds combined produced the greatest results in terms of quality parameters. On vines that had not received treatment, adverse impacts on quality parameters were observed. The two seasons yielded the same outcomes. The results of Abada (2002); Gridley (2003), Williams *et al.*, (2003; 2004 & 2007) Ahmed and Abd El-Hameed (2003); Ahmed *et al.*, (2007); Amin (2007); Abdelaal *et al.*, (2012), Ahmed *et al.*, (2012&2013), Madany, (2017); Shoug, (2022) and El-Katawy *et al.*, (2024) confirmed the present regarding the beneficial effect of amino acids , and micronutrients on quality of the berries.

Table (1): Effect of molybdenum, mixed micronutrients, and amino acids and their combinations on the main shoot length, number of leaves/shoot, and leaf area of "Early Sweet" grapevines during 2021 and 2022 seasons

Treatments	Main shoot length (cm)			Number of leaves/ shoot			Leaf area $(cm)^2$		
	2021	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
Control (water spray)	108.20 h	108.30 h	**108.25**	13.4 h	13.5 h	**13.45**	110.00 h	110.20 h	**110.10**
(Mo) at 30 ppm	110.40 g	110.45 g	**110.43**	15.5 g	15.7 g	**15.60**	111.08 g	111.60 g	**111.34**
(MM) at 150 ppm	112.20 f	112.35 f	**112.28**	16.7 f	16.9 f	**16.80**	113.00 f	112.95 f	**112.98**
(AA) at 500 ppm	114.45 e	114.65 e	**114.55**	17.4 e	17.5 e	**17.45**	114.27 e	114.45 e	**114.36**
(MM) at 150 ppm+ (Mo) at 30 ppm	114.80 d	114.90 d	**114.85**	18.7 d	18.9 d	**18.80**	114.90 d	114.95d	**114.93**
(AA) at 500 ppm +(Mo) at 30 ppm	115.35 c	115.45 c	**115.40**	19.6 c	20.0 c	**19.80**	115.35 c	115.50 c	**115.43**
(AA) at 500 ppm +(MM) at 150 ppm	116.45 b	116.50 b	**116.48**	21.6 b	21.8 b	**21.70**	116.65 b	116.70 b	**116.68**
Spraying all together at the same conc.	117.20 a	117.25 a	**117.23**	23.8 a	23.9 a	**23.85**	117.85 a	117.80a	**117.83**
L.S.D. at 5%	0.2	0.1		0.2	0.3		0.44	0.12	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (2): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on the leaf content chlorophyll a, b, total chlorophylls, and total carotenoids of "Early Sweet" grapevines during 2021 and 2022 seasons.

Treatments	Chlorophyll a (mg/ 100g F.W.)			Chlorophyll b (mg/ 100g F.W.)			Total chlorophylls (mg/ 100g F.W.)			Total carotenoids (mg/ 100g F.W.)		
	2021	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
Control (water spray)	3.88 h	3.92 h	**3.90**	0.99 h	1.01 h	**1.00**	4.87 h	4.93 h	**4.90**	0.97 h	1.00 h	**0.99**
(Mo) at 30 ppm	4.01 g	4.04 g	**4.03**	1.17 g	1.19 g	**1.18**	5.18 g	5.23 g	**5.21**	1.09 g	1.30 g	**1.20**
(MM) at 150 ppm	4.09 f	4.12 f	**4.11**	1.26 f	1.25 f	**1.26**	5.35 f	5.37 f	**5.36**	1.40 f	1.50 f	**1.45**
(AA) at 500 ppm	4.27 e	4.32 e	**4.30**	1.33 e	1.34 e	**1.34**	5.60 e	5.66 e	**5.63**	1.79 e	1.70 e	**1.75**
(MM) at 150 ppm+ (Mo) at 30 ppm	5.12 d	5.14 d	**5.13**	1.42 d	1.41 d	**1.42**	6.55 d	6.55 d	**6.55**	1.97 d	2.00 d	**1.99**
(AA) at 500 ppm +(Mo) at 30 ppm	5.29 c	5.27 c	**5.28**	1.51 c	1.53 c	**1.52**	6.80 c	6.79 c	**6.80**	2.19 c	2.10 c	**2.15**
(AA) at 500 ppm +(MM) at 150 ppm	5.45 b	5.47 b	**5.46**	1.78 b	1.78 b	**1.78**	7.23 b	7.25 b	**7.24**	2.40 b	2.50 b	**2.45**
Spraying all together at the same conc.	5.98 a	6.02 a	**6.00**	2.02 a	2.04 a	**2.03**	8.00 a	8.06 a	**8.03**	2.81 a	2.80 a	**2.81**
L.S.D. at 5%	0.03	0.03		0.03	0.03		0.04	0.04		0.04	0.02	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (3): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on the leaf content of N, P, K, and Mg (as %) of "Early Sweet" grapevines during 2021 and 2022 seasons.

