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Effect of Foliar Application with Different Concentration of Potassium Silicate and / or Seaweed Extract on “Banaty” Grapevines Growth and Chemical Content

Ali, H. A.[1,*]; Uwakiem M. Kh.[2] and Moatamed, O. M.[1]

[1]Hort. Dept. Fac. of Agric. Minia Univ. Egypt

[2]Viticulture Department, Horticulture Research Institute, Agricultural Research Centre, Cairo, Egypt.

[*]**Corresponding author:** ali.sayed1@mu.edu.eg

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Abstract: The current study was carried out in a private vineyard located west of Abu Qirqas Center, Minia Governorate, Egypt. The study was set out to investigate the impact of K-silicate and/or seaweed extract on growth and chemical content of Banaty grapevines, during the two consecutive seasons in 2021 and 2022 with on 30 vines from Banaty Seedless grapevines (10-years old). The experiment was arranged in Randomized complete block design included 10 treatments individual or combined of the potassium silicate and seaweed extract as foliar application with three replicates as following; control (sprayed with tap water), (0.05, 0.1 % 0.2% for each of K-silicate or seaweed extract and the same concentrations for each application combined together. The results indicated that all vegetative aspects and leaves chemical content were increased with increasing studied concentration and the highest mean values scored with foliar application at -silicate (0.2%)+seaweed extract (0.2%) without significant difference with the lower concentration. So, it could be suggested to use lower concentration 0.1% for each of the applications under the same conditions.

Key words: Banaty grapevines, Potassium silicate, Seaweed extract, Vegetative aspects, chemical content.

1. Introduction

Grapes (*Vitis vinifera* L.) are widely considered to be among the most prized, beloved, sought-after, tasty, revitalizing, and beneficial fruit crops on the world (**Mohsen, 2021**). With an annual production of 75.1 million metric tons, grapes rank third among the world's most popular fruits (**FAO, 2020**). In terms of production area and consumption rates, it ranks fourth among fruit crops in Egypt, after only olive (245142), mango (304118), and citrus (456082 fed). During the past ten years, Egypt's grape acreage has grown substantially, reaching 1,904,486 fed. (80036 hectares) with a productive area of 1,74,715 fed. (73409 hectares), yielding 1,60,000 metric tons (9.13 tons/feddan), as reported by **Kabsha *et al.* (2023**). Behira governorate accounts for almost 40% of Egypt's entire grape planted land and 18% of its total production; the cultivation of grapes extends from Alexandria in the north to Aswan in the south (**USDA, 2020**). Climate, soil type, and production technology are the primary characteristics that allow table grapes to be grown all over Egypt. According to **Dhekny (2016**), fresh grapes and grape products are full of healthful phenolic compounds, vitamins, and fiber. In Egypt, the White Banaty grape cultivar is highly valued for both fresh fruit and raisins.

As a result of climate change, viticulture is now more vulnerable than ever. High quality and optimal production are indicated by the climatic and geographical constraints on grapevine growing areas (**Magalhães, 2008**). Climate change will have a greater effect on grapevine phenology, yield, and berry quality due to additional pests and illnesses brought about by milder winters (**Jones 2013 and Fraga *et al.*, 2017**). Numerous efforts have been made to determine which horticulture techniques are most effective in enhancing the yield and berry quality of premium, well-liked, and long-lasting grapes meant for table use (**El-Mehrat *et al.*, 2018**). Thus, any horticultural applications, like as bio stimulants and nutritional elements, that might be made to enhance these qualities would be crucial.

Therefore, in order to supply the necessary elements for vine growth and productivity while preserving a healthy soil structure and a clean environment, it can be advantageous to use and assess various fertilization approaches (**Doaa *et al*., 2019**). The exorbitant expense of fertilizers is one of the biggest issues facing farmers. In addition to causing serious problems including soil salinity and underground water pollution, the overuse of chemical fertilizers has driven up the cost of mineral potassium fertilizer in Egypt. As a result, scientists have concentrated on developing partially safe substitutes for mineral fertilizers that are safe for the environment, humans, and animals (**Belal *et al*., 2017; Abd El Rahman and AlSharnouby, 2021**). According to **Inglese *et al*. (2002**), foliar spray is merely an additional precaution to ensure that plants receive an appropriate amount of nutrients. Although foliar fertilization does not take the place of soil fertilization on crops with broad leaf surfaces, it can improve the efficiency and uptake of nutrients that are provided to the soil (**Kannan, 2010**).

