Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Attempts to Reduce the Harmful Effects of Salinity on the Growth and Productivity of the Flame Seedless Grapevines

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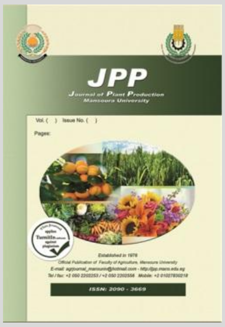

ABSTRACT

Salinity poses significant challenges to viticulture by impairing water availability and nutrient uptake, leading to reduced vine vigor and fruit quality. So, this study aimed to reduce the effect of salinity on the growth and productivity of the flame seedless grapevines using Argenine (100 mg/L), Hydroxy proline (100 mgL), Magnetine (75 g/vine), and Microhysa (250 ml/vine) materials during 2021/2022 and 2022/2023 seasons under Sohag agroclimatic conditions. Through the two seasons, the vines received three additions with the mentioned materials at the growth start, after berry setting and one month later. Growth parameters (total leaf area/vine, and main shoot length), photosynthetic pigments (Total chlorophyll content, and Leaf proline), chemical composition including N, P, K, Ca, Mg, Cl, Na and Fe, yield, Cluster weight, berry weight, berry size, T.S.S, acidity, and T.S.S /acidity ratio were compared to the control treatment for the both investigated seasons. The results of this study revealed that the mixture of Argenine (100 mg/L), Hydroxy proline (100 mgL), Magnetine (75 g/vine), and Microhysa (250 ml/vine) materials recorded the best performance for reducing the harmful effects of salinity on the growth and productivity of the flame seedless grapevines during the two investigated seasons compared to all other treatments. The findings underscore the potential of integrating organic and biological approaches in vineyard management as effective strategies for alleviating salinity. This research contributes valuable insights into sustainable practices for grape cultivation in saline-prone areas, aiming to improve both yield and fruit quality in Flame Seedless Grapevines.

Keywords: Flame seedless grapevines, salinity, sustainable practices

INTRODUCTION

Flame seedless grapevines hold significant importance in Egypt for various reasons, impacting both the agricultural economy and the broader horticultural landscape. As one of the country's major fruit crops, grapes, including the flame seedless variety, rank as the fourth most important fruit in Egypt, contributing substantially to agricultural output. With an annual production of approximately 1.7 million metric tons, flame seedless grapes are particularly notable for their desirable traits and high market demand, making them a key player in both domestic and international markets. Their early maturation and excellent quality enhance their export potential, generating foreign exchange and supporting local farmers' incomes (Aly et al., 2020). In terms of agronomic benefits, flame seedless grapevines are well-suited to Egypt's climatic conditions, especially in newly reclaimed semi-arid areas. This adaptability makes them a valuable crop for expanding agricultural production in less fertile regions. Additionally, the use of specific rootstocks can enhance growth and yield; grafting on rootstocks like Salt Creek or Freedom has been shown to improve fruit quality and increase resistance to pests and diseases, ensuring better productivity under varying environmental conditions (El-Gendy, 2013). Culturally, grapes have been cultivated in Egypt for thousands of years, forming an integral part of the country's agricultural heritage. The flame seedless variety adds a modern touch to this legacy by meeting current market needs while preserving traditional cultivation practices. Moreover, grapes contribute significantly to dietary diversity and nutrition among the Egyptian population, being rich in vitamins, antioxidants, and other beneficial compounds that promote health and wellness (Salem, 2019). However, the flame seedless grapevine is a vital component of Egypt's agricultural sector, offering economic benefits through export opportunities, adaptability to local conditions, and enhancing traditional grape cultivation practices. Its significance extends beyond economics to encompass cultural and nutritional aspects, reinforcing its status as an essential crop in Egypt's horticultural landscape.

Salinity poses significant challenges to the growth and productivity of flame seedless grapevines, particularly in arid and semi-arid regions. The impact of salinity on these vines can be understood through various physiological and biochemical responses. Increasing salinity levels have been shown to adversely affect vine height and the number of leaves. For instance, at a salinity level of 3000 ppm, the average height of flame seedless grapevines significantly decreased, with grafted vines showing better resilience compared to own-rooted ones. The total leaf number per scion also declined with higher salinity, indicating a direct correlation between salt concentration and vegetative growth (Desouky et al., 2015). The survival percentage of flame seedless grapevines varies significantly with salinity levels and rootstock type. Vines grafted on Salt Creek rootstock exhibited higher survival rates (up to 70-80%) under saline

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DOI: 10.21608/jpp.2025.377789.1451

conditions compared to own-rooted vines, which showed a survival rate of only 50% at 3000 ppm. This suggests that rootstock selection is crucial for managing salinity stress (Lo'Ay and EL-Ezz 2021).

Salinity affects the uptake of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K). Studies indicate that as salinity increases, the concentrations of these nutrients in leaf petioles decrease significantly1. Conversely, levels of sodium (Na) and calcium (Ca) often increase under saline conditions, further complicating nutrient balance within the plant (EL Ghayaty et al., 2019). Salinity induces osmotic stress, which reduces water availability to the roots. This stress leads to dehydration and can hinder photosynthesis due to impaired leaf water relations (Ibrahim and Abo-ELwafa 2018). High salt concentrations result in toxic accumulation of ions like Na^+ and Cl^- within plant tissues. This toxicity can lead to physiological damage, reduced photosynthetic efficiency, and ultimately lower yields (Al-Taey and abd Al-Ameer 2023). Salinity stress often triggers an increase in proline levels, which serves as an osmoprotectant but can also indicate stress severity. Elevated proline levels are associated with reduced growth rates and compromised metabolic functions (Ibrahim and Abo-ELwafa 2018).

To counteract the harmful effects of salinity, several strategies have been explored. Utilizing more salt-tolerant rootstocks such as Salt Creek can enhance survival and growth under saline conditions (Desouky et al., 2015). Application of soil conditioners like humic acid has shown promise in improving growth parameters by enhancing nutrient availability and reducing salt toxicity (Lo'Ay and EL-Ezz 2021; EL Ghayaty et al., 2019). Spraying antioxidants such as ascorbic acid can alleviate some negative impacts of salinity by improving physiological responses and promoting growth recovery (Al-Taey and abd Al-Ameer 2023). To mitigate the effects of salinity on flame seedless grapevines in Egypt, several effective treatments can be employed. These treatments focus on improving soil conditions, enhancing plant resilience, and promoting overall growth and productivity.

One of the most promising approaches involves the application of humic acid, which has been shown to significantly reduce soil salinity levels and improve grapevine growth. Studies indicate that applying humic acid at rates of 6 to 9 liters per feddan can decrease soil electrical conductivity (EC) from 4.2 ds/m to around 1.8 ds/m, thereby alleviating osmotic stress on the plants (Ghayaty et al., 2019). Similarly, the use of Uni-sal, an anti-salinity agent, at concentrations of 4 to 6 liters per feddan has demonstrated comparable effects in enhancing growth and fruit quality under saline conditions (Ali et al., 2013). In addition to these organic amendments, incorporating magnetic iron into the soil can improve its structure and nutrient availability. Applying magnetic iron at rates between 100 to 250 kg per feddan has been found beneficial in enhancing leaf area and overall vine health 23. Furthermore, the inoculation of grapevines with arbuscular mycorrhizal fungi can promote better nutrient uptake and increase tolerance to salinity stress, making it a valuable treatment option (Ghayaty et al., 2019). Foliar applications of antioxidants such as ascorbic acid or salicylic acid can also be effective in reducing oxidative stress caused by high salinity levels. These substances help improve physiological responses in grapevines, supporting better growth and development under challenging conditions (Ibrahim and Abo-ELwafa 2018).

