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Effect of Spraying With Foliar Fertilizer of a Mixture of Seaweed Extract and Amino Acids on the Growth and Yield of Eggplant (*Solanum Melongena* L.)

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Annotation: The research was performed at the Agricultural Research Station in the University of Basra, using complete randomised plot. This was factorial experiment where the cultivar singled out and two cultivars: Barcelona and Jawahar were treated and the foliar spraying which was treated by a solution of amino acid and seaweed extract. In the investigated parameters, spraying with the combination of 2 mg L^-1 was found to be better than the Barcelona cultivar. In all aspects, the Barcelona cultivar overlap was found under the spraying of the mixture at a dose of 2 mg L^{-1} under all of the investigated conditions.

Keywords: eggplant, cultivar, mixture of amino acids, seaweed extract.

Introduction

Application of foliar fertilizer consisting of a mixture of amino acids and seaweed extract to spray eggplant (Solanum melongena L.) has proved to be very effective for the increase of plant growth and yield. The foliar applications of phosphorous, due to their chances to be absorbed from leaves in the above ground parts and due to their efficiency in rapid plant development, especially in conditions where phosphorous in the soil is often limited, inefficient or unequally available. A seaweed extract is rich in the bioactive compounds including cytokinins, auxins,

gibberellins, trace minerals, and vitamins, and carbohydrates. They are natural growth stimulants because they promote cell division, elongation and increase in vegetative growth. Seaweed extract applications in eggplants contribute to root development, leaf area and chlorophyll content, which in turn increases photosynthetic efficiency. The translation signifies more energetic plants that are hardy to environmental stress.

Amino acids are required as building blocks of proteins and precursors of essential biomolecules in the plant metabolism. On the foliar application, they stimulate enzyme activity, enhance nitrogen assimilation and improve nutrient assimilation. Application of amino acids in combination with seaweed extract has a synergistic effect and amino acids chelate micronutrients in seaweed extract allowing them to be made available to plant. Conclusions from research demonstrate earlier flowering, higher fruit set, and larger, better-quality fruits when eggplants are treated with the foliar mix when compared to untreated control. Fruit firmness and marketable quality increase significantly and so do the yield per plant and overall fruit weight. In addition, the treatment helps the plants continue to grow healthy and are more resistant to disease and pests. This indicates that the foliar application of a fertilizer mixture of seaweed extract and amino acids is sustainable and effective agronomic practice that enhances eggplant growth and production. An increase in productivity, better fruit quality, and the lowering of dependence on chemical fertilizers makes its use highly suitable for an eco-friendly and cost-effective agricultural practice.

The eggplant crop, *Solanum melongena*, occupies an advanced position in terms of area occupied by vegetables of the Solanaceae family. As per the stats of the International Food and Agriculture Organization, the entire area cultivated with the eggplant crop in the world amounted to about 1.6 million hectares, of which the equivalent of 1.2 million hectares is in Asia alone [Maltoul et al., 1989]. In Iraq, the cultivated area in 2016 amounted to about 16,858 thousand hectares, and Iraq produces 387,435 thousand tons, with a productivity of 22,982 tons per hectare [FAO, 2010]. The crop of fruits, are eaten after cooking. It is also used in making pickles, and they can be kept frozen or canned for the purpose of export. Eggplant also has an important nutritional value, which is evident when compared to other vegetable crops. Each 100g of fresh fruit has 24 calories, 92.7% water, 4.0 g carbohydrates, 1.4 g protein, 0.3 g fat, and 1.3 g fiber. The fruits are also characterized by a good content of some vitamins, such as vitamins C, B5, B2, B12, and A, as well as mineral salts, especially potassium and iron [Maltoul et al., 1989].

In order to achieve this, one has to impel aubergine output by adopting growth boosters, in the capacity of amino acids, thus taking care of the processes of servicing the plant. When the spray is given on to the vegetative areas, 85% of nutrients that the plant required is provided in the form of foliar sprays [Rashad et al, 2010]. Amino acids are the essential constituents for synthesis of several chemicals in plants such as proteins, amines, nitrogenous bases (purines and pyrimidine), alkaloids, vitamins, terpenes, etc. and vital enzymes and hormones of metabolic activity [El-Shabisi et al., 2005]. Foliar sprays (or spray of amino acids on soil) have lately been applied [Azziwally, 2017] to increase plant development and output. Amino acids have always proved rather useful in its treatment of plants and have even expanded the growth range of the plant.