Silicon is an important component of biodynamics because of its reputation in the viticulture for influencing enzyme levels, which in turn induces stress resistance and changes grape quality attributes (**Losada *et al*., 2020**). Grapes' color, scent, bitterness, and astringency are all affected by a broad range of secondary metabolites. An essential component in determining grape quality is the concentration of hydrogen ions in the solution, denoted as pH, which is critical for the biological stability of grape juice. In addition, it affects the ionic structure of specific chemicals, such as anthocyanins (**Savoi *et al.*, 2020**). Potassium silicate is a soluble source of both potassium and silicon. Not only does it add minute amounts of potassium to agricultural production systems, but it also acts as a silica supplement (**Kanai *et al*., 2007**).

An essential type of bio stimulants is the naturally occurring molecules namely marine bioactive substances that are obtained from seaweeds **(Shukla *et al.*, 2019; Rouphael and Colla, 2020**). These compounds' capacity to enhance metabolism, raise antioxidant content, and improve nutrient availability has a positive impact on plant health, growth, and yield (**Zhang *et al.*, 2008**). Seaweed (*Ascophyllum nodosum* L.) contains a diverse range of compounds, such as cytokinins, auxins, and other plant growth regulators (**Khan *et al.*, 2012**). In addition, it contains a lot of organic matter, sterols, vitamins, amino acids, and complex polysaccharides. Therefore, seaweed extract is crucial for plant metabolism, productivity, and enhancing plant growth, fruiting, and harvest. In recent years, it has become a crucial strategy for attaining sustainable agriculture, especially in semi-arid and dry areas where soils lack organic nutrients (**Cataldo *et al.*, 2022**). Seaweed extract has been found to have an impact on the growth, yield, and quality of fruit in a number of grape varieties, including Ruby Seedless (**Stino *et al.*, 2017**), Flame Seedless (Salvi *et al.*, 2019), and Sangiovese (**Masoud *et al.*, 2023**).

The goal of the study to investigate the effect of potassium silicate and/or seaweed extract on some vegetative aspects and its chemical contents of Banaty grapevines under Minia governorate conditions.

2. Material and Methods

Trial Grapevines and their cultivation circumstances

The present study was conducted on 10-years old Banaty Seedless grapevines (*Vitis vinifera* L.), throughout two successive seasons of 2021 and 2022 seasons.

The purpose of this study was to examine the effects of K-silicate and seaweed extract foliar sprays on the growing, yield, and quality of Banaty grapevines in a private vineyard situated west of Abu Qirqas Center, Minia Governorate, Egypt. Thirty vines were nearly identical in terms of growth vigor.

Grapevines grown in clay soil and cultivated at 3 m between rows and 2 m apart between vines (700 vines/fed) under surface irrigation system using Nile water (water table depth > 1.5m). In both seasons, winter trimming was done during the second week of January. The selected vines were trained using typical head pruning method, with each vine having 60 eyes. Additionally, the Egyptian Ministry of Agriculture's recommended insect management, fertigation, and standard agricultural procedures were applied to the experimental vines.

Preliminary testing of the tested soil's physical and chemical characteristics according to **Wilde *et al*., (1985**) were indicated in Table (A).

Table (A): Chemical and physical analysis of vineyard soil.

Soil characters		2022/2023
Particle size distribution (%)	Sand	2.21
	Silt	36.97
	Clay	60.82
	Texture class	Clay
EC ppm (1:2.5 extract)		300
pH (1:2.5 extract)		7.50
Organic matter %		2.19
$CaCO_3$ %		2.25
Soil nutrients	Total N (%)	0.11
	Available P (ppm)	5.29
	Available K (ppm)	495.9
	Zn (ppm)	2.93
	Fe (ppm)	3.32
	Mn (ppm)	4.11
	Cu (ppm)	0.93

Treatments and experimental design

The experiment included 10 treatments individual or combined of the potassium silicate and seaweed extract as foliar application in Randomized complete block design (RCBD) with three replicates as following:

1. Control (sprayed with tap water).
2. Potassium silicate (0.05% K-silicate)
3. Potassium silicate (0.1% K-silicate)
4. Potassium silicate (0.2% K-silicate)
5. Seaweed extract (0.05% SWE).

