Study of the growth-stimulating effect of strawberry plants by foliar spraying with aspartic acid and seaweed extract

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Abstract

The experiment was conducted in the lath house of the Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala, during the 2024-2025 agricultural season on strawberry plants Cv. Paros to study the effect of spraying asparatic acid (0,50 and 100 mg L^{-1}) and seaweed extract (0, 2.5, and 5 mg L^{-1}) on the growth and yield of strawberry seedlings .The results showed the following The 100 mg L^{-1}spraying of asparatic acid had the highest average number of crowns, leaf area, and total soluble solids content of fruit juice compared to the control treatment (without spraying). The lowest average was achieved by spraying seaweed extract at 5 mg L^{-1}, while the highest average leaf chlorophyll content was achieved by spraying with asparatic acid at 100 mg L^{-1}, compared to the control treatment (without spraying), which achieved the lowest average. Regarding the interaction between spraying with asparatic acid and seaweed extract, it was observed that the interaction between spraying with asparatic acid at 100 mg L^{-1} , without spraying with seaweed extract, yielded the highest average leaf area. The interaction between spraying with asparatic acid at 50 mg/L and spraying with seaweed extract at 5 mg L^{-1} yielded the highest average leaf number, while the treatment with seaweed extract, without spraying with asparatic acid, yielded the highest average leaf chlorophyll content and fruit weight. It was also observed that the treatment with asparatic acid at 100 mg L^{-1} , without spraying with seaweed extract, yielded the highest average number of crowns per plant.

Keywords: Seaweed - Strawberry plant- yield - Aspartic acid- Rosaceae family.

Introduction

Strawberry (*Fragaria ananassa*) is a perennial herbaceous crop belonging to the Rosaceae family. It is an important small fruit widely distributed worldwide. Its popularity is due to its ability to adapt to diverse environmental conditions, its high nutritional value, and its rapid growth and production [1]. Strawberry cultivation is widespread in more than 63 countries. The cultivated area in 2021 amounted to approximately 389,665 hectares, with a global production rate of approximately 9.175 million tons [7] In Iraq, strawberry cultivation is relatively new and is limited to scientific experiment stations, some home gardens, and small agricultural areas. Most of the strawberries consumed in Iraq are imported from neighboring countries [19].Strawberries have a high nutritional and therapeutic value, due to their high content of a variety of vital compounds, such as vitamins, dietary fiber, proteins, carbohydrates, and phenolic compounds, especially anthocyanins [11]. Strawberries are a rich source of vitamin D, with concentrations ranging between 40 and 120 mg per 100 grams of fruit. Strawberries are an effective antioxidant, and numerous studies indicate that strawberry consumption is associated with protective effects against a number of chronic diseases, including cardiovascular disease. Cancer and high blood pressure, highlighting its importance as a functional food with multiple health benefits [10]Strawberries are a crop that requires relatively high fertilizer rates, given the plant's high capacity to produce large quantities of fruit despite its small size [16]. Foliar fertilization is an effective strategy for addressing nutrient deficiencies, as it directly contributes to improving the plant's ability to produce high-quality fruit with an appearance that meets marketing specifications. Studies have shown that the excessive use of chemical fertilizers leads to serious environmental problems, in addition to its potential negative effects on human and animal health. Consequently, there has been a recent increase in interest in finding safer alternatives to traditional fertilization, such as the use of amino acids [20]. These are simple organic compounds containing nitrogen, carbon, hydrogen, and oxygen. They consist of two chemical groups: the carboxyl group (COOH) and the amine group (NH_2), which gives them the properties of acids and amines. Amino acids are essential building blocks of protein, contributing approximately 20% of the total protein. A variety of them are involved in this process. The protein synthesis process gains its importance from the multiple functions it performs, as it contributes to building the plant structure and the formation of plant hormones [2].Asparatic acid is one of the essential amino acids and plays a pivotal role in the metabolic pathways related to nitrogen metabolism in plants. Studies have shown that this acid has a direct regulatory role in plant growth, as it affects the cellular networks responsible for nitrogen metabolism [6]. Furthermore, it contributes to enhancing plant tolerance and resistance to various diseases [8]. [18] observed that spraying Novo strawberry plants with amino acids (62% organic matter, consisting of 30% organic carbon, 10% organic nitrogen, 11% free amino acids, and various organic components) at a concentration of 1 ml L^{-1} , at a rate of two sprays per week throughout the cultivation period, resulted in a significant increase in fruit diameter, length, weight, number of fruits per plant, fruit weight per plant, and number and weight of fruits per square meter, compared to a control treatment without spraying. [14] found that spraying Festival strawberry plants with amino acids at a concentration of 10 ml L^{-1} four times, 75, 90, 105, and 120 days after planting, resulted in increased plant height, number of leaves per plant, dry weight of the plant's vegetative mass, and yield per plant. Recent interest in the quality of food products and their safety from pesticide and chemical fertilizer residues has gained traction. The recent widespread use of algae extracts has led to improvements in plant growth, increased productivity and quality, and the production of crops free of harmful chemicals[15]The purpose of the texperimento : study the feasibility of foliar spraying Paros strawberry plants with asparatic acid and seaweed extract as an alternative to the use of mineral fertilizers, either partially or fully, while maintaining or increasing growth and yield per unit area. This is aimed at reducing production costs, preserving the health of consumers and agricultural workers, and preventing soil degradation.

