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Response of Nemguard Peach Seedlings to Foliar Application with Amino Acids and Algae Extract

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ABSTRACT

In the current study, the effects of foliar sprays of two concentrations of amino acids (2 and 4 ml/L) and two concentrations of algae extract (2 and 4 ml/L) alone or in combination with each other were evaluated on the vegetative growth and nutritional status of one-year-old Nemagaurd peach rootstock seedlings compared to the control treatment (spray with water only). The study was conducted at the National Research Centre Nursery, Egypt, during two growing seasons of 2022 and 2023. Three times, foliar spraying was applied: April 25, May 23 and June 27 of both seasons. In comparison to the control, the results showed that foliar spraying amino acids and algae extract increased all characteristics of vegetative growth significantly, including stem diameter, stem length, leaves/seedling number, branches/seedling number, chlorophyll, leaf fresh weight, leaf area, and leaf dry weight. It also increased significantly the total carbohydrates and mineral content of leaves (N, K, P, Fe, Mg, Mn, Cu, and Zn). The study found that the application of amino acids and algae extract to Nemagaurd peach rootstock seedlings greatly enhanced their vegetative development and nutritional status. For the majority of the traits under study, the combination of amino acids at 4 ml/L plus algae extract at 4 ml/L was significantly higher than the control treatment and other treatments. The results were even more impressive: for example, amino acids at 2 ml/L plus algae extract at 4 ml/L; for other parameters, amino acids at 4 ml/L plus others.

Keywords Peach, amino acids, algae, minerals contents, vegetative growth

Introduction

Egypt's rapid reduction in peach orchards is primarily because of root-knot nematode infection of the root system (Abd Alhady, 2018). Since rootstocks are known to impact orchid production significantly, selecting suitable rootstocks for grafting commercial types is crucial. Rootstocks affect a tree's health; key three phases, and sensitivity to insects and viruses, among other factors that affect a tree's ecological compatibility. Additionally, an appropriate root is essential for the best possible nutrient absorption and transportation, which allows for a reduction in fertilizer use and lowers the risk of nutrient leaching and potential toxicity to the soil and environment without compromising fruit quality or yield (Abu Rayya *et al.,* 2021). The Nemguard peach (Prunus persical X *Prunus* davidiana Carrere) is a rootstock that is commonly used for peach cultivars and is also favored for almonds. It is characterized by its vigorous growth, exceptional disease resistance, demonstrated resistance to nematodes known to cause knotting in roots, and greater resistance to the gall crown compared to other rootstocks (Abdel Aziz, 2020). Furthermore, under Nubaria circumstances, the Nemagaurd rootstock significantly improved nutrient absorption, resulting in the greatest level of leaf mineral content and a notable increase in vegetative vigor of the Ne plus ultra and Nonpareil almond cultivars (Abu Rayya *et al.,* 2021).

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Plants require amino acids in large quantities. As precursors and constituents of proteins, they can have a direct or indirect impact on physiological activities related to plant growth and development (Rai, 2002). Proteins are essential for stimulating cell proliferation. Because they function as buffers and have both basic and acid groups, amino acids help keep the pH levels inside plant cells at a desirable level (Davies, 1982). Furthermore, due to their anti-oxidative qualities, amino acids are crucial for plants' defense against oxidative stress brought on by adverse environmental circumstances. It is in charge of promoting cell division and improving the manufacture of vitamins, proteins, plant colors, and natural hormones like ethylene and IAA (Sies, 1997). Numerous studies have disproved the claim that using amino acids as a foliar spray will improve some fruits' nutritional condition and vegetative growth (El-Salhy *et al.,* 2021; Shaymaa *et al.,* 2022; Abd-Elall, 2022; El-Bolok and Kasem, 2023; Hussein, 2023).

Algal extract is known to contain various plant growth regulators, such as cytokinins, auxins, and auxin-like compounds; organic matter and fertilizer nutrients; vitamins and amino acids; complex polysaccharides that are not found in land plants; sterols; and growth inhibitors like ABA (Khan *et al.,* 2009). These compounds are critical to plant metabolism and productivity. In recent times, foliar sprays utilizing biological agriculture and horticulture have been used to boost plant nutrient uptake, encourage development, and provide resistance against stress factors, fungal infections, and frost (Zodape, 2001). Numerous experiments revealed that using algae extract as a foliar spray to certain fruit crops increased their production, growth, and leaf chemical composition (Hikal, 2015; Merwad *et al.,* 2019; Eisa *et al.,* 2023).

The application of amino acids and algae extract at high rates promotes vegetative growth and improves the nutritional state of fruit crops, according to much-published research (Khan *et al.,* 2012; Thanaa *et al.,* 2016; Mohammed and Saleh 2019; Qaoud and Zagzog 2023). The aim of this study was to examine the effects of foliar spraying Nemagaurd rootstock seedlings with amino acids and algal extract, either separately or in combination, on their vegetative growth and nutritional condition. Both materials were employed in two concentrations for this purpose: low concentration (2 mL/L) and high concentration (4 mL/L), which was advised by earlier research. In order to minimize the expense of using a high concentration of these materials, it is also possible to investigate the possibility of using a low concentration of the two materials instead of a high concentration if doing so has a positive effect on the vegetative growth and nutritional status of Nemagaurd seedlings and results in an equal effect of the high concentration.

2. Materials and Methods

A one-year-old Nemagaurd peach seedling was used in this investigation, which was conducted in the National Research Center nursery in Egypt over the two growth seasons of 2022 and 2023. Five-kilogram plastic culture pots are used to grow seedlings. The chemical and physical examination of the farmed soil is displayed in Table 1.