Selecting appropriate rootstocks is critical for enhancing salinity tolerance. Grafting flame seedless grapevines onto more salt-tolerant rootstocks like Salt Creek or Freedom has shown improved resilience against saline irrigation water compared to own-rooted vines ((Desouky et al., 2015; Al-Taey and abd Al-Ameer 2023). This strategy not only supports survival but also enhances growth performance in saline environments. Thus, a combination of soil amendments (humic acid and Uni-sal), nutrient enhancers (magnetic iron), biological inoculants (mycorrhizal fungi), foliar treatments (antioxidants), and careful rootstock selection can effectively reduce the adverse effects of salinity on flame seedless grapevines in Egypt, promoting healthier vines and improved yields. Therefore, the detrimental effects of salinity on flame seedless grapevines are multifaceted, impacting growth, nutrient uptake, and overall productivity. Effective management strategies focusing on rootstock selection and soil amendments are essential for sustaining grapevine health in saline environments. Continued research into these interventions will be vital for optimizing grape production under challenging conditions.

So, this study aimed to evaluate the effectiveness of various treatments in reducing the harmful effects of salinity on the growth and productivity of flame seedless grapevines under Sohag agroclimatic conditions during the 2021/2022 and 2022/2023 seasons. Specifically, this research aims to assess the impact of Arginine (100 mg/L), Hydroxy proline (100 mg/L), Magnetine (75 g/vine), and Microhysa (250 ml/vine) on mitigating salinity stress, enhancing vegetative growth, improving yield, and optimizing fruit quality.

MATERIALS AND METHODS

Experiment location

The study was conducted in Sohag, Egypt (figure 1), a region characterized by specific soil, climatic, and agricultural conditions that significantly impact the growth of Flame Seedless Grapevines. The experimental farm was located in Sohag area where covered 0.125 feddan during the 2021/2022 and 2022/2023 seasons. The soils in Sohag are primarily classified as slightly to moderately calcareous, with a texture that ranges from coarse to loamy. Soil profiles indicate a pH range of 8.06 to 8.37, reflecting slightly alkaline conditions, and electrical conductivity (EC) levels vary from 1.16 to 7.00 dSm^{-1}, suggesting that the soils are slightly to moderately saline. Organic matter content is low, ranging from 0.27% to 0.92%, which can affect soil fertility and moisture retention. Additionally, the cation exchange capacity (CEC) is relatively low to medium, ranging from 4.7 to 15.7 cmol(+) kg^{-1}, indicating limited nutrient-holding capacity. The soils also exhibit low levels of total nitrogen, phosphorus, and potassium, which are crucial for healthy plant growth (Thabit et al., 2024). In terms of cultivated crops, the agricultural landscape in Sohag includes a variety of species suitable for the local soil conditions. Major crops cultivated in the region include olives, date palms, watermelon, sesame, and various cereals such as sorghum and barley. These crops are well-adapted to the slightly saline and alkaline soils prevalent in the area; however, certain crops like soybean, citrus fruits, and potatoes are considered unsuitable due to their sensitivity to salinity and specific soil conditions (Moursy and Thabit 2022). Irrigation practices are essential in Sohag due to the arid climate and the necessity to manage salinity levels in the soil. Drip irrigation is commonly employed as it allows for efficient water use while minimizing waterlogging and salinity buildup around the root zones of plants. This method is particularly beneficial for grapevines as it delivers water directly to the root system while reducing evaporation losses. The climatic conditions in Sohag feature a hot desert climate characterized by high temperatures during summer and mild winters. Average summer temperatures can exceed 40°C, while winter temperatures typically range from 10°C to 20°C. Rainfall is minimal and irregular, averaging around 10-20 mm annually, which necessitates reliance on irrigation for crop production. High evaporation rates further exacerbate water scarcity issues, making effective irrigation management critical for sustaining agricultural productivity in this region (Moursy and Thabit 2022). Thus, the combination of slightly saline soils, specific crop suitability, efficient irrigation systems, and distinct climatic conditions plays a pivotal role in determining agricultural practices adopted in Sohag, particularly for flame seedless grapevines. Understanding these factors is essential for developing effective strategies to enhance growth and productivity under challenging environmental conditions.

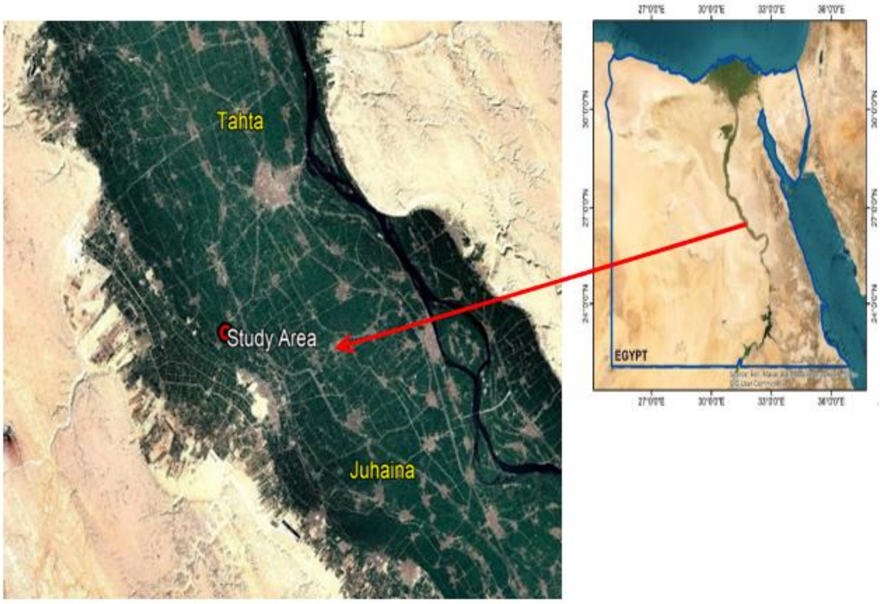


Figure 1. Experiment location map.

Experimental design

The experimental design for this study aimed at evaluating the effects of various treatments on the growth and productivity of flame seedless grapevines under saline conditions in Sohag, Egypt, during the 2021/2022 and 2022/2023 growing seasons. The study utilized a randomized complete block design (RCBD) to ensure statistical validity and reliability of the results.

1. Treatment Groups

The following 12 treatments were applied to the flame seedless grapevines:

T$_1$: Control (no treatment), **T$_2$**:Arginine at 100 ppm, **T$_3$**:Hydroxy proline at 100 ppm,**T$_4$:** Microhysa at 250 ml/vine, **T$_5$:**Magnetine at 75 g/vine,**T$_6$:**Arginine + Hydroxy proline, **T$_7$:**Arginine + Microhysa, **T$_8$**:Arginine + Magnetine, **T$_9$:**Hydroxy proline + Magnetine, **T$_{10}$:**Hydroxy proline + Microhysa,**T$_{11}$**:Magnetine + Microhysa,**T$_{12}$:**Arginine + Hydroxy proline + Magnetine + Microhysa

2. Replication and Blocks

The experimental design included three replicates for each treatment, organized into two blocks. This structure allowed for a total of six experimental units per treatment (3 replicates × 2 blocks = 6). Each block contained 72 grapevines, resulting in a total of 144 grapevines per treatment across both blocks. The planting distance was 2 m x 3 m, the grapevines were trimmed on the December end to be as 60 buds per a vine; and the Goble system was utilized for fixing the grown grapevines. The age of the grapevines was 9 years, and cultivated in sandy soil under drip irrigation.

3. Experimental Units

Each experimental unit consisted of a designated plot containing flame seedless grapevines, with each treatment applied uniformly across the vines within that plot. The total area of the experiment was 0.125 feddan, which was divided into plots to accommodate the treatments and replicates effectively.

4. Randomization

To minimize bias and ensure even distribution of environmental factors, the placement of each treatment was randomized within the blocks. This randomization helped account for variations in soil quality, microclimate, and other external factors that could influence vine growth and productivity.