When sprayed with amino acid at 0.25 millilitres per litre concentration, vegetative growth, plant height, and dry weight were [El-Zohiri and Asfori, 2009]. For instance, when 2 L.H.2 of the Tecamin Max solution was administered to a plant, there was an expansion in the length of the plant, the number of the roots of a plant, the total contents of chlorophyll of the leaves, and the leaf area if compared to other plant that has no treatment (Al Hamdani et al., 2017). However, as stated by [Al-Sultani and Al-Tufaili, 2020], the greatest plant growth was found in spraying tryptophan and arginine in a concentration of fifty milligrams per litre compared with the control. In terms of plant height, number of main branches, average leaf area, total chlorophyll in leaf, total amino acid content in fruit, and in terms of yield, arginine released superbly compare

to other control treatments including tryptophan. Most of the vegetable crops often grow in situations where organic fertilisers are largely involved. The addition of organic matter has been shown to make nutrients available to plants and to prompt plants to make use of such nutrients.

Materials and Methods

The experiment carried out (in the winter season 2022-2023) at Agricultural Research Station, College of Agriculture, University of Basra. The experiment had the aim to study the effect of foliar fertiliser, represented as a mixture of amino acid extract and seaweed extract, on the growth and yield of eggplant (Solanum melongena Barcelona and Jawaher cultivars). The design used was a Randomised Complete Block Design (RCBD) comprising Factorial experiment repeated thrice. Precisely, the width of experimental unit was three meters and the terrace width was sixty centimetres. In each of the experimental units, there was a longitudinal incision made.

Each pot was 40 cm apart and there was a total of 10 plants to the experimental unit. A distance of 1 m was maintained between each experimental units, thereby resulting in 18 experimental units for the purpose of preventing contact among the units. Two factors were considered: the first factor was comprised of 2 types of eggplant namely Barcelona and Jawaher; and the second factor included two levels of combination of amino acid extract with seaweed extract at 0, 1.5 and 3 mg/L. The plants were planted and sprayed October 15, 2022, and early in the morning. The first spray took place in November 15, 2022. The second spraying occurred one week subsequent to the first spraying. Two weeks after the second, a third application was made one week thereafter.

It was calculated on the basis of the individual plant as an average of 5 studied plants taken from the line for each experimental unit.

1. Plant height (g): Vegetative development and plant vitality as a whole is assessed through plant height. The measure of the length is taken with a metric measuring tape or ruler, from the place of the plant origin at the soil surface to the top of the plant, typically including the primary trunk of the plant. This then provides direct measurement of the plant's development under different treatment conditions. Increased plant height is typically between increased cell elongation and internodal development which can be influenced by foliar application as it reaches equilibrium around nutritional and hormonal status e.g., seaweed extracts and amino acids.

2. Number of leaves: On the main stem of an individual representative plant, the quantity of leaves is enumerated. Starting with the starting bog fully developed green leaf which is at the soil surface and growing up to the tip growth point of the plant. This count is important for determining plant health in relationship to the potential for photosynthesis. Therefore, an increased leaf count generally allows you to have a larger photosynthetic surface area and as a consequence, greater biomass production and yield. Additionally, this measure is very valuable to characterize the effect of foliar treatments on vegetative growth dynamics.

3. Leaf area (cm2 plant -1): The leafy area of one plant was measured at the end of the growing season, where cuttings were taken with a known disc-shaped area, small discs were cut from the leaves using a hollow metal cylinder of known inner diameter and the cutting of a fixed number of these discs, where ten leaflets were taken for each plant. Three plants were chosen randomly for each experimental unit, then the discs and leaves were dried for each plant separately, aerobically, and for each experimental unit, then the discs and leaves were weighed using a sensitive balance and by calculating the ratio of area to weight (1), and we obtain the leaf area for each plant according to the following law:

4. Leaf area of a plant -1- Weight of dry leaves (gm) divided by weight = dry tablets (gm) multiplied by the known leafy area of dry tablets (cm2): Leaf area is one of the basic measures of plant physiology as it provides the photosynthetic potential in a plant. The calculation is of an indirect type and is based on correlation of the weight of dry leaves with weight of a reference

dry tablet of a certain leaf area. The dry leave weight of leaves of a single plant is divided into the dry weight of a reference tablet in grams, and then the result is multiplied by the surface of the reference dry tablet in cm2. It allows to provide an estimation of the total plant leaf area. Such an approach presents a method for precisely and nonexorbitantly assessing the leaf area, a methodology not requiring sophisticated equipment to use and to assess effects of foliar treatments on leaf expansion and plant health.

The above calculation was used:

Leaf Area = (Dry weight of leaves / Dry weight of tablet) × Known area of tablet.