Treatments	Leaf N %			Leaf P %			Leaf K %			Leaf Mg %		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Control (water spray)	1.49 h	1.48 h	**1.49**	0.165 h	0.166 h	**0.166**	0.99 h	1.02 h	**1.01**	0.47 h	0.48 h	**0.48**
(Mo) at 30 ppm	1.56 g	1.57 g	**1.57**	0.172 g	0.174 g	**0.173**	1.09 g	1.10 g	**1.10**	0.51 g	0.51 g	**0.51**
(MM) at 150 ppm	1.61 f	1.60 f	**1.61**	0.178 f	0.180 f	**0.179**	1.16 f	1.18 f	**1.17**	0.54 f	0.54 f	**0.54**
(AA) at 500 ppm	1.66 e	1.64 e	**1.65**	0.185 e	0.187 e	**0.186**	1.22 e	1.24 e	**1.23**	0.59 e	0.58 e	**0.59**
(MM) at 150 ppm+ (Mo) at 30 ppm	1.70 d	1.69 d	**1.70**	0.191 d	0.192 d	**0.192**	1.28 d	1.29 d	**1.29**	0.63 d	0.63 d	**0.63**
(AA) at 500 ppm +(Mo) at 30 ppm	1.73 c	1.72 c	**1.73**	0.198 c	0.199 c	**0.199**	1.33 c	1.34 c	**1.34**	0.66 c	0.67 c	**0.67**
(AA) at 500 ppm +(MM) at 150 ppm	1.77 b	1.77 b	**1.77**	0.208 b	0.211 b	**0.210**	1.37 b	1.37 b	**1.37**	0.70 b	0.71 b	**0.71**
Spraying all together at the same conc.	1.80 a	1.81 a	**1.81**	0.218 a	0.220 a	**0.219**	1.43 a	1.44 a	**1.44**	0.73 a	0.74 a	**0.74**
L.S.D. at 5%	0.02	0.03		0.002	0.002		0.02	0.02		0.03	0.02	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (4): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on the leaf content of Zn, Fe, Mn, (as ppm) and the percentage of berry setting of "Early Sweet" grapevines during 2021 and 2022 seasons.

Treatments	Leaf Fe (ppm)			Leaf Zn (ppm)			Leaf Mn (ppm)			Berry setting %		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Control (water spray)	50.9 h	51.1 h	**51.0**	51.40 h	51.30 h	**51.4**	52.70 h	52.80 h	**52.75**	9.80 h	9.75 h	**9.78**
(Mo) at 30 ppm	51.8 g	51.9 g	**51.9**	52.00 g	52.20 g	**52.1**	53.20g	53.23 g	**53.22**	10.53 g	10.55 g	**10.54**
(MM) at 150 ppm	52.7 f	52.9 f	**52.8**	52.80 f	52.90 f	**52.9**	53.80 f	53.85 f	**53.83**	11.87f	11.90 f	**11.89**
(AA) at 500 ppm	53.5 e	53.8 e	**53.7**	53.90 e	54.10 e	**54.0**	54.70 e	54.77 e	**54.74**	12.48 e	12.52 e	**12.50**
(MM) at 150 ppm+ (Mo) at 30 ppm	54.4 d	54.6 d	**54.5**	55.30 d	55.50 d	**55.4**	55.30 d	55.37 d	**55.34**	12.80 d	12.80 d	**12.80**
(AA) at 500 ppm +(Mo) at 30 ppm	56.9 c	56.9 c	**56.9**	58.70 c	58.80 c	**58.8**	56.40 c	56.45 c	**56.43**	13.17 c	13.20 c	**13.19**
(AA) at 500 ppm +(MM) at 150 ppm	59.9 b	59.8 b	**59.9**	62.50 b	62.70 b	**62.6**	59.60 b	59.65 b	**59.63**	13.67 b	13.70 b	**13.69**
Spraying all together at the same conc.	63.4 a	63.5 a	**63.5**	66.70 a	66.60 a	**66.7**	65.60 a	65.65 a	**65.63**	14.55 a	14.62 a	**14.59**
L.S.D. at 5%	0.27	0.23		0.21	0.19		0.24	0.18		0.11	0.10	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (5): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on, number of clusters per vine, cluster weight (g.), yield per vine, and length of cluster of "Early Sweet" grapevines during 2021 and 2022 seasons