6. Seaweed extract (0.1% SWE).
7. Seaweed extract (0.2% SWE).
8. K-silicate (0.05%) + SWE (0.05%)
9. K-silicate (0.1%) + SWE (0.1%)
10. K-silicate (0.2%) + SWE (0.2%)

The treatments were sprayed shoots of seedlings with both of K-silicate and seaweed extract three times, the first at the beginning of growth, the second after berry setting, while the third one-month interval.

The seaweed extract analysis presented in Table (B) is based on (**James, 1994).**

Table (B): Analysis of the seaweed extract

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

Data collection

The effects of spraying K-silicate and/or seaweed extract at varying concentrations on berry quality, yield, and growth were assessed using the following metrics.

A- Vegetative development traits:

1. Average mean shoots length (cm).
2. Number of leaves/shoot.
3. Leaf area (cm^2): The following equation was used according to (**Ahmed and Morsy, 1999**) to measure twenty leaves from each vine that were in opposite to the basal clusters;

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

where, W = the maximum leaf width

4. Pruning wood weight/vine (kg).
5. Cane thickness (mm).

B- Leaves chemical content:

1. The following pigments (chlorophyll a, b, total chlorophyll and total carotenoid mg/100 g FW) were quantified in leaves according to Von Wettstein (1957).
2. In accordance with Summer (1985) and Chapman and Pratt (1961), in the 1st week of July, the leaf petioles that correspond to the basal clusters were tested for the percentage of N, P, and K, as well as the level of Zn, Fe, and Mn (ppm).

Statistical analysis

Comparing between the treatments were set as mentioned by **Mead *et al*. (1993)**, using new LSD at 5%.

3. Results and Discussion

3.1. Certain aspects of vegetative growth

Effect of K-silicate and seaweed extract sprays individually or in combine on Bantay grapevines vegetative aspects i.e., main shoot length, number of leaves/plant, leaf area, pruning wood weight and cane thickness during 2021 and 2022 seasons are presented in Table (1).

The concerned results indicated that the main shoot length, number of leaves/plant, leaf area, pruning wood weight and cane thickness significantly increased by foliar application of all treatments (0.05, 0.1 & 0.2 of potassium silicate) and (0.05, 0.1 & 0.2% of seaweed extract) individually or in combination compared with control (spray with tap water) in both seasons. The individual treatments showed that the highest concentration 0.2% of potassium silicate or seaweed extract increased certain aspect of vegetative growth with no significant difference between them. The uppermost values of main shoot length (99.1 & 101.8 cm), number of leaves/plant (25.1 & 25.9), leaf area (175.6 & 178.1 cm^3), pruning wood weight (1.98 & 2.08 kg) and cane thickness (1.07 & 1.12 mm) recorded for treatments of and potassium silicate + seaweed extract (0.2%) followed by (97.8 & 100.6 cm) for treatment of potassium silicate + seaweed extract (0.1%) with no discernible variations between them during both seasons, respectively. Control had the shortest main shoot length (90.4 & 93.1 cm) lowest number of leaves/plant (18.1 & 18.5), leaf area (165.6 & 168.0 cm^3), pruning wood weight (1.69 & 1.70 kg) and cane thickness (0.85 & 0.89 mm), respectively during both seasons. Throughout the two seasons, the vegetative growth mean values for the other treatments examined were in the middle.

The vegetative growth showed no statistically significant difference between K- silicate and seaweed extract treatments as foliar spray, although spraying with seaweed extract was better in some characteristics. Hence, a slight improvement of vegetative growth of Bantay grapevines under both treatments (0.2%) of K-silicate or seaweed extract as compared to the control. But, the combination between them results an improvement in vegetative growth aspects.