Table 1: Some chemical and physical properties of soil before treatment

Sand	Silt	Clay	Texture	OM (%)	EC dSm^{-1}	pH	HCO^{-3} (meq/100g soil)
66.8	14	19.2	Sandy loam	1.02	0.24	7.81	1.24

Cl^- (ppm)	Na^+ (ppm)	N (%)	P (%)	K (%)	Mg (%)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)
53.19	16	0.15	0.17	0.17	0.51	25	10	0.5	8.89

Two concentrations of amino acids, known as "Mono Acid Powder" (2 and 4 mL) [which contains 25% free amino acids, including aspartic 3.2%, glutamic 2.1%, alanine 3%, arginine 2%, glycine 3.6%, lysine 5.6%, valine 2%, methionine 2%, serine 1.3%, tyrosine 0.5%, and threonine 1.7%], as were two concentrations of algae extract known as "Hummer Hand" (2 and 4 ml/L) [which contains 80% algae and seaweed from Ascophylum nodosum and Laminaria], either separately or in combination with one another as opposed to the control treatment (spray with water only). Nine concentration treatments with five repetitions were used as treatments, and each experimental unit had three seedlings (135 seedlings total). During each season, the spraying was done three times at intervals of five weeks: on April 25,

May 23 and June 27 for both seasons. The Tween-20 was administered at a rate of 0.1 ml/L and utilized as a wetting agent after the seedling was sprayed in the morning till runoff.
The nine treatments involved in this study arranged as follows:

1. Control (spray with water only)
2. 2 ml/L amino acids
3. 4 ml/L amino acids
4. 2 ml/L algae extract
5. 4 ml/L algae extract
6. 2 ml/L amino acids with 2 ml/L of algae extract.
7. 2 ml/L amino acids with 4 ml/L of algae extract.
8. 4 ml/L amino acids with 2 ml/L of algae extract.
9. 4 ml/L amino acids with 4 ml/L of algae extract.

The following characteristics was measured at the end of August from both seasons:

1. Seedling length (cm).
2. Seedling diameter (mm).
3. Shoots/seedling number.
4. Leaves/seedling number.
5. Leaf area (cm^2) was measured by using a Cl-202 portable laser leaf area meter.
6. Total chlorophylls content of leaves (SPAD unit) were measured by using chlorophyll measuring device model SPAD-502.
7. Fresh weight of leaves (g).
8. Dry weight of leaves (g).
9. Total carbohydrate content of leaves (mg/g dry weight) according to Dobois *et al.* (1956).
10. Leaf macro elements content (N, P, K and Mg %) according to (Pregl, 1945; Chapman and Pratt, 1961; Brown and Lilleland, 1976; Jackson, 1973) respectively.
11. Leaf micro elements content (Fe, Mn, Cu and Zn ppm) according to Jackson, (1973).

2.1. Statistical analysis

The experiment was set up in accordance with RCBD, and analysis of variance (ANOVA) was used to statistically assess the data (Snedecor and Cochran, 1990). Duncan's Multiple Range Test was used to compare the means at the 5% probability level (Duncan, 1955). Using MSTAT-C, computers were used to tabulate and statistically analyze all the data.

3. Results

3.1. Vegetative growth

3.1.1. Seedling length (cm)

When compared to the control throughout the two seasons under study, Figure 1 unequivocally demonstrated that the majority of treatments had a notable impact on Nemagaurd seedling length. This means that in both of the analyzed seasons, the tallest seedling was obtained by spraying Nemagaurd peach seedlings with amino acids at a rate of 4 ml/L and algal extract at a rate of 4 ml/L. The tallest measurements were 119.33 and 126.49 cm, respectively. In both of the seasons under study, the control treatment produced seedlings that were the smallest (87.33 and 92.57 cm, respectively).

3.1.2. Seedling diameter (cm)

The diameter of Nemagaurd seedlings was positively impacted by foliar application of amino acids and algal extract, either separately or together (Figure 2). During the 2022 and 2023 seasons, amino acids at 2 ml/L with algal extract at 4 ml/L (0.77 and 0.81 cm) demonstrated the highest significant values for stem diameter (1 and 1.05 cm), respectively. However, in the seasons of 2022 and 2023, respectively, the control treatment had the lowest significant values for stem diameter (0.43 and 0.46 cm).

3.1.3. Number of shoots/seedling

The results shown in Figure (3) demonstrated that the application of foliar with both amino acids and algae extract increased significantly the shoots number of Nemagaurd seedling. This was particularly true when the amino acids and algae extract were applied at 4 ml/L and 4 ml/L together, as this combination produced the highest value (25.67 and 33 shoots/seedling, respectively) in the first and second seasons. The control treatment produced the fewest number of shoots per seedling throughout the course of the two seasons.

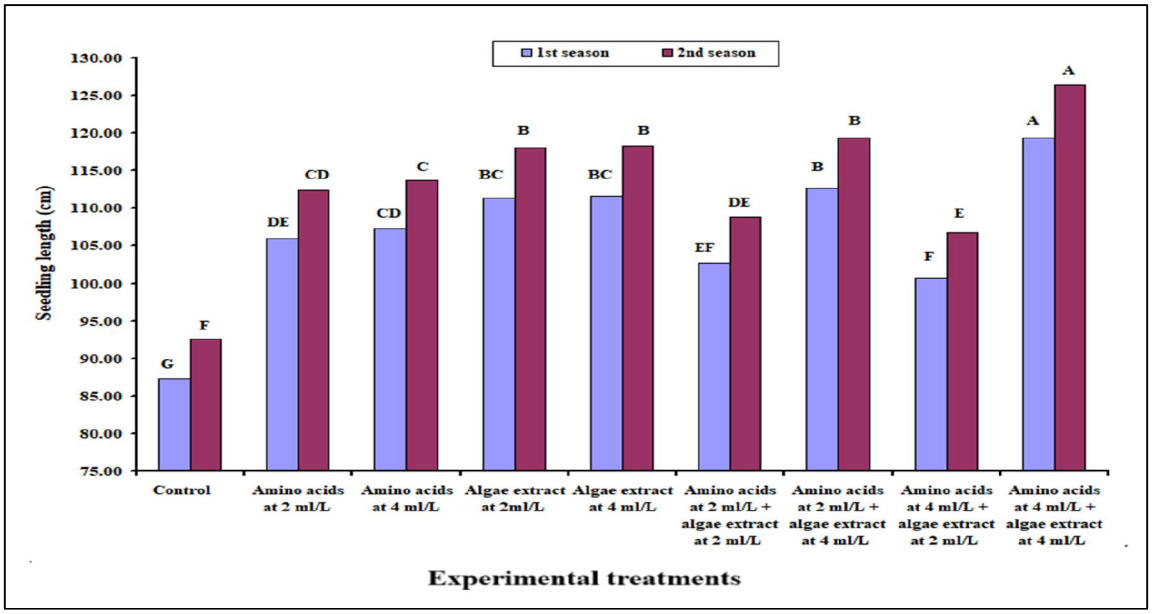

Fig. 1: Effect of foliar spraying with algae extract and amino acids on length of Nemagaurd seedling throughout the two seasons studied.