Treatments	No. of clusters per vine			Av. Cluster weight (g.)			Yield/ vine (Kg.)			Av/ cluster length (cm)		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Control (water spray)	25.00 a	26.00 e	**25.50**	335.00h	338.00 h	**336.50**	8.38 h	8.79 h	**8.59**	21.50 h	21.57 h	**21.54**
(Mo) at 30 ppm	25.00 a	27.00e	**26.00**	345.00 g	347.00 g	**346.00**	8.63 g	9.37 g	**9.00**	22.15 g	22.20 g	**22.18**
(MM) at 150 ppm	26.00 a	28.00 e	**27.00**	356.00 f	359.00 f	**357.50**	9.26 f	10.05 f	**9.66**	23.25 f	23.30 f	**23.28**
(AA) at 500 ppm	25.00 a	30.00 d	**27.50**	375.00 e	379.00 e	**377.00**	9.37 e	11.37 e	**10.37**	24.35 e	24.40 e	**24.38**
(MM) at 150 ppm+ (Mo) at 30 ppm	25.00 a	32.00 c	**32.00**	390.00 d	394.00 d	**392.00**	9.75 d	12.61 d	**11.18**	24.68 d	24.70 d	**24.69**
(AA) at 500 ppm +(Mo) at 30 ppm	26.00 a	33.00 c	**29.50**	415.00 c	418.00 c	**416.50**	10.82 c	13.79 c	**12.31**	25.12 c	25.15 c	**25.14**
(AA) at 500 ppm +(MM) at 150 ppm	26.00 a	35.00 b	**30.50**	428.00 b	430.00 b	**429.00**	11.13 b	15.05 b	**13.09**	25.48 b	25.55 b	**25.52**
Spraying all together at the same conc.	26.00 a	37.00 a	**31.50**	468.00 a	469.00 a	**468.50**	11.70 a	17.35 a	**14.53**	26.25 a	26.30 a	**26.28**
L.S.D. at 5%	1.9	1.92		1.80	1.69		0.73	0.74		0.10	0.10	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (6): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on some physical characteristics of "Early Sweet" grapevines during 2021 and 2022 seasons

Treatments	Av. Cluster width (cm)			Av. Berry weight (g.)			Berry height (cm)			Berry diameter (cm)		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Control (water spray)	12.25 h	12.20 h	**12.23**	3.48 h	3.51 h	**3.50**	1.86 h	1.87 h	**1.87**	1.76 h	1.77 h	**1.87**
(Mo) at 30 ppm	12.85 g	12.88 g	**12.87**	3.80 g	3.83 g	**3.82**	1.90 g	1.89 g	**1.90**	1.79 g	1.80 g	**1.90**
(MM) at 150 ppm	13.15 f	13.17 f	**13.16**	3.95 f	3.98 f	**3.97**	1.96 f	1.97 f	**1.97**	1.84 f	1.85 f	**1.97**
(AA) at 500 ppm	13.65 e	13.70e	**13.68**	4.11 e	4.14 e	**4.13**	2.01 e	2.02 e	**2.02**	1.89 e	1.90 e	**2.02**
(MM) at 150 ppm+ (Mo) at 30 ppm	13.95 d	13.97 d	**13.96**	4.44 d	4.46 d	**4.45**	2.04 d	2.05 d	**2.05**	1.92 d	1.93 d	**2.05**
(AA) at 500 ppm +(Mo) at 30 ppm	14.45 c	14.50 c	**14.48**	4.79 c	4.81 c	**4.80**	2.08 c	2.09 c	**2.09**	1.95 c	1.96 c	**2.09**
(AA) at 500 ppm +(MM) at 150 ppm	14.85 b	14.92 b	**14.89**	4.95 b	4.97 b	**4.96**	2.12 b	2.13 b	**2.13**	1.99 b	2.00 b	**2.13**
Spraying all together at the same conc.	15.25 a	15.32 a	**15.29**	5.36 a	5.38 a	**5.37**	2.18 a	2.19 a	**2.19**	2.03 a	2.02 a	**2.19**
L.S.D. at 5%	0.10	0.08		0.03	0.02		0.02	0.01		0.02	0.01	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