This could be because of how potassium silicate affects the vegetative growth of Bantay grapevines; a higher potassium content in the leaf may lead to an increase in cells per leaf, an increase in chloroplasts per cell, and an increase in leaf area **Taiz and Zeiger (2002**). Potassium, on the other hand, is an important macronutrient that is required for plant life since it is important for the activation of numerous enzymes, controls stomata opening and shutting, maintains the permeability of the cell wall, and controls osmotic pressure within the cell (**Al-Mohammadi and Ismail, 2023**). In addition to the Si role, which may be understood in light of Silicon's function as a phenolic endogenous plant growth regulator and a growth promoter (**Hayat *et al.*, 2010**). Applications of silicon enhanced Flame seedless's quality, yield, and growth (**Al-Wasfy, 2014**). The encouraging impact of potassium silicate on vegetative growth of grapevines was emphasized by **Uwakiem (2015)** on Early Sweet grapevines, **Mostafa (2017)** on Superior grapes, **Eisa *et al.* (2023**) on Thompson Seedless grapes, they all indicated an increment in different vegetative aspects due to the applying of potassium silicate on grapevines.

Table (1). Effect of spraying K-silicate and seaweed extract on vegetative aspects of Bantay grapevines during 2021 and 2022 seasons

Characteristics / Treatments	Average main shoots length (cm)		Number of leaves/shoot		Leaf area (cm^2)		Pruning wood weight (kg)/vine		Cane thickness (mm)	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Control	90.4	93.1	18.1	18.5	165.6	168.0	1.69	1.70	0.85	0.89
K- silicate (0.05%)	93.3	95.1	20.5	20.7	170.2	172.2	1.72	1.79	0.91	0.96
K- silicate (0.1%)	95.0	97.5	21.8	22.0	171.6	174.2	1.80	1.86	0.96	1.01
K- silicate (0.2%)	96.3	98.9	22.8	23.1	172.7	175.4	1.85	1.91	0.98	1.04
SWE (0.05%)	94.8	97.4	21.7	22.1	171.8	173.7	1.79	1.86	0.96	1.00
SWE (0.1%)	96.3	99.0	22.9	23.4	173.3	175.3	1.85	1.94	1.01	1.05
SWE (0.2%)	97.5	101.3	23.8	24.4	174.5	176.2	1.89	2.00	1.02	1.08
K silicate (0.05) + SWE (0.05%)	96.2	99.0	23.0	23.5	173.2	175.3	1.86	1.94	1.00	1.05
K- silicate (0.1%)+ SWE (0.1%)	97.8	100.6	24.1	24.8	174.7	176.8	1.93	2.02	1.05	1.10
K- silicate (0.2%)+ SWE (0.2%)	99.1	101.8	25.1	25.9	175.6	178.1	1.98	2.08	1.07	1.12
New LSD at 5%	**1.4**	**1.5**	**1.1**	**1.2**	**1.3**	**1.4**	**0.06**	**0.07**	**0.03**	**0.04**

Researchers all agreed that it is beneficial to use natural plant extracts to encourage growth. There may be growth-promoting compounds readily available, which could explain the enhanced growth, such as vitamins B complex (**Cabrera *et al.*, 2003**) and natural hormones such IAA, amino acids, cytokinin, and GA3 found in seaweed extract (**Blunden, 1991**). Moreover, the seaweed extract's enhanced concentration of macro elements and micro elements may also account for its ability to promote growth. A class of growth regulators known as polyamines, which are essential in promoting elongation and cell division, which in turn increases shoot length and leaf area, can be synthesized via oligosaccharides called laminarin, in addition to alginates, enzymes, polysaccharides, and 1.3–1.6 D-glucan (**Colavita *et al.*, 2011**). Studies yielded similar results conducted on Ruby Seedless grapevines by **Ahmed (2022),** Early Sweet grapevines by **Mohamed *et al.*, (2021**), Flame seedless grapevines by **El-Senosy (2022**), Thompson seedless grapevines by **Al-Sagheer *et al.* (2023**), and Prime seedless grapevines by **Abada *et al.* (2023).** All of these studies showed that the vegetative growth parameters increased as the concentration of seaweed extract increased.