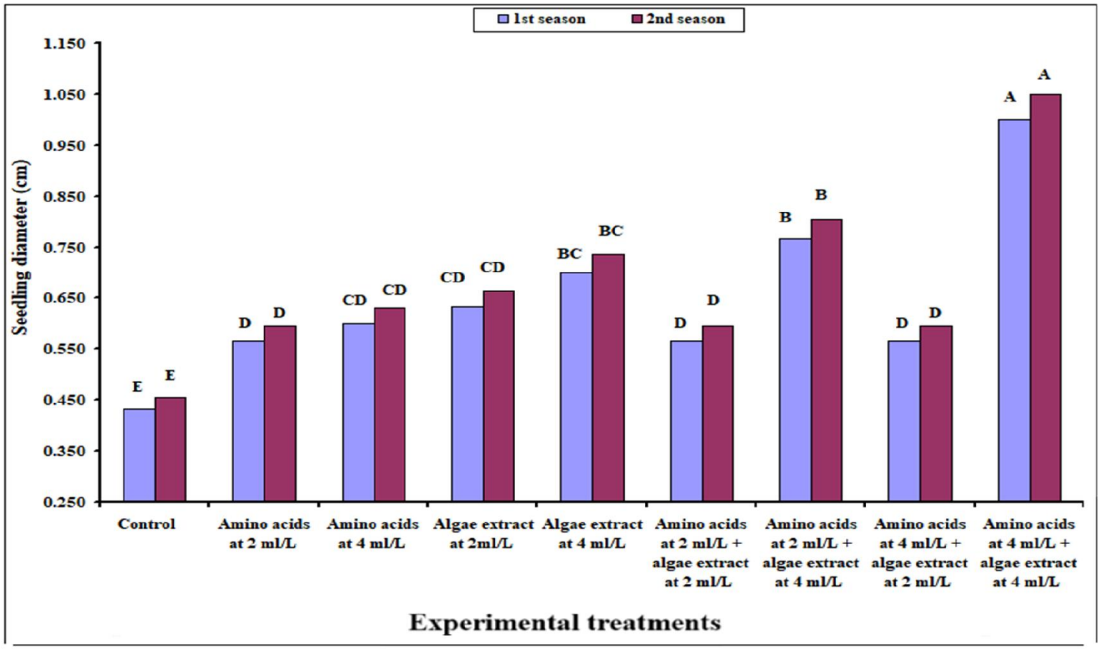

Fig. 2: Effect of foliar spraying with algae extract and amino acids on diameter of Nemagaurd seedling throughout the two seasons studied.

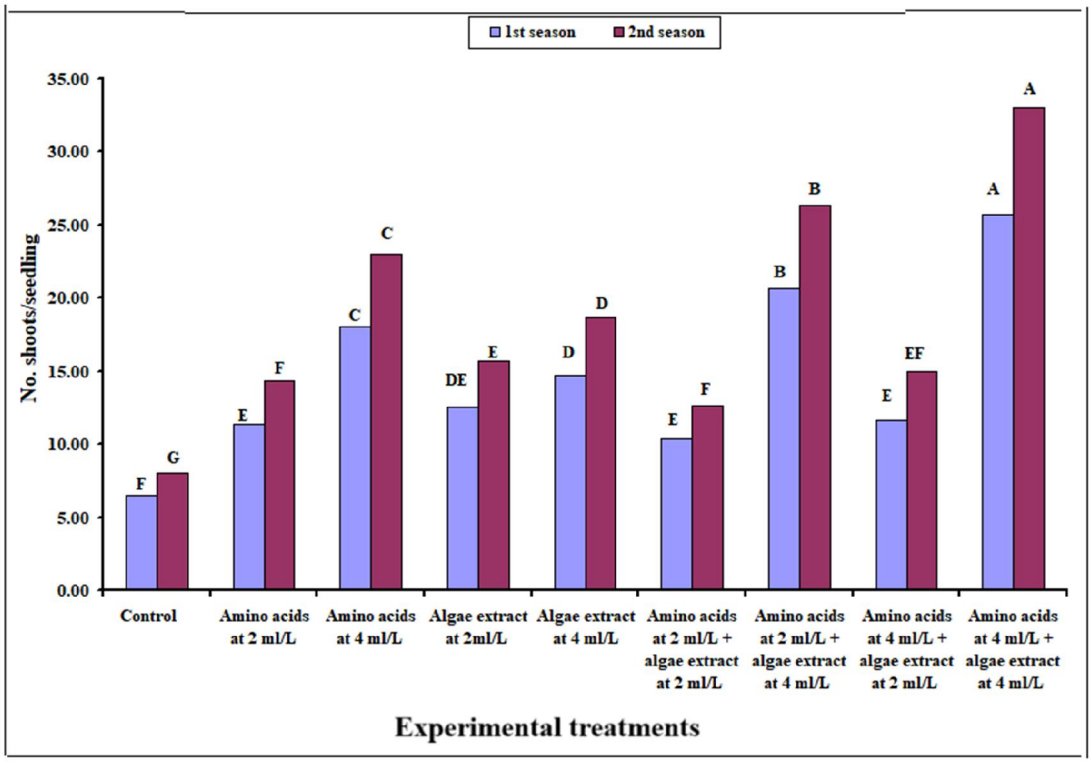

Fig. 3: Effect of foliar spraying with algae extract and amino acids on shoots number of Nemagaurd seedling throughout the two seasons studied