Material and Methods

Prepare samples:

The experiment was conducted in the lath house of the Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala, during the 2024-2025 agricultural season to study the effect of spraying aspartic acid (0, 50, and 100 mg L^{-1}) and seaweed extract (0, 2.5, and 5 mg L^{-1}) on the growth and yield of the strawberry Cv. Paros. Plants grown in trays were brought from the Hanging Gardens Nursery in Al-Muqdadiyah District and transferred to 10 kg anvils filled with a soil mixture of 3:1 peat moss on November 12, 2004. The roots of the plants were treated with a fungicide before transfer. After the transfer was complete, the plants were irrigated in the ath house

at a 50% Textile ratio. Two weeks after planting, a balanced NPK fertilizer was added at a rate of 5 g per plant. General maintenance operations were carried out during the planting period, including weeding, weeding, and fungicide control. Pentanol

Studied traits:

1. **Number of crown (Crown plant $^{-1}$)**

   Calculate the number of crowns on five plants from each experimental unit at the end of the experiment and divide by the number of plants.

2. **Number of leaves (leaf plant^{-1})**

   Calculate the number of leaves on five plants from each experimental unit at the end of the experiment and divide by the number of plants.

3. **leaf area (cm^2)**

   Fifteen fully developed leaves were selected and placed in labeled plastic bags to prevent wilting. They were then wiped with a damp cloth to remove any dust. They were then weighed using a sensitive balance. Pieces of known area were taken from these pieces and weighed. Leaf area was calculated based on fresh weight, using the following equation:

Leaf area (cm2) = (Leaf weight (g) × Area of cut disk (cm2)) / Weight of cut disk (g)

4. Relative Chlorophyll Content (Spad Unit)

This was estimated using a Minolte SPAD 502 direct chlorophyll meter. The readings were taken from five fully developed leaves from each seedling in the experimental unit, and the average of the readings was taken by dividing the sum by the number of leaves.

5. Average percentage of dry matter in the shoot and root system (%)

The plants and soil were extracted from the containers at the end of the experiment.

Using running water, the roots were washed to remove any soil. The shoot and root systems were then separated using pruning shears from the crown area. The shoot and root parts were washed and weighed using a sensitive balance. The shoot and root parts were placed separately in perforated paper bags for each experimental unit. They were air-dried and then placed in an electric oven at 65°C until the weights were constant. They were then weighed using a sensitive balance. After measuring the fresh and dry weights of the shoot and root systems, the following equation was applied to calculate the percentage of dry matter for the shoot and root systems separately.**Results and Discussion**

1. Number of crowns (crown plant $^{-1}$)

The results shown in Table 1 show that the asparatic acid spray treatments had a significant effect on increasing the number of crowns per plant. The 100 mg/L spray treatment had the highest average number of crowns, reaching 3.611 plant crowns, and did not differ significantly from the 50 mg/L^{-1} spray treatment. The control treatment (without spray) had the lowest average, reaching 2.944 plant crowns. The seaweed extract spray treatments did not significantly affect the average number of crowns per plant. Regarding the interaction between the asparatic acid and seaweed extract spray treatments, we note that the 100 mg/L spray treatment, without spraying with seaweed extract, had the highest average number of crowns, reaching 4.0 plant crowns. The control treatment (without spraying) had the lowest average, reaching 4.0 plant crowns. 2.333 plant crowns.