3.2. Leaves chemical content

Results depicted in Tables 2 to 4 express the average values of leaves chemical characters of Bantay grapevines (chlorophyll a, b, total chlorophyll, total carotenoid, leaves N, P, K, Zn, Fe and Mn) as affected by foliar spraying with various concentration of K-silicate and seaweed extract individually or in combination through the winter seasons of 2021 and 2022.

3.2.1. Leaves pigments content mg/g F.W

Table (2) showed the impact of K-silicate and/or seaweed extract on the chlorophyll, a-, b-and total chlorophyll as well as total carotenoid levels in the leaves of Bantay grapevines at various concentrations. The results clearly showed that, compared to the untreated treatment, treating Bantay grapevines with K-silicate and/or seaweed extract at varying concentrations considerably increased the leaves pigment content. As the concentrations of the studied applications rose, gradual improvements on these parameters were noted. There was no discernible improvement in pigment content (a, b, total chlorophyll and carotenoid) when the levels of K-silicate or seaweed extract were increased from 0.1 to 0.2%. Instead of utilizing potassium silicate, it was far better to apply 0.2% seaweed extract topically to increase the pigments concentration. The mentioned parameters were improved greatly when employing combined applications compared to using each material alone. Vine treatments including 0.2%

potassium silicate+0.2% seaweed extract resulted in the highest mean pigments content, while treatments involving lesser concentrations showed no discernible differences. Applying a medium concentration of potassium silicate (0.1%) and seaweed extract (0.1%) to the vines produced the most cost-effective outcomes in terms of leaves pigments content. Chlorophyll a (mg/100g FW) reached 1.39 & 1.37 under the promised treatment, chlorophyll b (mg/100g FW) reached 1.12 & 1.13, total chlorophyll (mg/100g FW) reached 2.52 & 2.50, total carotenoid (mg/100g FW) reached to 9.6 & 10.1, respectively, during the two seasons. During the two seasons, the leaves of the untreated vines attained 1.11 & 1.15 of chlorophyll a (mg/100g FW), 0.93 & 0.95 of chlorophyll b (mg/100g FW), 2.04 & 2.10 of total chlorophyll (mg/100g FW), 6.0 & 6.4 of total carotenoid (mg/100g FW), respectively. During both seasons, the percentage of increment in chlorophyll a (29.73 & 21.74%), chlorophyll b (23.66 & 21.05%), total chlorophyll (26.96 & 21.43) and (60.0 & 57.81%), respectively, when comparing to the control treatment.

Potassium silicate has many benefits in plant nutrition, and many specialists have studied these benefits. All steps of protein synthesis and plant growth require potassium, according to **Arquero *et al.* (2006**). Protein synthesis, metabolite transfer, stomatal function, and internal pH stabilization are all impacted by it. Additionally, **Abd El-Rahman and Hoda (2016)** discovered that, when potassium enhanced the amount of photosynthetic pigments, enzyme activity and appropriate solutes in plant leaves, the physiological response was improved. One possible explanation for silicon beneficial effects is that it has numerous impacts, including reducing oxidative stress, improving plant water content and photosynthetic activity, and so on (**Zhu *et al.*, 2024**). These outcomes align with the findings of **Uwakiem (2015**) on Early Sweet grapevines, **Mostafa (2017)** on Superior grapevines, **Eisa *et al.*, (2023**) on Thompson Seedless grapes and **Awad *et al.*, (2024)** on Flam seedling, they found that foliar application with potassium silicate increased plant pigments, i.e (chlorophyll a, b, total chlorophylls and total carotenoids).

The rise in chlorophyll content resulting from higher concentrations of seaweed extract could be attributed to the decrease in chlorophyll degradation that led to higher chlorophyll levels may have been partially caused by the betaines present in the seaweed extract (**Whapham *et al.*, 1993 and Blunden *et al.*, 1997**). Similarly, as reported by **Salvi *et al.* (2019**), plants that were administered seaweed extract showed an increase in pigment levels through enhanced photosynthesis and stomatal conductance. It has been shown in previous studies that high concentration spraying of seaweed extract yields the highest values of pigments. These results align with those of **Mohamed *et al.* (2021)** on Early Sweet, **El-Senosy (2022**) on Flame seedless, **Belal *et al.*, (2023)** on Early Sweet, and **Abada *et al*. (2023)** on Prime Seedless.