3.1.4. Number of leaves/seedling

Figure (4) illustrates how, during the two study seasons, foliar spraying Nemagaurd seedlings with amino acids and algae extract, either separately or in combination, significantly increased the number of leaves per seedling when compared to the control. Without significantly differentiating between the two treatments, the largest number of leaves per seedling was obtained in both seasons in the treatments with 4 ml/L of amino acids + 4 ml/L of algal extract and 2 ml/L of amino acids with 4 ml/L algae extract. During the first and second seasons, the control treatment recorded 46 and 80 leaves per seedling, respectively, the lowest value of leaf number per seedling.

3.1.5. Leaf area (cm^2)

In the first and second seasons, respectively, leaf area measured when seedlings were sprayed with amino acids at 4 ml/L with algal extract at 4 ml/L (33.26 and 29.93 cm^2) was the highest value. Amino acids at 2 ml/L with algae extract at 4 ml/L (30.15 and 29.91 cm^2) came in second. However, over the course of the two seasons, the control treatment's leaf area values were the lowest (21.21 and 20 cm^2, respectively) (Figure 5).

3.1.6. Total chlorophylls content of leaves (SPAD unit)

Foliar spraying with amino acids and algal extract alone or in combination throughout the two research seasons had a substantial impact on the total leaf chlorophyll content of Nemagaurd seedlings when compared to the control treatment (Figure 6). The two seasons' highest significant values of total leaf chlorophyll content (34.20 and 30.78) were obtained by foliar spraying with 2 ml/L amino acids with 4 ml/L of algal extract. Amino acids followed these values at 4 ml/L + algae extract at 2 ml/L (30.73 and 27.66), respectively. Conversely, during the two seasons, the control treatment yielded the least significant values of total leaf chlorophyll content (19.63 and 17.67, respectively) (Figure 6).

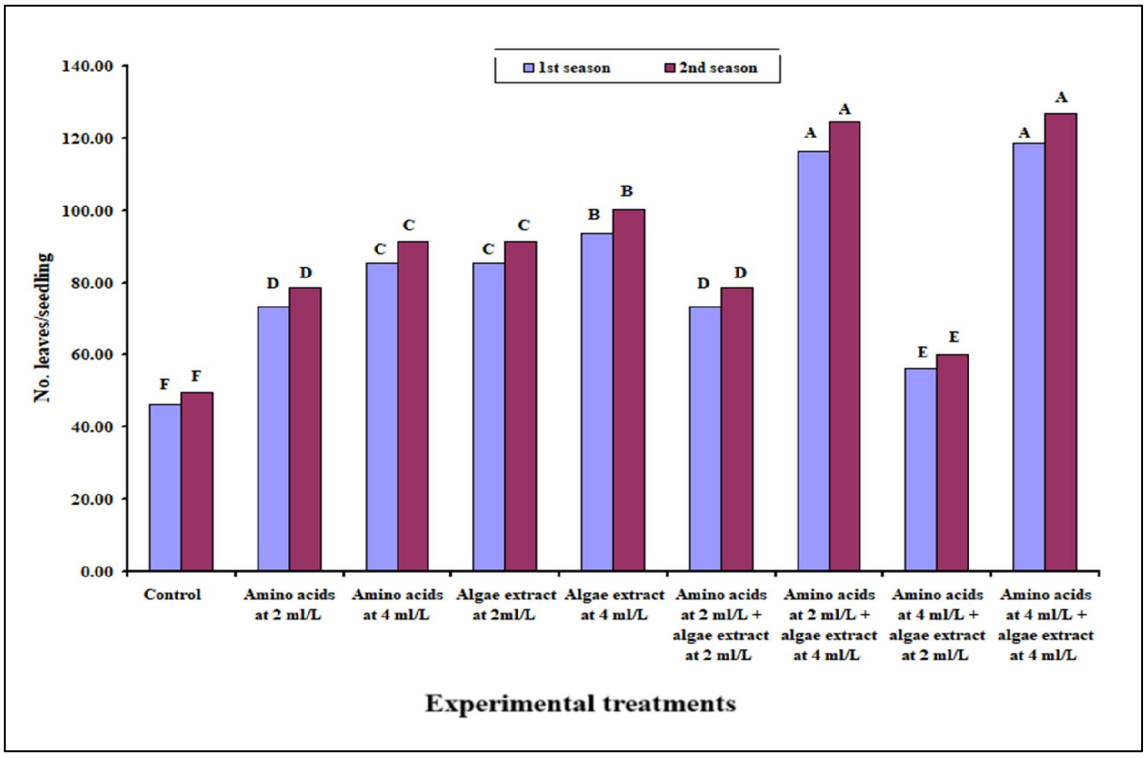

Fig. 4: Effect of foliar spraying with algae extract and amino acids on leaves number of Nemagaurd seedling throughout the two seasons studied.