5. Data Collection

The experimental soils were examined for their physic-chemical properties (Sand, Silt, Clay, pH (1:2.5), EC (dSm^{-1}), soluble cations (Ca^{++}, Mg^{++}, Na^{+}, K^{+}) and soluble anions (HCO_3^-, Cl^-, SO_4^{-}), available iron (Fe), sodium adsorption ration (SAR)). The irrigation water sample was collected from the irrigation source and analyzed for the parameters (pH, EC (dS/m), soluble cations and anions). Grapevines' data collection was conducted at regular intervals throughout both growing seasons (2021/2022 and 2022/2023). Key parameters measured included vegetative growth metrics (total leaf area/vine, and main shoot length), photosynthetic pigments (Total chlorophyll content, and Leaf proline), chemical composition including N, P, K, Ca, Mg, Cl, Na and Fe, yield, Cluster weight, berry weight, berry size, T.S.S, acidity, and T.S.S /acidity ratio. All followed soil and water analysis' procedures were described in Moursy et al. (2022) and Moursy et al. (2020b).

6. Statistical Analysis

Grapevines' data were subjected to statistical analysis using Mstat software (version 8.0.1). The different treatments' means were compared using new Least Significant Difference (LSD) was calculated at 5% significance level according to Snedecor and Cochran (1980) and Steel and Torrie (1980).

RESULTS AND DISCUSSION

Results

1.Soil and Water characterization

Table (1) showed the characterization of the soil and water samples investigated in the experiment. The soil sample analysis reveals a sandy texture with 78.0% sand, 11.3% silt, and 10.7% clay. This high sand content indicates that the soil has excellent drainage and aeration properties, which can be beneficial for root development. However, sandy soils typically have lower nutrient and water retention capabilities compared to finer-textured soils, meaning that crops grown in such conditions may require more frequent irrigation and fertilization, particularly during dry spells. The soil pH measured at 8.1 indicates alkaline conditions. High pH levels can significantly affect nutrient availability; for instance, micronutrients such as iron may become less accessible to plants, potentially leading to deficiencies that can hinder growth and yield. Alkaline soils may also limit the types of crops that can thrive, necessitating careful selection of plant species that are tolerant of such conditions. Electrical conductivity (EC) is recorded at 3.7 dSm^{-1}, which suggests a high level of salinity in the soil. Elevated salinity can adversely impact plant growth by affecting water uptake and causing osmotic stress. Moreover, the salinity may affected by the land topography which lead to the spatial variability of the salinity (Mhalla et al., 2019). This situation may lead to reduced crop yields and could require management strategies such as leaching or the use of salt-tolerant crop varieties to mitigate the negative effects of salinity on plant health. The cation concentrations in the soil provide further insights into its fertility status. Calcium (Ca^{++}) is measured at 9.9 meq/l, magnesium (Mg^{++}) at 4.1 meq/l, sodium (Na^{+}) at 19.3 meq/l, and potassium (K^{+}) at 1.7 meq/l. Calcium is essential for maintaining cell wall structure and overall plant health, while magnesium plays a critical role in photosynthesis. The sodium concentration is notably high, suggesting potential sodicity issues that could lead to soil structure degradation over time. Potassium is vital for various physiological processes within plants but is present at relatively low levels in this soil. In terms of anion concentrations, bicarbonates (HCO_3^-) are measured at 2.8 meq/l, chlorides (Cl^-) at 14.7 mg/l, and sulfates (SO_4^{--}) at 12.7 mg/l. High chloride levels can be detrimental to sensitive crops, while bicarbonates may indicate the presence of carbonates that could further influence pH levels. Sulfates are generally less harmful but should be monitored in conjunction with other salts to ensure they do not contribute to salinity problems (Moursy et al., 2020a). Iron concentration is recorded at 0.9 mg/l, which is important for plant growth since it is crucial for chlorophyll synthesis. However, its availability may be limited due to the alkaline nature of the soil. The Sodium Adsorption Ratio (SAR) value of 7.8 indicates potential sodicity issues; a SAR above 6 suggests that poor soil structure may develop over time, adversely affecting water infiltration and root growth.

Table 1. The experimental soil and irrigation water characterization

Property	Unit	Value
Soil sample		
Sand	%	78.0
Silt	%	11.3
Clay	%	10.7
Texture Grade	---	Sandy
pH (1:2.5)	---	8.1
EC	dSm^{-1}	3.7
Ca^{++}	meq/l	9.9
Mg^{++}	meq/l	4.1
Na^{+}	meq/l	19.3
K^{+}	meq/l	1.7
HCO_3^-	meq/l	2.8
Cl^-	meq/l	14.7
SO_4^{--}	meq/l	12.7
Fe	meq/l	0.9
SAR	---	7.8
Water sample		
pH	---	7.92
EC	dSm^{-1}	0.217
CO_3^{--}	mg/l	0.2
HCO_3^-	mg/l	3.7
Cl^-	mg/l	9.8
SO_4^{--}	mg/l	15.2
Ca^{++}	mg/l	10.9
Mg^{++}	mg/l	4.7
Na^{+}	mg/l	3.4
K^{+}	mg/l	0.3

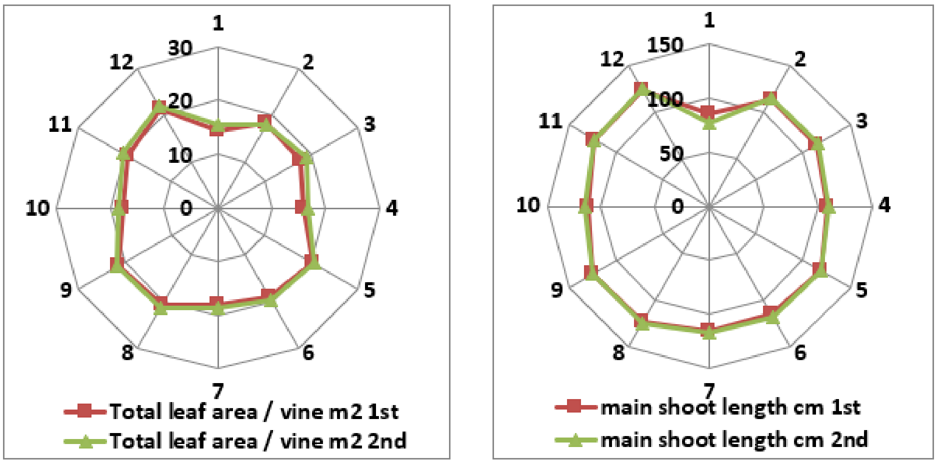
Abbreviations: pH = Potential of Hydrogen; EC = Electrical Conductivity; CO_3^{--} = carbonates; HCO_3^- = Bicarbonates; Cl^- = Chloride; SO_4^{--} = sulfates; Ca^{++} = Calcium; Mg^{++} = Magnesium; Na^+ = Sodium; K^+ = potassium, Fe = Iron; SAR = Sodium Adsorption Ratio.

Turning to the water sample analysis, while the pH value is 7.92, it is a critical parameter as it influences nutrient solubility and biological activity in water systems. The electrical conductivity (EC) value is was 0.217 dSm^{-1}; however, it is essential for assessing the salinity of irrigation water over time. The carbonate concentration is low at 0.2 mg/l, while bicarbonate levels are measured at 3.7 mg/l. These values suggest minimal risk of carbonate precipitation when this water is used for irrigation, making it suitable for agricultural purposes without significant adverse effects on soil chemistry. Chloride levels in the water sample are recorded at 9.8 mg/l, which are relatively low and indicate that this water source should not pose significant risks of salt stress to crops when used for irrigation. Sulfate concentration stands at 15.2 mg/l; similar to chlorides, this level is moderate and generally safe for irrigation practices. Cation concentrations in the water sample include calcium (10.9 mg/l), magnesium (4.7 mg/l), sodium (3.4 mg/l), and potassium (0.3 mg/l). Similar findings were covered in the study of Moursy and Negim (2022). These values suggest that the water contains essential nutrients beneficial for plant growth; calcium and magnesium can enhance soil structure when used for irrigation, while low sodium levels minimize sodicity risks. This comprehensive analysis highlights critical insights into both the soil and water quality that will influence agricultural practices in the area. The sandy texture of the soil necessitates careful management regarding irrigation and fertilization strategies due to its inherent limitations in nutrient and moisture retention. The alkaline pH and high salinity levels present challenges that may require specific management approaches to optimize crop production effectively. Meanwhile, the water sample appears suitable for irrigation based on its low salinity and adequate nutrient content, making it an important resource for supporting agricultural activities in this region.