2. leaves number (leaf plant^{-1})

The results in Table 2 show that the averages of the spray treatments with asparatic acid and seaweed extract, individually, did not differ significantly from each other in the average number of leaves. Regarding the interaction between the spray treatments, the interaction between spraying with asparatic acid at a concentration of 50 mg/L and seaweed extract at a concentration of 5 ml/L resulted in the highest average number of leaves, reaching 13 leaves per plant. The comparison treatment without spraying yielded the lowest average, reaching 8,333 leaves per plant.

3. Characteristic studied: Leaf area (cm^2)

The results shown in the table show the significant effect of spraying with asparatic acid. We note that leaf area increased with increasing acid concentration. The spraying treatment with a concentration of 100 mg/L had the highest average leaf area, reaching 7.688 cm2, while the control treatment without spraying had the lowest average, reaching 6.128 cm2. The spraying treatments with seaweed extract did not have a significant effect on increasing the area per leaf. Regarding the interaction between spraying with asparatic acid and seaweed extract, we note that the spraying treatment with 4-asparatic acid at a concentration of 100 mg/L without spraying with seaweed extract had the highest average, reaching 7.943 cm2, while the control treatment without spraying had the lowest average, reaching 5.737 cm2.

4-Leaf Chlorophyll Content (SPAD Unit)

From the results shown in Table 4, we note that the spray treatments with asparatic acid had no significant effect on increasing leaf chlorophyll content. However, the spray treatments with seaweed extract significantly increased leaf chlorophyll content. The 5 ml/L spray treatment yielded the highest mean, reaching 68.64 SPAD units, while the lowest mean was 62.18 for the control treatment without spray. This did not significantly differ from the 2.5 ml/L spray treatment.

5. Percentage of dry matter of the vegetative mass (%)

The results in Table 5 show that the treatments of asparatic acid and seaweed extract, either individually or in combination, had no significant effect on the percentage of dry matter of the vegetative mass.

6. Root Dry Matter Percentage (%)

The results in Table 6 show that the asparatic acid spray treatments had a significant effect on increasing the root dry matter percentage. The highest average was 15.44% when sprayed at a concentration of 100 mg/L, while the control treatment had the lowest average, 13.88%. Neither the seaweed extract spray treatments, individually nor the interaction treatments, significantly affected the root dry matter percentage.

7. Average Fruit Weight (g.fruit^{-1})

The results in Table 7 show that asparatic acid had a significant effect on increasing the average fruit weight. The highest average was 18.99 g when spraying with the acid at a concentration of 100 mg/L, while the treatment without spraying yielded the lowest average of 17.13 g. Regarding the algae extract spray treatments, we observed an increase in the average fruit weight with increasing algae extract concentration. The 5 ml/L spray treatment yielded the highest average of 19.21 g, while the unsprayed treatment yielded the lowest average of 16.47 g. Regarding the interaction between the asparatic acid and seaweed extract spray treatments, the treatment without asparatic acid spraying and the treatment with 5 ml/L algae extract yielded the highest average of 20.81 g, while the control treatment without spraying yielded the lowest average of 16.47 g.

to the choice of polynomial at the 0.05 probability level.

8. Total Dissolved Solids (TDS)

The results in Table 8 show that the asparatic acid spray treatments had a significant effect on increasing the total dissolved solids (TDS) ratio. The highest average was 16.62% when spraying at a concentration of 100 mg/L, while the control treatment had the lowest average, 14.76%. Neither the seaweed extract spray treatments, individually nor the interaction treatments, significantly affected the total dissolved solids ratio

Table.1. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the Number of Crowns (crown plant^{-1})

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
2.944B	3.500abc	3.000abc	2.333c	0
3.167AB	3.500abc	2.667bc	3.333abc	50
3.611A	3.667ab	3.167abc	4.000a	100
	3.556A	2.944A	3.222A	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of polynomial at the 0.05 probability level.