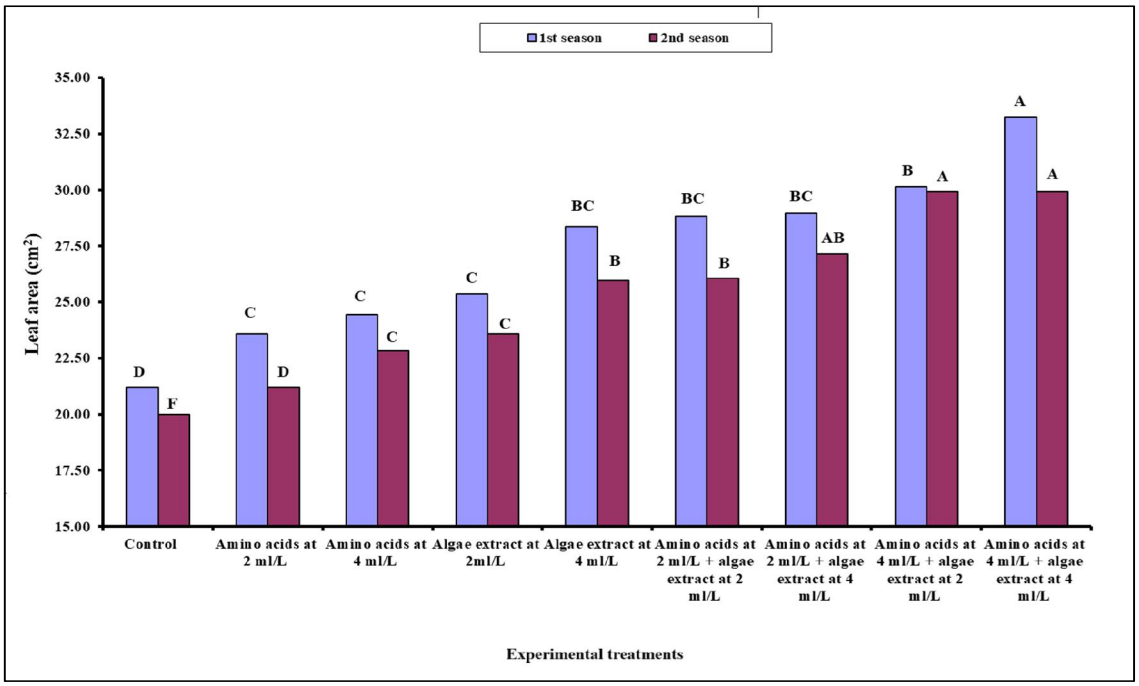

Fig. 5: Effect of foliar spraying with algae extract and amino acids on leaf area of Nemagaurd seedling throughout the two seasons studied.

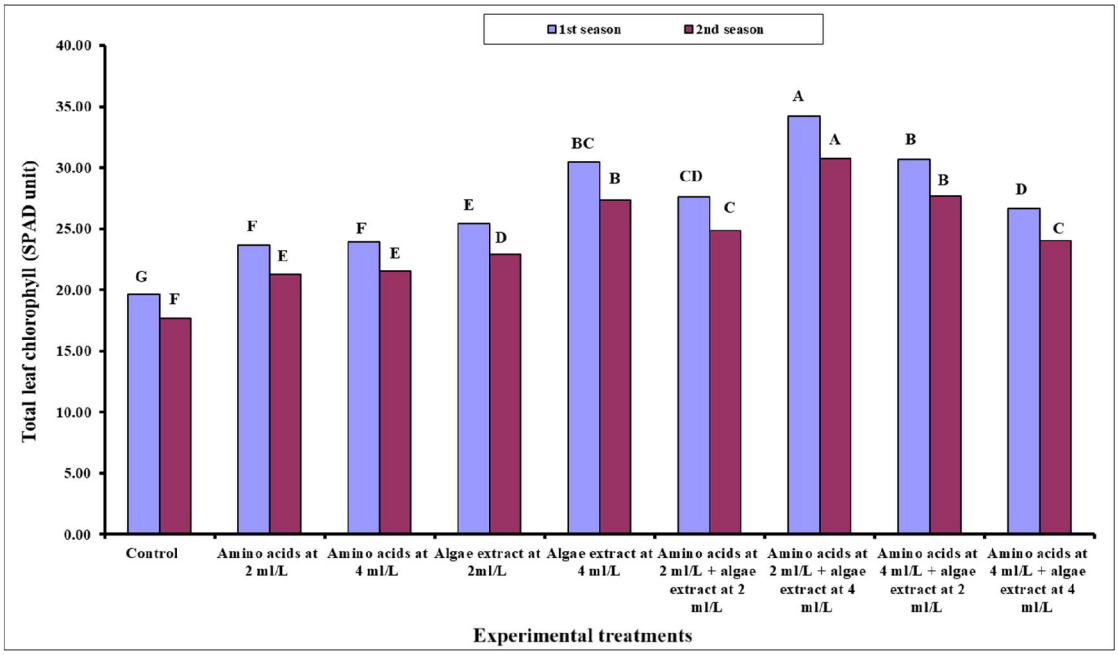

Fig. 6: Effect of foliar spraying with algae extract and amino acids on leaf total chlorophyll of Nemagaurd seedling throughout the two seasons studied.

3.1.7. Fresh weight of leaves (g)

In the two experimental seasons, there were no appreciable variations in the outcomes of foliar spraying with amino acids at 4 ml/L, algal extract at its concentrations, and amino acids at 2 ml/L + algae extract at its concentrations (Figure 7). The largest significant weight of fresh leaf (4.14 and 3.60 g) was attained simultaneously by foliar spraying with 4 ml/L amino acids and 4 ml/L of algal extract over the two seasons, respectively. On the other hand, during the two seasons, the control treatment produced the least amount of fresh leaf weight (1.18 and 1.50 g, respectively).

3.1.8. Dry weight of leaves (g)

Figure (8) shows the results of foliar treatment of amino acids at 4 ml/L and algal extract at 4 ml/L. This combination significantly affected the highest leaf dry weight (3 and 2.70 g) that Nemagaurd seedlings recorded over the two seasons, respectively. In contrast, during the first and second seasons, the control treatment reported the lowest significant weight of dried leaves (1.09 and 1.33 g, respectively).

3.1.9. Total carbohydrate content of leaves (mg/g dry weight)

The greatest significant values of total leaf carbohydrate content (3.71 and 3.82 mg/g) were obtained from foliar spraying with 2 ml/L of amino acids and 4 ml/L of algal extract at during the two seasons, respectively. This was followed by amino acids at 4 ml/L and algae extract at 2 ml/L (3.68 and 3.79 mg/g). However, during the two seasons, the control treatment's total leaf chlorophyll content recorded the lowest significant values (1.88 and 2.16 mg/g, respectively) (Figure 9).