2.Effect of different treatments on growth parameters, photosynthetic pigments, and chemical composition of flame seedless grapevines during the two investigated seasons

Growth parameters

Table (2) detailing the effects of various treatments on the vegetative growth characteristics of Flame Seedless grapevines during the 2021/2022 and 2022/2023 seasons provides valuable insights into how different interventions can enhance vine performance under saline conditions. The treatments assessed include a control group, individual applications of Argenine and Hydroxy proline, as well as combinations with Microhysa and Magnetine. The control group exhibited the lowest values for both total leaf area and main shoot length, with measurements of 14.47 m² and 85.67 cm, respectively, indicating that untreated vines struggled under salinity stress. In contrast, the application of Argenine at 100 ppm resulted in significant improvements, with total leaf area reaching 18.17 m² and main shoot length increasing to 114.27 cm in the first season. Hydroxy proline also showed notable effects, achieving a total leaf area of 17.63 m² and a similar main shoot length to Argenine. Among the treatments, Magnetine at 75 g/vine emerged as particularly effective, yielding the highest total leaf area (20.50 m²) and maintaining a strong main shoot length (119.13 cm) in the first season. The combination treatments generally outperformed individual applications, with the combination of Argenine, Hydroxy proline, Magnetine, and Microhysa achieving the highest total leaf area of 21.33 m² and main shoot length of 125.17 cm in the second season fig (2).



(a) (b)

Figure 2. Effect of different treatments on (a) total leaf area (m2/vine); (b) main shoot length (cm) during the two investigated seasons.

Table 2. Effect of different treatments on some vegetative growth characteristics of flame Seedless grapevines during 2021/2022 and 2022/2023 seasons

Treatments	Total leaf area / vine		main shoot length	
Unit	m^2		cm	
Season	1st	2nd	1st	2nd
T_1	14.47	15.40	85.67	76.47
T_2	18.17	17.97	114.27	115.87
T_3	17.63	18.97	114.70	116.33
T_4	15.80	16.77	109.17	110.43
T_5	20.50	20.67	119.13	119.17
T_6	19.00	19.93	115.77	117.47
T_7	18.00	18.67	115.67	117.17
T_8	20.77	21.60	123.13	124.57
T_9	21.30	21.63	123.73	124.77
T_{10}	17.67	18.53	112.30	114.33
T_{11}	19.47	20.33	122.10	123.07
T_{12}	21.33	21.90	124.03	125.17
LSD (0.05)	1.22	1.46	3.69	2.65
minimum	14.47	15.40	85.67	76.47
maximum	21.33	21.90	124.03	125.17

T_1: Control (no treatment), T_2:Arginine at 100 ppm, T_3:Hydroxy proline at 100 ppm, T_4: Microhysa at 250 ml/vine, T_5:Magnetine at 75 g/vine, T_6:Arginine + Hydroxy proline, T_7:Arginine + Microhysa, T_8:Arginine + Magnetine, T_9:Hydroxy proline + Magnetine, T_{10}:Hydroxy proline + Microhysa, T_{11}:Magnetine + Microhysa, T_{12}:Arginine + Hydroxy proline + Magnetine + Microhysa

This suggests a synergistic effect where multiple treatments together significantly enhance growth compared to single treatments. The data also indicate a general trend of improvement from the first to the second season across most treatments, highlighting the potential for enhanced growth conditions or treatment effectiveness over time. Statistical analysis confirms that these differences are significant at a $p < 0.05$ level, underscoring the reliability of these findings. The similar findings were observed in the previous research studies of Ali et al. (2013); Abd El-Rahman et al. (2019); and Ahmad (2016).

Photosynthetic pigments

The table (3) illustrating the effects of various treatments on photosynthetic pigments in Flame Seedless grapevines during the 2021/2022 and 2022/2023 seasons highlights significant differences in total chlorophyll content and leaf proline levels. The control group, which received no treatment, recorded a total chlorophyll content of 30.50% in the first season, decreasing slightly to 29.40% in the second season. In contrast, treatments with Argenine at 100 ppm resulted in a notable increase in chlorophyll content, reaching 47.80% in the first season and 48.67% in the second season, indicating that this treatment effectively enhances photosynthetic capacity.

Hydroxy proline also demonstrated beneficial effects, with total chlorophyll levels of 45.97% and 47.00% across the two seasons. Other treatments, such as Microhida and Magnetine, showed moderate improvements in chlorophyll content compared to the control but were less effective than Argenine and Hydroxy proline. Notably, the combination of Argenine and Hydroxy proline yielded a total chlorophyll content of 48.00% in the first season and 48.83% in the second season, suggesting that these treatments work synergistically to enhance photosynthetic pigment levels.

In terms of leaf proline accumulation, which is often associated with stress responses in plants, the control group exhibited low levels (0.13 mg/100g FW in the first season), while most treatments resulted in reduced proline concentrations, indicating improved stress tolerance. For instance, Argenine treatment led to proline levels of 0.08 mg/100g FW and 0.09 mg/100g FW across the two seasons, while Hydroxy proline maintained lower levels at 0.07 mg/100g FW (fig 3).

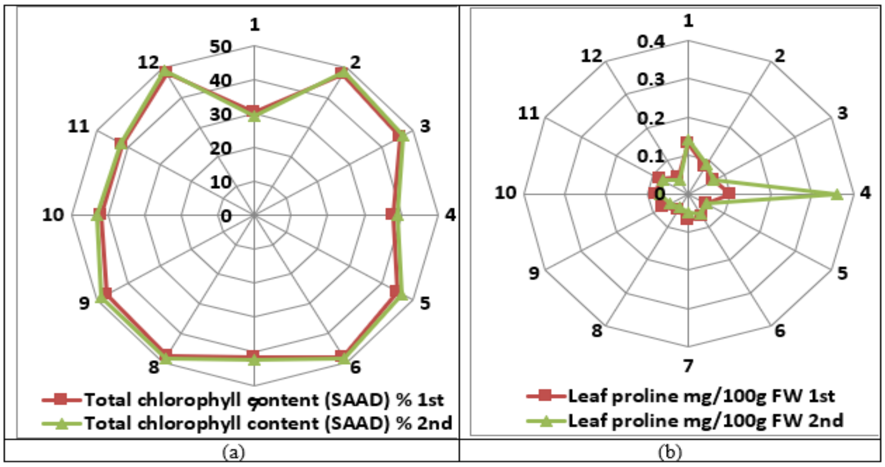


Figure 3. Effect of different treatments on (a) total chlorophyll content (%); (b) leaf proline (mg/100g fresh weight) during the two investigated seasons.