Table 2. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the number of leaves (leaf plant^{-1})

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
10.88A	12.33ab	12.00ab	8.333b	0
11.61A	13.00a	10.50ab	11.33ab	50
11.00A	11.00ab	10.67ab	11.33ab	100
	12.11A	10.06A	10.33A	Average seaweed extract

Data means with similar letters do not differ significantly from each other according to the choice of polynomial at the 0.05 probability level.

Table 3. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the leaf area (cm^2)

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
6.128C	6.440cd	6.207cd	5.737d	0
6.898B	6.860bc	7.063abc	6.770bc	50
7.688A	7.657ab	7.463ab	7.943a	100
	6.986A	6.911A	6.817A	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of polynomial at the 0.05 probability level.

Table 4. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the Relative chlorophyll content (spad unit)

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
64.40A	71.53a	65.97ab	55.72c	0
66.18A	66.68ab	65.70ab	66.16ab	50
64.10A	67.71ab	59.94bc	65.65ab	100
	68.64A	63.87B	62.18B	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of polynomial at the 0.05 probability level.

Table 5. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the vegetative dry matter (5)

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
29.44A	33.33a	31.00a	24.00a	0
29.00A	28.67a	26.67a	31.67a	50
27.88A	24.33a	31.00a	28.33a	100
	28.78A	29.56A	28.00A	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of polynomial at the 0.05 probability level.

Table 6. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the Root dry matter (%)

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
13.88B	14.00a	14.00a	13.67a	0
13.22B	13.00b	12.00b	14.67a	50
15.44A	15.67a	13.67a	15.67a	100
	14.22	13.67A	14.66A	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of polynomial at the 0.05 probability level.

Table 7. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the fruit weight gm plant-1

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
17.13B	20.81a	17.27ab	13.31d	0
17.48AB	17.74ab	18.42ab	16.29c	50
18.99A	19.10ab	18.05ab	19.81ab	100
Average seaweed extract	19.21A	17.91B	16.47C	

Data means with similar letters are not significantly different from each other according tothe choice of polynomial at the 0.05 probability level.

Table 8. Effect of spraying with Aspartic Acid and Seaweed Extract and Their Interaction on the TSS (%)

Average Asparatic acid	Average seaweed extract mg L^{-1}			Asparatic acid (mg L^{-1})
	5	2.5	0	
14.76B	15.70a	16.07a	12.51b	0
16.08A	16.07a	16.28a	15.90a	50
16.62A	16.73a	16.48a	16.66a	100
	16.17A	16.27A	15.02A	Average seaweed extract

Data means with similar letters are not significantly different from each other according to the choice of the polynomial at the 0.05 probability level.

Conclusion

It has been known that Asp is the primary precursor of the essential amino acids lysine, threonine, isoleucine and methionine [9].Also, Asp can be directly used as a substrate to replenish the tricarboxylic acid (TCA) cycle [4]. Besides, Asp is an indispensable component for de novo nucleotide biosynthesis[17],The reason due to the content of these seaweed extracts on many nutrients, both macro and micro, such as iron, which is important in activating oxidation reduction enzymes in the electron transport chain in the respiration process and helping it build chlorophyll and store iron in chloroplasts in the form of phytoferritin, which leads to greater vegetative growth[3], also, the zinc element contained seaweed extracts contributes to the manufacture of the amino acid (Treptophan), which is the basic material in the manufacture of auxin (IAA) which is important in cell division and expansion, which leads to greater vegetative growth, as well as copper and boron found in seaweed extracts, which are important in transporting electrons and transporting sugars, which encourages photosynthesis and other growth processes and thus leads to greater growth [13] his can be attributed to the fact that the seaweed extract contains proteins, vitamins, sugars, and mineral elements such as potassium and magnesium, which play a role in the vital processes within the plant, such as photosynthesis, activating the work of some enzymes, and building proteins, calcium and magnesium are the largest percentage of the components of the middle plate, and the magnesium atom represents the center of the chlorophyll molecule[12] .

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