Table (2). Effect of spraying K-silicate and seaweed extract on chlorophyll a, b, total chlorophyll and total carotenoid of Bantay grapevines during 2021 and 2022 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	1.11	1.15	0.93	0.95	2.04	2.10	6.0	6.4
K- silicate (0.05%)	1.19	1.22	0.98	0.99	2.17	2.21	7.1	7.4
K- silicate (0.1%)	1.25	1.26	1.02	1.03	2.27	2.29	7.7	8.1
K- silicate (0.2%)	1.29	1.29	1.05	1.06	2.34	2.35	8.2	8.7
SWE (0.05%)	1.26	1.27	1.03	1.04	2.29	2.31	7.9	8.2
SWE (0.1%)	1.33	1.32	1.08	1.08	2.41	2.40	8.6	9.0
SWE (0.2%)	1.37	1.34	1.10	1.11	2.47	2.45	9.0	9.5
K silicate (0.05) + SWE (0.05%)	1.32	1.31	1.07	1.09	2.39	2.40	8.5	8.9
K- silicate (0.1%)+ SWE (0.1%)	1.39	1.37	1.12	1.13	2.52	2.50	9.1	9.6
K- silicate (0.2%)+ SWE (0.2%)	1.44	1.40	1.15	1.15	2.59	2.55	9.6	10.1
New LSD at 5%	**0.06**	**0.04**	**0.04**	**0.04**	**0.08**	**0.07**	**0.6**	**0.7**

3.2.2. Leaves N, P and K%

Table (3) showed the results of the treatments given to the leaves of Bantay grapevines in terms of nitrogen, phosphorus and potassium content. In both the 2021 and 2022 seasons, leaves phosphorus and potassium content percentage indicated a significant ($P \leq 0.05$) increase in the treatments compared to the untreated vine. However, there was no discernible distinction at ($P \leq 0.05$) between the foliar applications of K-silicate or seaweed extract at concentrations of 0.1 and 0.2% in either season. The nutrient content was higher after applying 0.2% seaweed extract topically compared to the individual treatments. The results indicated that vines supplemented with varying concentrations of potassium silicate and seaweed extract had an increased phosphorus and potassium content percentage. The highest mineral percentage was achieved with a combination of 0.2% K-silicate and 0.2% seaweed extract, followed by the lower concentrations of them that did not differ significantly ($P \leq 0.05$). Scores for the other treatments were in the middle for both seasons.

Table (3). Effect of spraying K-silicate and seaweed extract on leaf N, P and K% of Bantay grapevines during 2021 and 2022 seasons

Characteristics / Treatments	Leaf N%		Leaf P%		Leaf K%	
	2021	2022	2021	2022	2021	2022
Control	1.65	1.68	0.16	0.15	1.10	1.12
K- silicate (0.05%)	1.70	1.71	0.20	0.21	1.15	1.18
K- silicate (0.1%)	1.78	1.79	0.23	0.24	1.20	1.22
K- silicate (0.2%)	1.83	1.85	0.25	0.27	1.23	1.25
SWE (0.05%)	1.79	1.81	0.24	0.25	1.21	1.23
SWE (0.1%)	1.85	1.89	0.27	0.30	1.25	1.27
SWE (0.2%)	1.89	1.95	0.29	0.33	1.27	1.29
K silicate (0.05) + SWE (0.05%)	1.86	1.88	0.28	0.29	1.26	1.27
K- silicate (0.1%)+ SWE (0.1%)	1.93	1.95	0.31	0.34	1.30	1.32
K- silicate (0.2%)+ SWE (0.2%)	1.98	2.01	0.32	0.37	1.33	1.35
New LSD at 5%	**0.06**	**0.07**	**0.03**	**0.04**	**0.04**	**0.04**

3.2.3. Leaves content of Zinc, iron and manganese (ppm)

Data in Table 4, detected that the grapevine sprayed with 0.05, 0.1 and 0.2% K-silicate or/and seaweed extract had a pronounced certain effect on the mean values of zinc and iron and manganese ppm in leaves. The single foliar applications recorded a significant increased the micronutrient content comparing to the control, but 0.1 and 0.2% for potassium silicate or seaweed extract had no significant differences during both seasons. As for the combination treatments, the highest mean value of Zn, Fe and Mn ppm was observed with vines sprayed with 0.2 % potassium silicate+0.2 % seaweed extract comparing to the other treatments followed by the lower concentration, while the lowest mean values indicated with the untreated plants. Both seasons showed the same pattern.