5. Leaves concentration of total chlorophyll (mg g - 1fresh weight): Total chlorophyll content is an important indicator of the leaves' photosynthetic capacity and overall vigour of the plant. Instead, it is expressed in terms of milligrams of chlorophyll per gramme of fresh leaf tissue (mg g^{-1} fresh weight). The procedure consists of extracting chlorophyll from a specified amount of fresh leaf material by use of solvents such as acetone or ethanol followed by measurement in the spectrophotometer to determine the amount of chlorophyll present. For a greater amount of chlorophyll means better food absorption, more effective photosynthesis, bigger plant vitality. It is often seen that foliar sprays using seaweed extract and amino acids improve chlorophyll levels which ensures fast and fruitful development of plant.

The total amount of chlorophyll in the green leaves is calculated through:

1. Take 0.5 grams of soft vegetable tissue

2. Crush the tissue with a ceramic mortar with an amount of 10 ml of acetone 80% (20 ml of water was added for every 80 ml of pure and concentrated acetone) after the crushing was done in two batches, the first was crushing with 2 ml of acetone, and the remaining amount was added

3. The crushed tissue was centrifuged for 5 minutes

4. The optical absorption of the dye was measured using a UV visible spectrophotometer at two wavelengths 663 (chlorophyll A) and 645 (chlorophyll B) nanometres, and then the amount of dye was calculated according to the following equation:

a) (1000 x w/v) (663) D x 8.02 + (645) D x 20.0 = Total chlorophyll

It represents: D: optical absorption

(663)D: optical absorption readout with 663 nm wavelength

(645) D: Optical absorption readout with of 645 nm wavelength

b) V: the volume of the total extract used (10 ml acetone)

T. W: the weight of the soft tissue.

- ✓ The number of leaves has been calculated. Plant-1
- ✓ Plant yield (g. plant): The plant yield was calculated using the electric balance in the laboratory

RESULTS AND DISCUSSION

As shown in Table 2, the plant height traits under the influence of cultivar were not significant. However, spraying with solution of seaweed extract and amino acids was important on plant height traits. In that regard, plants given a concentration of 2 ml L-1 were by far superior to those given a concentration of 1 ml L-1 and those given the control treatment. Therefore, the interaction was significant, since Barcelona aubergine plants that were treated with the solution having concentration of 2 ml L-1 performed well to the extent that the maximum plant height of 91.69 cm was attained. Contrary to the cultivar jawahir treated with distilled water which gave the lowest plant height.

As seen in Table 3, plant height characteristic does not have any significance on cultivar. In contrast, the trait number of leaves of the plant was affected by the spraying with a solution of seaweed extract and amino acids. The plants that have been treated with the concentration of 2 ml L −1 significantly outperformed the plants that were treated with concentrations of 1 ml L −1 and control treatment. The concentration of 1 millilitre per litre was given to the plants, and as compared to the control treatment, they fared greatly well. There was significant interaction because the plants of the aubergine cultivar Jawaher treated with a solution of 2 ml L -1 performed extremely well by producing the highest number of leaves per plant that were 61.07 leaf. Plant -1. However, in case of cultivar Jawaher, treated with distilled water, that had the lowest number of leaves per plant, producing only 35.47 leaf. Plant -1.

As shown in Table 3, the cultivar had little effect on the height of plant. Opposite to that, spraying of a solution of amino acids and seaweed extract to the fenugreek plants greatly affected the leaf area trait. It was shown that the plants that were treated with the concentration of 2 ml L-1 and the plants with the concentration of 1 ml L-1 treated exceptionally well when compared with the treatment and there wasn't a significant difference among the two groups. Concerning the interaction, there was as there was a significant interaction and the plants of the aubergine cultivar Jawaher had led the best performance with the concentration of 2 millilitres per litre. It produced the highest number of leaves per plant which was 327 square centimetres. As an example of a treatment that received distilled water, the lowest number of leaves produced from such cultivation was 62.1 square centimetres.

However, treatment with a solution of amino acids and seaweed extract was very effective on the trait of the weight of the fruit as plants treated with a concentration of 2 ml L-1 and plants treated with a concentration of 1 ml L 1excelled. Table 4 revealed that the cultivar did not have any significant effect on fruit weight (g) (This is shown in Table 4). They were compared with the therapy that served as the control and there was no difference between them available to perceive. The interaction was important and it was because the fruit weight of the Barcelona aubergine plants that was treated with the solution at 2 ml L-1 concentration, was highest, 0.327 gm. The opposite was however true to the treatment that gave the lowest weight of the same cultivar treated with distilled water of 99.5 gm.