Table 3. Effect of different treatments on photosynthetic pigments of flame Seedless grapevines during 2021/2022 and 2022/2023 seasons

Treatments	Total chlorophyll content (SAAD)		Leaf proline	
Unit	%		mg/100g FW	
Season	1st	2nd	1st	2nd
T_1	30.50	29.40	0.13	0.14
T_2	47.80	48.67	0.08	0.09
T_3	45.97	47.00	0.07	0.07
T_4	37.77	39.07	0.10	0.36
T_5	45.20	46.37	0.05	0.05
T_6	48.00	48.83	0.07	0.06
T_7	41.57	42.47	0.07	0.05
T_8	47.83	48.53	0.05	0.04
T_9	46.90	48.50	0.07	0.05
T_{10}	42.00	42.93	0.08	0.07
T_{11}	41.63	42.40	0.08	0.07
T_{12}	48.23	49.23	0.05	0.04
LSD (0.05)	1.97	1.36	0.09	0.23
minimum	30.50	29.40	0.05	0.04
maximum	48.23	49.23	0.13	0.36

T_1: Control (no treatment), T_2:Arginine at 100 ppm, T_3:Hydroxy proline at 100 ppm,T_4: Microhysa at 250 ml/vine, T_5:Magnetine at 75 g/vine,T_6:Arginine + Hydroxy proline, T_7:Arginine + Microhysa, T_8:Arginine + Magnetine, T_9:Hydroxy proline + Magnetine, T_{10}:Hydroxy proline + Microhysa,T_{11}:Magnetine + Microhysa,T_{12}:Arginine + Hydroxy proline + Magnetine + Microhysa

The combination treatment of Argenine, Hydroxy proline, Magnetine, and Microhida achieved a total chlorophyll content peak of 48.23% in the second season while maintaining a low proline level of 0.04 mg/100g FW, further emphasizing its potential for enhancing photosynthetic efficiency while minimizing stress responses. The similar findings were observed in the previous research studies of Ali et al. (2013); Abd El-Rahman et al. (2019); Mohamed et al. (2023); and Ahmad (2016). However, results suggest that specific treatments can significantly improve photosynthetic pigment levels in Flame Seedless grapevines under saline conditions, thereby enhancing their growth and resilience against environmental stressors. The data also indicate that some combinations may provide synergistic benefits that optimize vine health and productivity during challenging growing conditions.

Chemical composition

The table (4) presents a comprehensive analysis of various nutrient levels in Flame Seedless grapevines, specifically focusing on nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), sodium (Na), and iron (Fe) across two growing seasons. Each treatment applied to the grapevines resulted in different nutrient profiles, which are crucial for understanding their growth and resilience. Nitrogen (N) is a vital macronutrient that plays a significant role in plant growth and development. The control group showed relatively low nitrogen levels, with 1.29% in the first season and a slight decrease to 1.22% in the second season. In contrast, treatments such as Argenine at 100 ppm resulted in significantly higher nitrogen content, reaching 2.40% and 2.44% across the two seasons. This increase indicates that Argenine enhances nitrogen uptake, which is essential for promoting vegetative growth and overall vine health. Phosphorus (P) is another critical nutrient for energy transfer and photosynthesis. The control group had phosphorus levels of 0.17% in the first season, decreasing to 0.15% in the second season. Treatments like Hydroxy proline and Argenine + Hydroxy proline improved phosphorus levels to 0.35% and 0.41%, respectively, highlighting their effectiveness in enhancing nutrient availability. Potassium (K) is vital for regulating various physiological processes, including water uptake and enzyme activation. The control group recorded potassium levels of 1.01% in the first season, which increased slightly to 1.18% in the second season. Notably, treatments such as Hydroxy proline and Magnetine improved potassium levels to 1.61% and 1.68%, respectively, suggesting that these treatments can enhance potassium availability under saline conditions. Calcium (Ca) is essential for cell wall structure and stability, with the control group showing calcium levels of 2.23% in the first season and a slight increase to 2.26% in the second season. Most treatments maintained or slightly improved calcium levels, with Argenine + Hydroxy proline achieving 2.66% and Argenine + Microhysa at 2.48%.

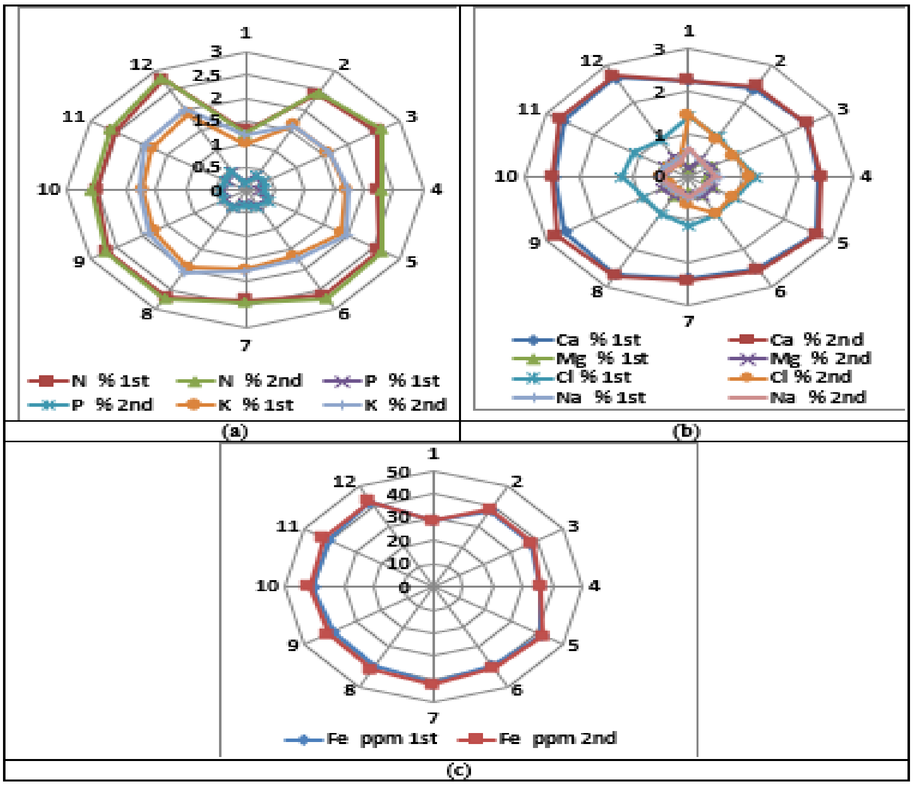


Figure 4. Effect of different treatments on chemical composition: (a) NPK (%); (b) Ca, Mg, Cl, Na (%); and (c) Fe (ppm) during the two investigated seasons.

Table 4. Effect of different treatments on chemical composition of flame Seedless grapevines during 2021/2022 and 2022/2023 seasons

Treatment	N		P		K		Ca		Mg		Cl		Na		Fe	
Unit							%								ppm	
Season	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1	1.29	1.22	0.17	0.15	1.01	1.18	2.23	2.26	0.21	0.20	1.41	1.45	0.64	0.66	28.73	28.86
T_2	2.40	2.44	0.35	0.37	1.61	1.59	2.38	2.45	0.45	0.48	1.08	1.04	0.44	0.42	38.07	38.80
T_3	2.58	2.65	0.31	0.35	1.62	1.65	2.46	2.50	0.47	0.51	0.98	0.95	0.42	0.40	37.37	38.33
T_4	2.23	2.31	0.25	0.31	1.68	1.72	2.36	2.42	0.33	0.39	1.22	1.13	0.54	0.50	35.63	36.27
T_5	2.61	2.67	0.41	0.45	1.89	1.97	2.66	2.72	0.50	0.52	0.98	0.94	0.39	0.36	41.80	42.47
T_6	2.63	2.71	0.37	0.42	1.65	1.73	2.48	2.53	0.49	0.52	1.02	0.98	0.43	0.38	39.43	40.53
T_7	2.39	2.43	0.30	0.33	1.72	1.76	2.38	2.44	0.39	0.42	1.18	0.67	0.51	0.48	41.67	42.40
T_8	2.69	2.73	0.42	0.44	1.94	2.06	2.66	2.69	0.53	0.53	1.00	0.39	0.43	0.39	39.63	41.47
T_9	2.67	2.71	0.40	0.43	1.78	1.87	2.61	2.78	0.51	0.54	0.97	0.38	0.43	0.38	38.63	40.50
T_{10}	2.51	2.58	0.35	0.40	1.73	1.76	2.45	2.48	0.43	0.45	1.21	0.51	0.54	0.51	40.25	41.63
T_{11}	2.54	2.62	0.36	0.40	1.83	1.94	2.63	2.71	0.49	0.52	1.13	0.41	0.47	0.41	40.57	42.27
T_{12}	2.78	2.81	0.45	0.47	1.91	2.02	2.67	2.73	0.52	0.55	0.99	0.37	0.41	0.37	42.10	42.73
LSD (0.05)	0.08	0.05	0.16	0.11	0.19	0.08	0.05	0.09	0.16	0.12	0.08	0.17	0.17	0.16	1.09	1.11
minimum	1.29	1.22	0.17	0.15	1.01	1.18	2.23	2.26	0.21	0.20	0.97	0.37	0.39	0.36	28.73	28.86
maximum	2.78	2.81	0.45	0.47	1.94	2.06	2.67	2.78	0.53	0.55	1.41	1.45	0.64	0.66	42.10	42.73