Potassium silicate caused an increase in the nutritional status of Bantay grapevine leaves in terms of N, P, K%, Zn, Fe, and Mn ppm. This showed that K^+ is necessary to activate the ATPase plasmalemma, which establishes the conditions necessary for the existence of metabolites like amino acids and sucrose according to **Barker and Pilbeam (2007**). Many macronutrients' absorption and translocation are impacted by the use of potassium silicate (**Das *et al.*, 2017**). This may also indicate that Si has a function part in enhancing plant nutrient uptake and metal ion compartmentation (**Liang *et al.*, 2007**). Using a variety of nutrients in foliar feeding enhances the growth of roots and the transfer of nutrients from leaves to roots, as well as the roots' uptake of the same substances or nutrients via the spray (**Sakara and Al-Bakry, 2022**). These potassium silicate results are the findings of **Singh *et al.*, (2020)**, **Eisa *et al*. (2023**), and **Rasouli *et al*. (2024)** corroborated the above potassium silicate foliar applying results. These studies also showed that potassium silicate foliar application improved the nutrient status of macro and micronutrients of various grapevines.

Plant hormones included in seaweed extract may promote root development and improve nutrient absorbance, hence boosting overall plant vigor and growth. Several studies have shown the special growth-stimulating properties of seaweed extract, which may alter the soil's biological, chemical, and physical properties in addition to affecting the structure of plant roots (**Taskos *et al.*, 2019**). Furthermore, the seaweed extract's capacity to enhance nutritional status may be explained by include both macro and micronutrients (**Cabrera *et al*., 2003**). Our findings concur with those of **Mohamed *et al.* (2021)** on early sweet grapevine leaves; **El-Senosy (2022)** on flame seedless grapevine leaves; **Belal *et al.* (2023**) on early sweet grapevine leaves; and **Abada *et al*. (2023)** on prime seedless grapevine leaves. They all found that an increase in seaweed extract concentration was associated with a rise in N, P, and K% as well as Fe, Zn, and Mn ppm in grapevine leaves.

Table (4). Effect of spraying K-silicate and seaweed extract on leaf Zn, Fe and Mn ppm of Bantay grapevines during 2021 and 2022 seasons

Characteristics / Treatments	Leaf Zn ppm		Leaf Fe ppm		Leaf Mn ppm	
	2021	2022	2021	2022	2021	2022
Control	50.1	51.0	53.2	54.0	51.5	51.8
K- silicate (0.05%)	57.2	59.1	60.3	60.7	57.6	56.8
K- silicate (0.1%)	60.0	61.5	62.8	62.8	60.0	59.4
K- silicate (0.2%)	61.3	62.8	64.3	64.6	62.0	61.5
SWE (0.05%)	59.3	61.2	62.3	63.0	60.1	59.0
SWE (0.1%)	61.5	63.3	64.0	65.1	62.5	61.3
SWE (0.2%)	62.9	64.5	65.5	66.8	64.4	63.4
K silicate (0.05) + SWE (0.05%)	60.8	63.3	65.0	65.2	62.7	61.5
K- silicate (0.1%)+ SWE (0.1%)	63.0	65.3	66..9	67.1	64.9	63.7
K- silicate (0.2%)+ SWE (0.2%)	64.3	66.6	68.4	68.9	66.8	65.7
New LSD at 5%	**1.5**	**1.4**	**1.7**	**1.9**	**2.1**	**2.2**

4. Conclusion

The highest mean values were obtained with a foliar application of 0.2% potassium silicate + 0.2% seaweed extract; smaller concentrations showed no significant variance. The most cost-effective method for improving growth parameters and chemical contents of "Banaty" grapevines was to treat the plants with a medium dose of potassium silicate (0.1%) and seaweed extract (0.1%). Hence, under the identical circumstances, the research suggests using a mixed medium concentration of 0.1%.

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