The results in Table 5 indicated that the cultivar was indicative of the trait of the number of fruits produced by each plant. But the most successful cultivar in producing the greatest number of fruits (69.9 plant fruits –1) was the Barcelona cultivar. The cultivar Jewels, on the other hand, set the least fruits which totalled 60 fruits. Plant -1 had a great influence on the weight of the fruit as it was not sprayed with a solution of amino acids and seaweed extract. The weight of the fruit was influenced by this. On the interaction, it was quite high as the plants of the Barcelona aubergine cultivar that were handled using the solution at concentration of 2 ml L-1 do exceedingly well and produced the greatest number of fruits, that is 76.2 fruits. Number of plants produced in Jawaher cultivar treated with water was significantly lower compared with lowest number. It comes to 52,552.5.

Table 1. Physiochemical properties of irrigation soil and water

Traits	values	units
pH	7.4	____
N	26.40	$g.kg^{-1}$
P	9.4	$g.kg^{-1}$
K	18.20	$g.kg^{-1}$
$CaCo_3$	201.60	$g.kg^{-1}$
organic matter	1.38	$g.kg^{-1}$
total organic carbon	0.80	$g.kg^{-1}$
E.C	6.87	$ds.m^{-1}$

Co_3	0	Meq/L
Hco_3	2.08	Meq/L
Ca^{++}	1.08	Meq/L
Mg^{++}	17.2	Meq/L
available sulfur	13.28	$g.kg^{-1}$
Soil separators		
sand	76.56	%
Silt	7.81	%
clay	15.63	%
Soil texture	Clay sandy	
Irrigation water		
E.C	5.67	$ds.m^{-1}$
pH	7.7	___
Ca^{++}	16.4	$mMol.L^{-1}$
Mg^{++}	11.4	$mMol.L^{-1}$
Na^{+}	9.6	$mMol.L^{-1}$
Cl^{-1}	14.01	$mMol.L^{-1}$
So_4^{-2}	15.5	$mMol.L^{-1}$

* The analysis was done in the central laboratory of the College of Agriculture / University of Basra.

Table 2. Effect of cultivar and spraying with amino acid solution + seaweed extract and the interaction between them on eggplant plant height

cultivar	spraying solution			Cultivar average effect
	0	1	2	
Barcelona	82.70	86.23	91.69	86.88
jawahir	82.21	85.32	86.94	84.82
Average effect of spraying solution	82.21	85.32	89.32	
LSD (0.05)				
interaction cultivar and spraying solution	**spraying solution**			cultivar
5.781	4.088			NS

Table 3. Effect of cultivar and spraying with amino acid solution + seaweed extract and the contact between them on the number of leaves of the eggplant plant

cultivar	spraying solution			Cultivar average effect
	0	1	2	
Barcelona	44.98	50.51	57.22	50.90
jawahir	35.47	50.15	61.07	48.90
Average effect of spraying solution	40.23	50.33	59.14	
LSD (0.05)				
interaction cultivar	**spraying solution**			cultivar

and spraying solution		
7.484	5.292	NS

Table 3. the effect of cultivar and spraying with amino acid solutions + seaweed extract and the interaction between them on the number of leaves of the eggplant plant

Table 4. the effect of cultivar and spraying with amino acid solutions + seaweed extract and the interaction between them on the number of leaves of the eggplant plant

cultivar	spraying solution			Cultivar average effect
	0	1	2	
jawahir	62.1	246.7	242.5	183.8
Barcelona	94.3	236.0	327.1	219.1
Average effect of spraying solution	78.2	241.4	284.8	
LSD (0.05)				
interaction cultivar and spraying solution	spraying solution			cultivar
72.99	51.61			NS

Table (5) Effect of cultivar and spraying with amino acid solution + seaweed extract and the interaction between them on the number of fruits .plant^{-1}) of eggplant plant

cultivar	spraying solution			Cultivar average effect
	0	1	2	
jawahir	108.6	122.5	136.2	122.4
Barcelona	99.5	236.0	327.1	114.3
Average effect of spraying solution	104.0	121.1	130.0	
LSD (0.05)				
interaction cultivar and spraying solution	spraying solution			cultivar
17.85	12.62			NS

cultivar	spraying solution			Cultivar average effect
	0	1	2	
jawahir	52.5	61.9	65.6	60.0
Barcelona	58.9	74.7	76.2	69.9
Average effect of spraying solution	62.2	64.4	68.3	
LSD (0.05)				
interaction cultivar and spraying solution	spraying solution			cultivar
13.28	NS			7.67

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