T_1: Control (no treatment), T_2:Arginine at 100 ppm, T_3:Hydroxy proline at 100 ppm,T_4: Microhysa at 250 ml/vine, T_5:Magnetine at 75 g/vine,T_6:Arginine + Hydroxy proline, T_7:Arginine + Microhysa, T_8:Arginine + Magnetine, T_9:Hydroxy proline + Magnetine, T_{10}:Hydroxy proline + Microhysa,T_{11}:Magnetine + Microhysa,T_{12}:Arginine + Hydroxy proline + Magnetine + Microhysa

This indicates that these treatments support calcium uptake, which is crucial for maintaining vine integrity. Magnesium (Mg) plays a role in chlorophyll synthesis and enzyme function. The control group had magnesium levels of 0.21% in the first season, decreasing slightly to 0.20% in the second season. Treatments generally resulted in higher magnesium levels; for instance, Hydroxy proline reached 0.45%, indicating its potential to enhance magnesium availability. Chloride (Cl) and Sodium (Na) are often associated with salinity stress but can also play roles in plant metabolism at certain concentrations. The control group exhibited chloride levels of 1.41 ppm in the first season, while sodium levels were relatively low at 0.64 ppm but increased slightly over time. Lastly, Iron (Fe) is crucial for chlorophyll synthesis and overall plant health, with control group values at 28.73 ppm in the first season and increasing slightly to 28.86 ppm in the second season. Treatments such as Hydroxy proline + Magnetine showed improved iron content at higher concentrations, emphasizing their role in enhancing micronutrient availability. Our findings are in harmony with those obtained by Ali et al. (2013); Abd El-Rahman et al. (2019); Mohamed et al. (2023); and Ahmad (2016). Therefore, this analysis demonstrates that specific treatments can significantly improve the nutritional status of Flame Seedless grapevines by enhancing essential nutrient uptake, thereby supporting better growth and resilience against environmental stressors such as salinity or nutrient deficiencies. The results underscore the importance of targeted nutrient management strategies to optimize grapevine health and productivity during cultivation.

3.Berry qualities

The table detailing the effects of various treatments on the berry qualities of Flame Seedless grapevines during the 2021/2022 and 2022/2023 seasons reveals significant improvements across multiple parameters, including yield, cluster weight, berry weight, berry size, total soluble solids (T.S.S), acidity, and the ratio of T.S.S to acidity. The control group yielded 5.13 kg in the first season and increased slightly to 5.40 kg in the second season, indicating a modest performance compared to treated vines. In contrast, treatments such as Argenine at 100 ppm resulted in substantial increases in yield, reaching 9.77 kg in the first season and 9.93 kg in the second season. This treatment also enhanced cluster weight significantly, with values of 345 g and 346.67 g for the respective seasons. Berry weight and size also improved markedly under Argenine treatment, with weights of 2.53 g and sizes measuring 2.67 cm in the second season.

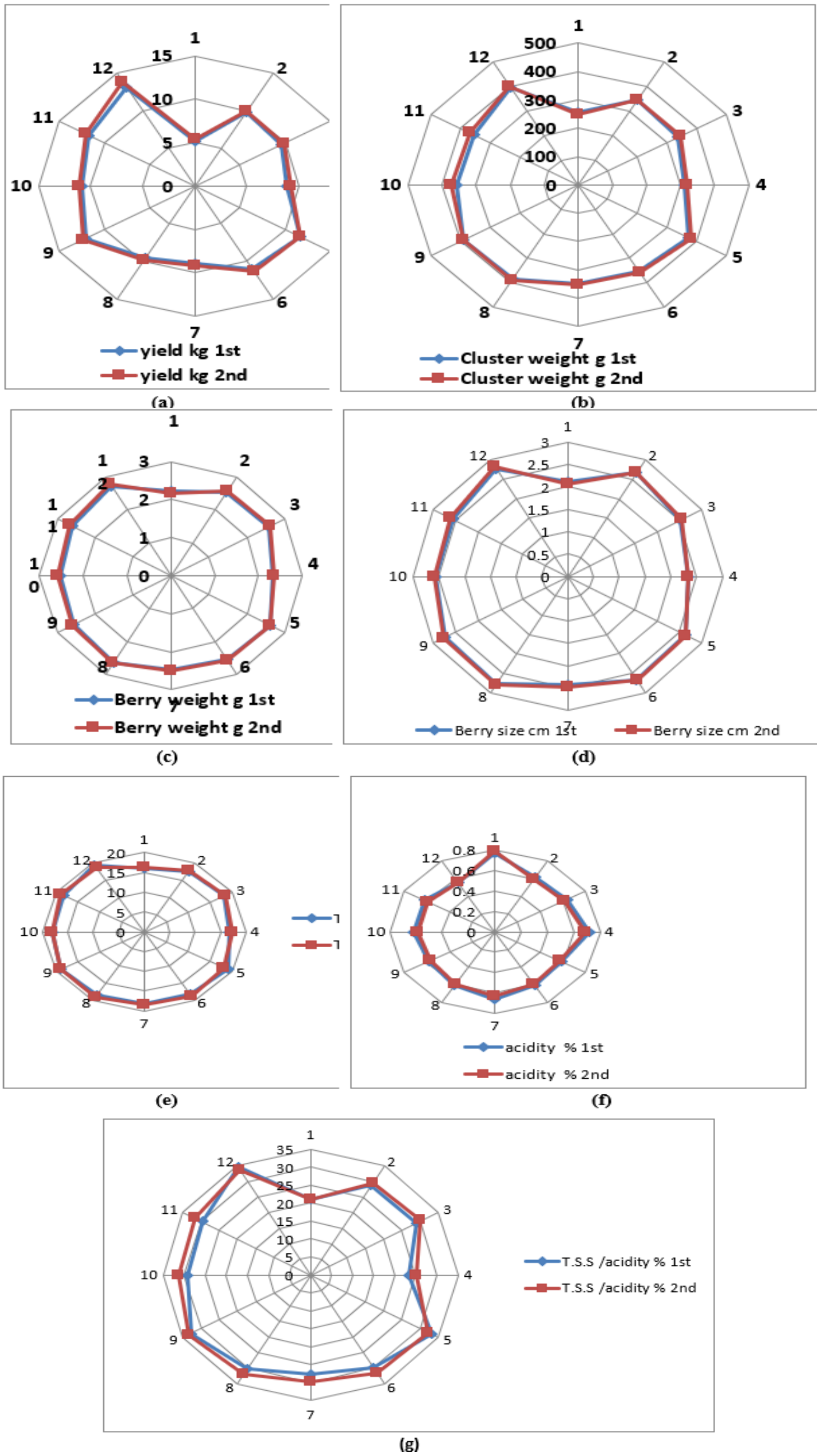


Figure 5. Effect of different treatments on (a) yield (kg); (b) cluster weight (kg); (c) berry weight (g); (d) cluster size (cm); (e) TSS (%); (f) acidity; and (g) TSS/acidity (%) during the two investigated seasons.