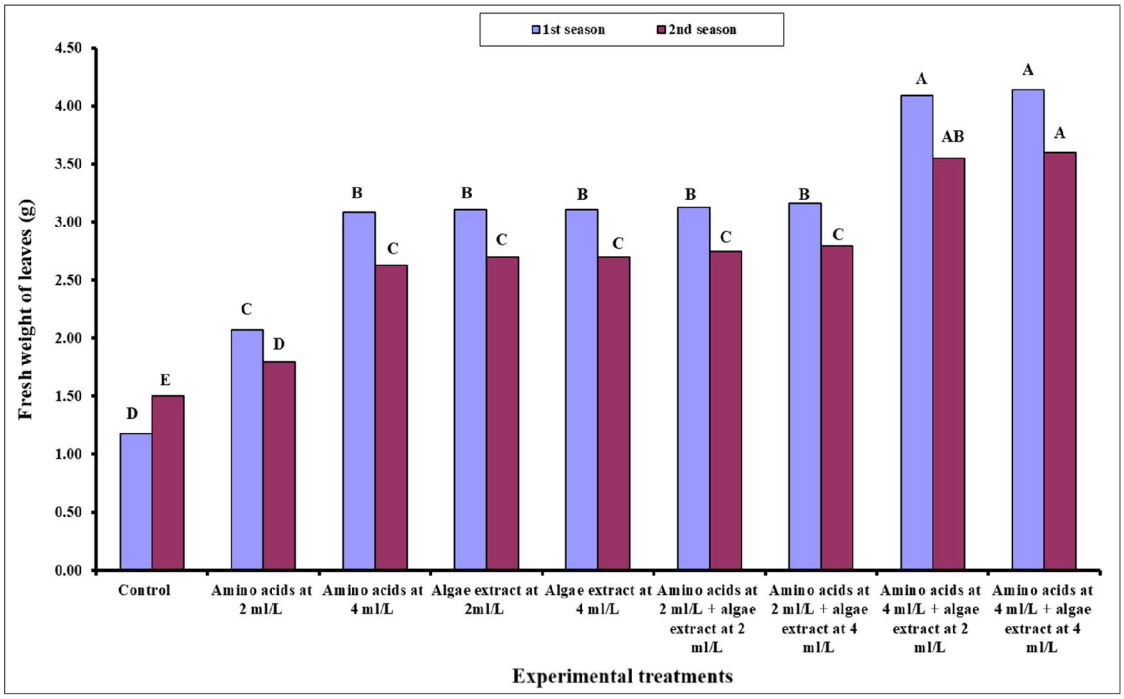

Fig. 7: Effect of foliar spraying with algae extract and amino acids on leaf fresh weight of Nemagaurd seedling throughout the two seasons studied.

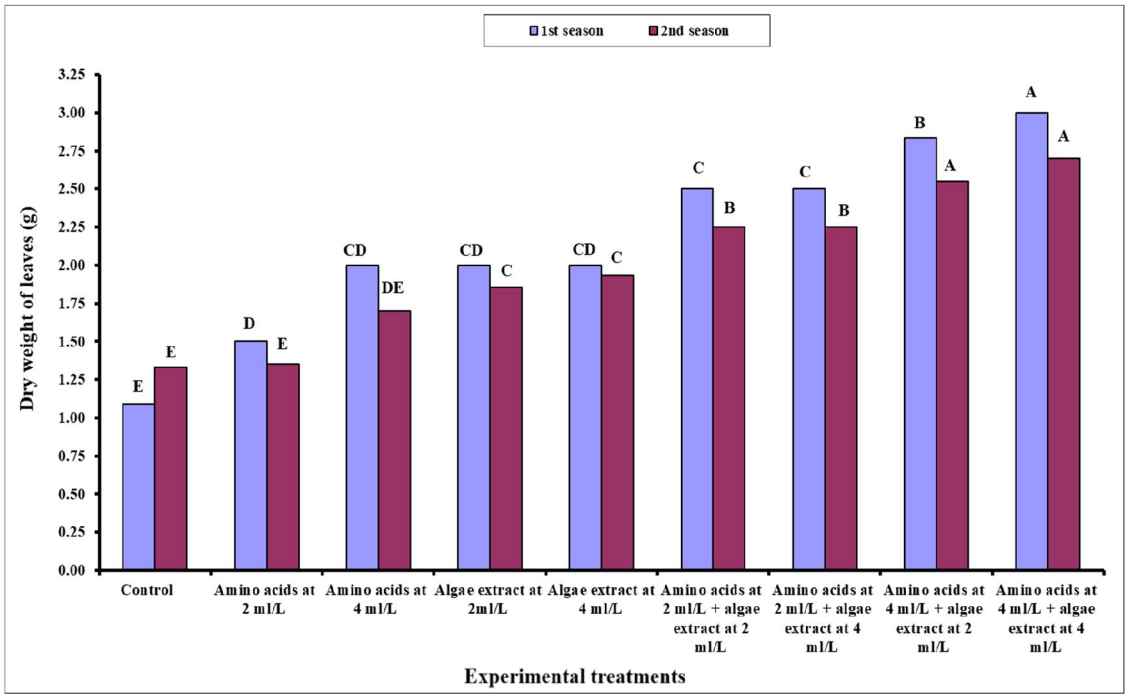

Fig. 8: Effect of foliar spraying with algae extract and amino acids on leaf dry weight of Nemagaurd seedling throughout the two seasons studied.