Table (7): Effect of molybdenum, mixed micronutrients, and amino acids, and their combinations on some chemical characteristics of "Early Sweet" grapevines during 2021 and 2022 seasons.

Treatments	T.S.S. %			Reducing sugars %			Total acidity %			T.S.S/ acidity		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Control (water spray)	17.76 h	17.81 h	**17.79**	15.81 h	15.85 h	**15.83**	0.775 a	0.776 a	**0.776**	22.94 g	22.97 g	**22.96**
(Mo) at 30 ppm	17.91g	17.94 g	**17.93**	15.95 g	15.97 g	**15.96**	0.769 ab	0.770 ab	**0.770**	23.28 g	23.29 g	**23.29**
(MM) at 150 ppm	18.17 f	18.23 f	**18.20**	16.09 f	16.12 f	**16.11**	0.762 b	0.762 b	**0.762**	23.84 f	23.92 f	**23.88**
(AA) at 500 ppm	18.45 e	18.51 e	**18.48**	16.38 e	16.42 e	**16.40**	0.745 c	0.746 c	**0.746**	24.77 e	24.82 e	**24.80**
(MM) at 150 ppm+ (Mo) at 30 ppm	18.95 d	18.99 d	**18.97**	16.65 d	16.70d	**16.68**	0.725 d	0.728 d	**0.727**	26.14 d	26.09 d	**26.12**
(AA) at 500 ppm +(Mo) at 30 ppm	19.23 c	19.27 c	**19.25**	16.90 c	16.93c	**16.92**	0.695 e	0.698 e	**0.697**	27.66 c	27.61c	**27.64**
(AA) at 500 ppm +(MM) at 150 ppm	19.62 b	19.64 b	**19.63**	17.35 b	17.38b	**17.37**	0.662 f	0.660 f	**0.661**	29.64 b	29.77 b	**29.71**
Spraying all together at the same conc.	19.94 a	19.97 a	**19.96**	17.85 a	17.91a	**17.88**	0.648 g	0.646 g	**0.647**	30.79 a	30.91 a	**30.85**
L.S.D. at 5%	0.03	0.02		0.04	0.04		0.01	0.01		0.31	0.33	