Table 5. Effect of different treatments on berry qualities of flame Seedless grapevines during 2021/2022 and 2022/2023 seasons

Treatment	yield		Cluster weight		Berry weight		Berry size		T.S.S		acidity		T.S.S /acidity	
Unit	kg		g				cm		%					
Season	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1	5.13	5.40	256.67	248.33	2.22	2.16	2.12	2.07	16.10	16.43	0.77	0.79	20.92	20.90
T_2	9.77	9.93	345.00	346.67	2.53	2.56	2.67	2.68	17.67	17.73	0.62	0.60	28.67	29.57
T_3	9.60	9.87	335.00	346.67	2.57	2.62	2.52	2.54	18.17	18.37	0.63	0.61	29.00	30.27
T_4	8.77	9.23	310.00	320.00	2.32	2.34	2.33	2.35	16.83	17.40	0.72	0.69	23.49	25.23
T_5	11.63	11.67	375.00	383.33	2.60	2.61	2.64	2.65	19.13	18.17	0.58	0.57	33.19	32.07
T_6	11.00	11.37	353.33	358.33	2.54	2.57	2.68	2.69	18.17	18.70	0.61	0.59	29.95	31.67
T_7	8.97	9.23	348.33	353.33	2.47	2.49	2.42	2.47	18.13	18.40	0.66	0.63	27.61	29.67
T_8	9.60	9.83	385.00	390.00	2.64	2.65	2.78	2.80	18.57	19.00	0.61	0.59	30.27	32.00
T_9	12.07	12.30	388.33	390.00	2.57	2.61	2.73	2.76	19.00	18.97	0.58	0.57	32.79	33.43
T_{10}	10.80	11.03	358.33	373.33	2.53	2.58	2.55	2.59	18.13	18.03	0.62	0.58	29.09	31.23
T_{11}	11.70	12.00	353.33	366.67	2.61	2.66	2.55	2.62	18.40	18.87	0.62	0.59	29.70	31.80
T_{12}	13.17	13.80	395.00	403.33	2.72	2.77	2.77	2.82	19.43	18.73	0.56	0.56	34.55	33.67
LSD (0.05)	0.76	0.63	18.03	16.65	0.12	0.11	0.12	0.08	0.51	0.41	0.13	0.00	1.59	1.27
minimum	5.13	5.40	256.67	248.33	2.22	2.16	2.12	2.07	16.10	16.43	0.56	0.56	20.92	20.90
maximum	13.17	13.80	395.00	403.33	2.72	2.77	2.78	2.82	19.43	19.00	0.77	0.79	34.55	33.67

T1: Control (no treatment), T2:Arginine at 100 ppm, T3:Hydroxy proline at 100 ppm,T4: Microhysa at 250 ml/vine, T5:Magnetine at 75 g/vine,T6:Arginine + Hydroxy proline, T7:Arginine + Microhysa, T8:Arginine + Magnetine, T9:Hydroxy proline + Magnetine, T10:Hydroxy proline + Microhysa,T11:Magnetine + Microhysa,T12:Arginine + Hydroxy proline + Magnetine + Microhysa

These enhancements suggest that Argenine effectively promotes fruit development and overall quality. Hydroxy proline treatment also demonstrated positive effects on berry quality, yielding 9.60 kg and 9.87 kg across the two seasons while improving berry weight to 2.57 g and T.S.S to 18.17% in the second season. Similarly, Microhysa treatment resulted in an increase in yield to 8.77 kg and improved berry size and weight, although not as significantly as Argenine or Hydroxy proline. Magnetine treatment produced the highest yield among all treatments at 11.63 kg in the first season and slightly less at 11.67 kg in the second season, along with a notable increase in cluster weight (375 g) and berry weight (2.60 g). The total soluble solids also reached impressive levels of 19.13% in the first season, indicating that Magnetine enhances sugar accumulation within the berries. Combination treatments further optimized berry qualities; for instance, the combination of Argenine + Hydroxy proline + Magnetine + Microhysa achieved a remarkable yield of 13.17 kg in the second season, with berry weights reaching up to 395 g and T.S.S levels at 19.43%. This suggests that synergistic effects from combining treatments can significantly enhance berry quality attributes. However, the obtained results are in consistence with the observations of Ghayaty et al. (2019); Ali et al. (2013); Abd El-Rahman et al. (2019); Mohamed et al. (2023); and Ahmad (2016).

Discussion

Growth parameters

The treatment that exhibits the best effect on the vegetative growth characteristics of Flame Seedless grapevines, as indicated by the data from the table, is the combination of Argenine (100 ppm) and Hydroxy proline, along with the treatment of Magnetine. However, the combination treatment of Argenine + Hydroxy proline + Magnetine + Microhysa stands out as the most effective overall. This combination treatment achieved the highest values in both total leaf area and main shoot length across both growing seasons (Ali et al., 2013). Specifically, it resulted in a total leaf area of 21.33 m² in the second season and a main shoot length of 125.17 cm. These results are significantly higher than those observed in the control group, which had a total leaf area of only 15.40 m² and a main shoot length of 76.47 cm in the second season. The effectiveness of this combination can be attributed to the synergistic effects of the individual treatments. Argenine is known for enhancing nitrogen uptake and promoting overall plant vigor, while Hydroxy proline contributes to stress tolerance and improved physiological responses. Magnetine enhances nutrient availability and uptake efficiency, which can lead to better growth performance (Ghayaty et al., 2019). The addition of Microhysa likely supports soil health and microbial activity around the roots, further benefiting plant growth (Mohamed et al., 2023). In contrast, while treatments like Magnetine alone also showed strong results (with a total leaf area of 20.67 m² and main shoot length of 119.17 cm), they did not surpass the combined treatment's outcomes. This indicates that combining these treatments can lead to enhanced growth responses that are greater than those achieved by any single treatment alone. However, the combination treatment of Argenine, Hydroxy proline, Magnetine, and Microhysa is recommended for maximizing vegetative growth in Flame Seedless grapevines due to its significant impact on both leaf area and shoot length, ultimately supporting better vine health and productivity under various growing conditions (Abd El-Rahman et al. (2019); Ahmad (2016)) .

Photosynthetic pigments

Based on the obtained data presented regarding the effects of different treatments on photosynthetic pigments in Flame Seedless grapevines, the treatment that demonstrates the best performance is Argenine at 100 ppm. This treatment resulted in the highest total chlorophyll content across both growing seasons, with values of 47.80% in the first season and 48.67% in the second season. The significant increase in chlorophyll content indicates that Argenine effectively enhances the photosynthetic capacity of the grapevines, which is crucial for their growth and fruit development (Ghayaty et al., 2019). Higher chlorophyll levels are associated with improved light absorption and photosynthesis, leading to better overall plant health and productivity. In comparison, the control group recorded much lower chlorophyll levels at 30.50% and 29.40%, highlighting the substantial benefits of Argenine treatment. In addition to chlorophyll content, Argenine treatment also resulted in lower leaf proline levels (0.08 mg/100g FW in the first season and 0.09 mg/100g FW in the second season). Proline is often associated with stress responses in plants; thus, lower proline levels suggest that Argenine helps mitigate stress, contributing to healthier vines (Ahmad, 2016). While other treatments, such as Hydroxy proline and Magnetine, also showed beneficial effects on chlorophyll content (with values of 45.97% and 45.20%, respectively), they did not surpass the results achieved with Argenine. The combination treatment of Argenine with Hydroxy proline yielded a total chlorophyll content of 48.00% and 48.83%, but still did not exceed the performance of Argenine alone. Overall, Argenine at 100 ppm stands out as the most effective treatment for enhancing photosynthetic pigments in Flame Seedless grapevines due to its significant contributions to chlorophyll content and its role in reducing stress indicators like proline levels (Abd El-Rahman et al., 2019). This combination of effects is likely to lead to improved growth and yield potential for the grapevines, making it a highly recommended practice for growers aiming to optimize vine health under various environmental conditions (Ali et al. (2013); Mohamed et al. (2023)).