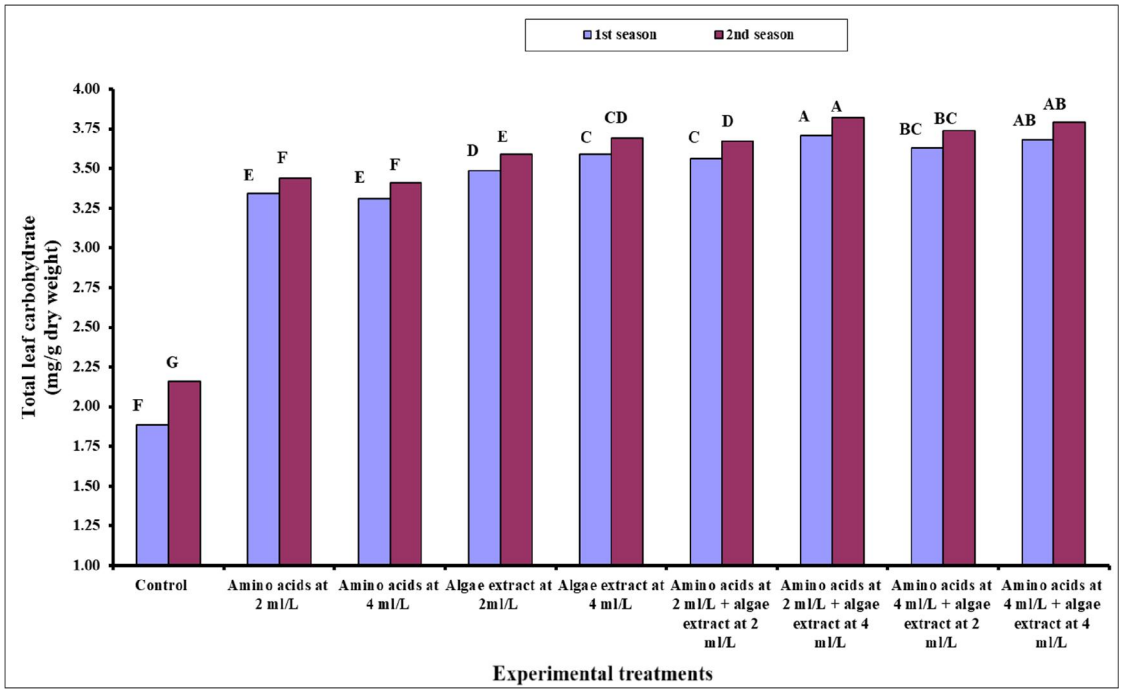

Fig. 9: Effect of foliar spraying with algae extract and amino acids on leaf total carbohydrate of Nemagaurd seedling throughout the two seasons studied

3.1.10. Leaf macro elements content (%)

Table (2) indicates that throughout the two seasons, foliar spraying with algal extract and amino acids had a substantial impact on the macroelement content of nitrogen, phosphorus, potassium, and magnesium in the leaves of Nemagaurd seedlings. In comparison to the control treatment, foliar spray treatments containing amino acids and algal extract, either separately or in combination resulted in a marked increase in the leaf content of the macroelements under investigation.

Table 2: Effect of foliar spraying with algae extract and amino acids on leaf macro elements content of Nemagaurd seedling throughout the two seasons studied

Treatments	N (%)		P (%)		K (%)		Mg (%)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	0.50I	0.52I	0.39E	0.41E	1.32G	1.39G	0.45G	0.49G
2 ml/L of amino acids	0.68H	0.72H	0.42D	0.45D	1.43F	1.51F	0.54F	0.57F
4 ml/L of amino acids	0.86D	0.89D	0.43D	0.45D	1.45F	1.53F	0.60E	0.63E
2ml/L of algae extract	0.79F	0.82F	0.43D	0.46D	1.55E	1.63E	0.64D	0.67D
4 ml/L of algae extract	0.72G	0.75G	0.43D	0.46D	1.76D	1.86D	0.69C	0.70C
2 ml/L of amino acids at + 2 ml/L of algae extract	0.83E	0.86E	0.46C	0.49C	1.87C	1.97C	0.67C	0.73C
2 ml/L of amino acids + 4 ml/L of algae extract	1.01C	1.05C	0.48B	0.51B	1.88C	1.98C	0.73B	0.77B
4 ml/L of amino acids + 2 ml/L of algae extract	1.19B	1.24B	0.49B	0.52B	2.01B	2.12B	0.73B	0.78B
4 ml/L of amino acids + 4 ml/L of algae extract	1.22A	1.28A	0.55A	0.58A	2.32A	2.45A	0.86A	0.93A

The same letters within the same column are not significantly different from each other according to Duncan's multiple range test at the 5% level.

Nitrogen percentages varied in both seasons at different treatments of algae extract and amino acids: 1.22-0.68%, phosphorus (0.55-0.42%), potassium (2.32-1.43%), and magnesium (0.86-0.54%). In the

second season, the corresponding percentages were (1.28-0.72%), (0.58-0.45%), (2.45-1.51%), and (0.93-0.57%). In addition, during the first season, these elements were present in control leaves in amounts of 0.50, 0.39, 1.32, and 0.45%, while in the second season; they were present in amounts of 0.52, 0.41, 1.39, and 0.49%, respectively. Specifically, throughout the first and second seasons, the treatment involving 4 ml/L of amino acids with 4 ml/L of algal extract produced the highest significant levels of N, P, K, and Mg. This was followed by 4 ml/L of amino acids with 2 ml/L of algae extract. On the other hand, the Nemagaurd seedling leaves under the control treatment showed the lowest levels of these components.

10. Leaf micro elements content (ppm)

The microelement content in the leaves of Nemagaurd seedlings was greatly raised by the foliar spraying of algal extract and amino acids, as shown by the results in Table 3. The greatest values of Fe (73.84 and 76.79 ppm), Mn (63.57 and 64.18 ppm), Cu (18.03 and 18.95 ppm), and Zn (31.03 and 32.69 ppm) were recorded during the 2022 and 2023 seasons, respectively, under the treatment with 4 ml/L of amino acids with at 4 ml/L of algal extract. But in both seasons, the control treatment had the noticeably lowest leaf content of Fe, Mn, Cu, and Zn.