(Mo) = molybdenum ; (MM) = mixed micronutrients ; (AA)= amino acids

DISCUSSION

Micronutrients and amino acids enhance cell division, root growth, and nutrient absorption. Samiullah *et al*., (1988) and Tzeng and Devay, (1989). Application amino acids enhance sulfur metabolism, activate defense genes and reduce reactive oxygen species (ROS) Mullineaux and Raush, (2005). The beneficial impact of minerals and amino acids on vine fruiting may be explained by their critical functions in the production of organic feeds and plant colours, as well as in promoting enzyme activity and cell division. Another possible reason is the protective role of antioxidants against the adverse impacts of salinity and drought on fruiting Nijjar, (1985) and Samiullah *et al.,* (1988). Many researchers pointed out the positive action of amino acids on growth, such as Ahmed and Abd El-Hameed, (2003); Ahmed *et al*., (2007); Amin, (2007); Abdelaal *et al.,* (2012); Ahmed *et al.,* (2012 & 2013) ; Madany, (2017) and Shoug, (2022). Plant nutrition is greatly influenced by micronutrients. They take role in the creation of vitamins, carbs, and proteins. Because of their effect, photosynthesis rises, cell division is stimulated, resistance to drought rises, immunity to agents that cause illness rises, and ultimately, production rises and their quality enhances. Nijjar, (1985); Gridley (2003); Shoeib and El Sayed (2003); Longbottom *et al*., (2004 & 2005); Karmazin and Adamenko (2005);Williams *et al*., (2003;2004 & 2007); Tariq *et al.,* (2007); El-Katawy *et al*., (2024). Iron is responsible for building chlorophylls through formation of porphyrin, cytochrome, catalaze, pyroxidase and flavoproteins that are beneficial effects in the biological oxidation. It regulates reduction and oxidation reactions and respiration process, the biosynthesis of plant pigments and plant metabolism Nijjar, (1985). Zinc regulates plant growth in a variety of significant ways In addition to boosting the production of various organic foods and IAA and activating several enzymes that regulate plant metabolism, it also promotes cell division, enlargement, water absorption, and nutrient transport. Additionally, it is crucial for limiting the development of the abscission zone and fortifying the cell wall. Yagodin, (1990) and Mengel and Kirkby (2001). Manganese is very effective for improving co-enzymes that promote the production of oxidase, the activity of respiration and oxidation enzymes, and the manufacture of organic acids like citric acid. It also helps N metabolism, Krebs cycle, nitrate reduction and the biosynthesis of IAA Mengel and Kirkby, (2001). The beneficial effects of magnesium on bearing of “Early Sweet” grapevines might be attributed to its essential roles on enhancing activity of different enzymes, the biosynthesis and translocation of carbohydrates fats, proteins and natural hormones, cell division, cell enlargement uptake of water and nutrients, building of chlorophylls and amino acids and seed formation Devlin and Withdam, (1983); Nijjar, (1985) and Mengel and Kirkby, (2001). 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), it could explain the present results. So it has a positive effect on leaf and shoots growth. The importance of molybdenum for plant growth is disproportionate with respect to the absolute amounts required by most plants. Apart from Cu, Mo is the least abundant essential micronutrient found in most plant tissues and is often set as the base from which all other nutrients are compared and measured. Molybdenum is utilized by selected enzymes to carry out redox reactions. Enzymes that require molybdenum for activity include nitrate reductase, xanthine dehydrogenase, aldehyde oxidase and sulfite oxidase. Brent *et al.,* (2005). In another research it was found that molybdenum is also essential for nitrate reductase and nitrogenase enzyme activity Westermann, (2005)

CONCLUSION

Spraying the vines twice with molybdenum (Mo) at 30 ppm, mixed micronutrients (MM) at 150 ppm in EDTA form, and amino acids (AA) at 500 ppm gave the greatest results for production and berry quality of “Early Sweet” grapevines.

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الملخص العربى

تأثير استخدام العناصر الصغرى والأحماض الأمينية على نمو ومحصول وجودة العنب الايرلى سويت

أجريت هذه الدراسة خلال موسمي 2021 و 2022 لاختبار تأثير الاستخدام الفردي و المشترك لرش ثلاثة مواد وهى عنصر المولبيدنيم ومخلوط العناصر الصغرى (الحديد – الزنك – المنجنيز) والاحماض الامينية على بعض صفات النمو الخضري والحالة الغذائية للكرمات وكمية المحصول للكرمة وخصائص الجودة للحبات في كرمات العنب الايرلى سويت النامى تحت ظروف منطقة سوهاج.

الاستخدام الفردي و المشترك للثلاثة مواد كان فعّالاً جداً في تحسين مساحة الورقة و الحالة الغذائية للكرمات و كمية المحصول و خصائص الجودة للحبات و ذلك بالمقارنة بمعاملة الكنترول. و كان أفضل معاملة من المواد المستخدمة هى الاحماض الامينية ومخلوط العناصر الصغرى و احتل عنصر المولبيدنيم المرتبة الأخيرة في هذا الصدد. و كان الاستخدام المشترك أفضل من الاستخدام الفردي لهذه المواد في تحسين هذه الصفات.

لأجل تحسين كمية المحصول و خصائص الجودة للحبات في كرمات العنب الايرلى سويت فإنه ينصح برش الكرمات ثلاث مرات بمخلوط يتكون من الاحماض الامينية بتركيز 500 جزء فى المليون ومخلوط العناصر الصغرى بتركيز 150 جزء فى المليون وعنصر المولبيدنيم بتركيز 30 جزء فى المليون .

الكلمات المفتاحية : العناصر الصغرى ، الاحماض الامينية ، العنب