Chemical composition

Based on the provided data from the table on the chemical composition of Flame Seedless grapevines, the treatment that demonstrates the best performance is Argenine at 100 ppm. This treatment significantly enhances several key nutrient levels compared to the control group and other treatments, particularly in nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and iron (Fe). In the first season, Argenine treatment resulted in nitrogen levels of 2.40%, which is a substantial increase from the control's 1.29%. In the second season, this value slightly increased to 2.44%, indicating consistent performance. The phosphorus content also improved, reaching 0.35% in both seasons, compared to only 0.17% in the control group. Additionally, potassium levels increased to 1.61%, further highlighting Argenine's effectiveness in enhancing nutrient uptake. Moreover, Argenine treatment positively influenced calcium and magnesium levels, with values of 2.38% and 0.45% in the second season, respectively. These nutrients are crucial for various physiological processes in plants, including cell wall structure and enzyme function (Abd El-Rahman et al., 2019). While other treatments like Hydroxy proline and Magnetine also showed beneficial effects on nutrient levels, Argenine consistently outperformed them across multiple parameters (Ghayaty et al., 2019). For instance, Hydroxy proline achieved nitrogen levels of 2.58% and potassium levels of 1.62%, but did not surpass Argenine's overall nutrient enhancement. The superior performance of Argenine can be attributed to its role as an amino acid that enhances nitrogen availability and promotes overall plant health and growth. This is particularly important for grapevines, as adequate nitrogen levels are essential for vegetative growth and fruit development (Mohamed et al., 2023). In conclusion, Argenine at 100 ppm stands out as the most effective treatment for improving the chemical composition of Flame Seedless grapevines due to its significant contributions to key nutrient levels that support vine health and productivity (Ali et al. (2013); Ahmad, (2016)).

Berry qualities

Based on the provided search results, the treatment that appears to have the best effect on the performance of Flame Seedless grapevines is the combination of Argenine, Hydroxy proline, Magnetine, and Microhysa. This treatment yielded the highest values in multiple quality parameters during both growing seasons, including yield, cluster weight, berry weight, and total soluble solids (T.S.S). In particular, this combination treatment achieved a remarkable yield of 13.17 kg in the second season, which is significantly higher than the control group and other treatments. Additionally, it resulted in a berry weight of 395 g and a berry size of 2.77 cm, indicating superior fruit development. The T.S.S was also notably high at 19.43%, which is essential for determining the sweetness and overall quality of the grapes. The effectiveness of this treatment can be attributed to the synergistic effects of the components involved. Argenine is known to enhance nitrogen uptake and promote vegetative growth, while Hydroxy proline can improve stress tolerance and overall plant health. Magnetine contributes to nutrient availability and uptake efficiency, and Microhysa aids in enhancing soil health and microbial activity around the root zone. Together, these treatments not only improve yield but also enhance fruit quality attributes such as size, weight, and sugar content. Our point of view regarding these obtained parameters is in harmony with the studies of Ghayaty et al. (2019); Ali et al. (2013); Abd El-Rahman et al. (2019); Mohamed et al. (2023); and Ahmad (2016), whereas the combination treatment stands out as the most effective intervention for improving both yield and quality in Flame Seedless grapevines, making it a recommended practice for growers aiming to optimize production under varying environmental conditions.

CONCLUSION

This study successfully demonstrated that the application of Argenine (100 mg/L), Hydroxy proline (100 mg/L), Magnetine (75 g/vine), and Microhysa (250 ml/vine) significantly mitigates the adverse effects of salinity on the growth and productivity of Flame Seedless grapevines in Sohag agroclimatic conditions during the 2021/2022 and 2022/2023 seasons. The results indicate that these treatments not only enhanced vegetative growth parameters, such as total leaf area and main shoot length, but also improved photosynthetic pigments, chemical composition, and overall fruit quality metrics. The combination treatment yielded the highest total leaf area and main shoot length compared to all other treatments, highlighting its effectiveness in promoting vine vigor. Additionally, the reduction in leaf proline levels associated with these treatments suggests an alleviation of salinity-induced stress, which is crucial for maintaining healthy vine physiology. The enhanced nutrient uptake, as evidenced by increased levels of nitrogen, phosphorus, potassium, calcium, magnesium, chloride, sodium, and iron in treated vines, further supports the notion that these materials can improve nutrient availability under saline conditions. Moreover, the study's findings underscore the potential for integrating organic and biological approaches into vineyard management practices. By utilizing these treatments, grape growers can adopt sustainable strategies to enhance grapevine resilience against salinity while improving yield and fruit quality. This research contributes valuable insights into effective salinity management practices in viticulture, particularly for Flame Seedless grapevines in saline-prone regions. Future studies could explore the long-term impacts of these treatments on grapevine health and productivity as well as their potential applications in other grape varieties facing similar challenges. Moreover, this work lays a foundation for developing innovative solutions to combat salinity stress in viticulture, aiming to ensure sustainable grape production in challenging environments.

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محاولات للحد من آثار الملوحة الضارة على نمو وإنتاجية عنب الفليم الخالي من البذور

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[3]قسم الاراضي والمياه، كلية الزراعة، جامعة سوهاج، سوهاج، 82524، مصر

الملخص

تشكل الملوحة تحديات كبيرة أمام زراعة العنب من خلال إضعاف توافر المياه وامتصاص العناصر الغذائية، مما يؤدي إلى انخفاض قوة العنب وجودة الفاكهة. هدفت هذه الدراسة إلى تقليل تأثير الملوحة في نمو وإنتاجية العنب صنف الفليم بدون بذور باستخدام مواد الأرجينين (100 ملجم/ لتر)، الهيدروكسي برولين (100 ملجم لتر)، الماجنتين (75 جم/ كرمة)، والميكروهيزا (250 مل/ كرمة خلال موسمي 2022/2021 و 2023/2022 في ظل الظروف المناخية الزراعية بسوهاج. تلقت النباتات خلال الموسمين ثلاث إضافات مع المواد المذكورة عند بداية النمو وبعد عقد الثمار وبعد شهر واحد. صفات النمو (إجمالي مساحة الورقة/كرمة، وطول البراعم الرئيسية)، وأصباغ التمثيل الضوئي (إجمالي محتوى الكلوروفيل، وبرولين الورقة)، والتركيب الكيميائي بما في ذلك النيتروجين، الفسفور، البوتاسيوم، الكالسيوم، الماغنسيوم، الصوديوم، الكلوريد، الحديد، المحصول، وزن الكرمه، وزن العنبة، حجم العنبة، ونسبة المواد الصلبة الذائبة والحموضة ونسبة المواد الصلبة الذائبة إلى الحموضة مع معاملة المقارنة للموسمين المدروسين. أظهرت نتائج هذه الدراسة أن خليط مواد الأرجينين (100 ملجم/لتر) والهيدروكسي برولين (100 ملجم/لتر) والماجنتين (75 جم/كرمة) والميكروهيسا (250 مل/كرمة) سجل أفضل أداء في تقليل الآثار الضارة للملوحة على نمو وإنتاجية العنب الفليم خالى البذور خلال الموسمين المدروسين مقارنة بجميع المعاملات الأخرى. تؤكد النتائج إمكانية دمج المواد العضوية والحيوية في زراعة العنب كاستراتيجيات فعالة للتخفيف من الملوحة. يساهم هذا البحث برؤى قيمة حول الممارسات المستدامة لزراعة العنب في المناطق المعرضة للملوحة، بهدف تحسين كل من المحصول وجودة الفاكهة في أصناف العنب الفليم الخالى من البذور.