Table 3: Effect of foliar spraying with algae extract and amino acids on leaf macro elements content of Nemagaurd seedling throughout the two seasons studied

Treatments	Fe (ppm)		Mn (ppm)		Cu (ppm)		Zn (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	66.00H	68.64H	52.34I	52.84I	13.22G	13.90G	21.11G	23.09G
2 ml/L of amino acids	67.66G	70.77G	54.38H	55.00H	14.00F	14.72F	24.33E	25.88E
4 ml/L of amino acids	68.90F	71.66F	55.86G	56.40G	14.39E	15.13E	27.94C	29.72C
2ml/L of algae extract	70.12E	72.92E	56.72F	57.26F	15.04D	15.81D	23.31F	24.79F
4 ml/L of algae extract	69.88E	72.68E	58.98E	59.55E	15.67C	16.47C	25.67D	27.30D
2 ml/L of amino acids at + 2 ml/L of algae extract	70.91D	73.75D	60.00D	60.45D	15.66C	16.46C	23.09F	24.56F
2 ml/L of amino acids + 4 ml/L of algae extract	72.74C	75.65C	60.45C	61.03C	16.41B	17.25B	24.57E	26.13E
4 ml/L of amino acids + 2 ml/L of algae extract	73.44B	76.38B	62.11B	62.71B	16.34B	17.17B	28.65B	30.47B
4 ml/L of amino acids + 4 ml/L of algae extract	73.84A	76.79A	63.57A	64.18A	18.03A	18.95A	31.03A	32.69A

The same letters within the same column are not significantly different from each other according to Duncan's multiple range test at the 5% level.

4. Discussion

The study's findings demonstrated that the amino acids and algae extract, either separately or in combination with other treatments, had a positive impact on all of the Nemagaurd seedlings' vegetative growth parameters, including length, diameter, the number of shoots per seedling, the number of leaves per seedling, leaf area, total chlorophyll content, leaf fresh weight, and leaf dry weight. They also significantly increased the amount of nutrients in the leaves, including N, P, K, Mg, Fe, Mn, Cu, and Zn. The importance of amino acids as precursors and constituents of proteins, which are vital for stimulating cell growth, can be ascribed to increasing vegetative growth and leaf chlorophyll content by foliar spraying with amino acid treatment (Rai, 2002). Amino acids contribute to the maintenance of physiological processes that favorably or indirectly influence plant growth and development. These activities include enhanced metabolite accumulation in leaves, increased cell division, and elongation. Furthermore, it increases the amount of chlorophyll in the leaves by enhancing photosynthesis. The current findings concur with Wallsgrove (1995) conclusion that amino acids play a critical role in the creation of chlorophyll, with chlorophyll catalyzing photosynthesis (Spinelli *et al.,* 2009).

Additionally, the regulatory effect of algae extracts in raising endogenous hormone levels in treated plants, such as IAA, GA3, and active cytokinins, which encourage cell division and elongation (Miller, 1961); additionally, other compounds in the algae extracts (Mancuso *et al.,* 2006) influence cellular

metabolism in treated plants, resulting in enhanced growth. The findings of Khan *et al.,* (2012) and Hikal (2015), who reported that foliar spraying of algae extract boosted vegetative development, i.e., shoot length, leaf area, number of leaves, leaf area, leaf chlorophyll content, and fresh and dry weight, are consistent with our results.

Compared to seedlings that were not treated, amino acids improved the mineral contents of the leaves. The findings of Thomas *et al.,* (2010) and Laila *et al.,* (2014) showed that foliar amino acid administration enhanced the uptake of N and accumulation of K, P, Mg, Ca, Fe, Mn and Zn, in leaves, which could help to explain our results. Additionally, algal extract increases the uptake of nutrients by roots (Crouch *et al.,* 1990). This leads to higher water and nutrient efficiency in root systems, which promotes greater overall plant growth and vigor. The nutrient concentration simulative impact of algal extract may be explained by the findings of Thanaa *et al.,* (2016), Merwad *et al.,* (2019), and Eisa *et al.,* (2023). They showed that algal extract improved cell permeability, which facilitated faster mineral entrance into root cells. This increased plant nutrient uptake.

The highest and most notable increase in the vegetative growth of Nemagaurd seedlings was generated by the high concentration of the mixture of amino acids and algae extract. This could be because the therapy is helping the seedlings' nutritional state. The outcomes of Khan *et al.,* (2012), who observed that 'Perlette' grapevines treated with spray treatments of amino acids mixture and algal extract had higher contents of P, N, K, Fe, B, and Zn in their leaves than grapevines that were not treated, corroborate these findings. Furthermore, Thanaa *et al.,* (2016) demonstrated that foliar treatment of a combination of amino acids (0.5 ml L) and seaweed extract (2 ml L) boosted the amount of chlorophyll and mineral content in the leaves of "Anna" apples and their vegetative growth.

Furthermore, Mohammed and Saleh (2019) discovered that the grape sapling varieties "Halawani" and "Black Hamburg" exhibited increased leaf area, branch count, chlorophyll content, percentage of dry matter in the leaves, percentage of ripened wood, and total wood due to the high concentration of amino acids and algae extract. According to Qaoud and Zagzog (2023), applying amino acids and seaweed extract topically to grapevine cvs. "Arra 15" and "Arra 20" greatly improved several aspects of their vegetative development and mineral contents.

5. Conclusion

The aforementioned results indicate that the treatment containing 4 ml/L of amino acids in combination with 4 ml/L of algae extract was the most successful when compared to the other treatments. This treatment produced the best results for the majority of vegetative growth parameters and total leaf nutrients in the Nemagaurd seedlings. Other treatments that were effective included 2 ml/L of amino acids in combination with 4 ml/L of algae extract for certain parameters and 4 ml/L of amino acids plus 2 ml/L of algae extract concerning other parameters. In light of the fact that employing modest rather than high doses of amino acids and algae extract will enhance the development vigor of Nemagaurd seedlings and provide robust rootstock for the graft, we thus accept our hypothesis.

6. Acknowledgements

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