

Effect of foliar spray of seaweed extract on growth and yield of two tomato hybrids (*Solanum lycopersicum* L.)

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Abstract

This research was carried out in a plastic house belonging to farmers from the people of Nasiriya, Al-Graf district of the district of Dhi Qar during the agricultural season 2026-2025 AD, with the aim of studying the effect of spraying with different concentrations of seaweed extract in the growth and production of two hybrids from tomato. They are jawahir and yasmine. The design of the complete random sectors was adopted by three repeats, and in the split-plot design method, the concentration of seaweed extract (where the extract of seaweed (5, 2.5, 0) ml/l was the (Main Plot), and the hybrid represented (SubPlot).

The results revealed that the concentration of 5 ml/l of seaweed extract achieved the highest averages in all the studied qualities, with the average plant height of (98.4cm) , the chlorophyll content (52.6 SPAD), and the yield of one plant (4.3 kg). The content of T.S.S. reached (4.63%), and the fruit content of vitamin C (22.13 mg / 100 g), while hybrids surpassed hybrids, jawahir gave the highest height as well as the content of one leaves of chlorophyll and the yield of the plant amounted to (90.6cm, 48.2SPAD, 3.6kg) respectively, while no moral differences were recorded in other qualities. The overlap between the concentration of 5 ml/l and the highest-altitude hybrid jawahir and the content of chlorophyll and the single plant and vitamin C (102.7 cm, 55.8 SPAD, 4.6 kg, 23.41 mg/100 g) were shown respectively. Seaweed extract was sprayed and leafy sprayed on tomato plants three times during the growing season, during which the concentration of 5 ml/l showed effectiveness in improving growth indicators and increasing what is in the tomato plant, while the hybrid jawahir, the results showed that it was suitable for the conditions of the study area to obtain the highest quotient.

Keywords: Foliar spray, seaweed extract, tomato productivity, hybrid varieties

1-Introduction

The tomato *Solanum lycopersicum* L. One of the most important horticultural crops in both the world and Iraq, because of its high nutritional value and wide spread in consumer tables. Tomatoes occupy a prestigious position among the crops of vegetables grown in Iraq, as they are grown in various governorates in spring and autumn....and...in protected agriculture.

Agricultural production is facing increasing challenges in light of climate change, the deterioration of soil fertility and the overuse of chemical fertilizers that cast a negative shadow on product quality and environmental safety. Therefore, there is an urgent need to look for safe and effective natural alternatives that promote growth and improve productivity without harming the ecosystem. Seaweed extracts stand out as promising and multi-beneficial bio stimulants, containing a wide spectrum of active compounds such as amino acids, growth hormones oxin, cytokine, gibberellin, polysaccharides, vitamins and major and micro nutrients. Studies have shown that these extracts improve the absorption of nutrients, stimulate the representative energy of the plant, increase the efficiency of production and increase the tolerance of unsuitable conditions [11] That the extract extracted from brown algae *Durvillaea* potato rum and *Ascophyllum nodosum* led to a comprehensive improvement in the growth characteristics of tomato, including clusters of flowers, number of flowers, number of fruits, length of roots, dry weight of the root and vegetative aggregate and the SPAD chlorophyll index, in addition to improving the productivity and quality of fruits. [7] Paper spraying with *A. nodosum* algae extract by 0.2% increased the height of the toma plant

by 10% compared to the witness in open farm conditions. He pointed out [2] In a study he conducted using concentrations of 0, 2.5, 5, 10 and 20 ml/ l - From the algae extract on the tomato that the concentration of 5 ml/l spraying the soil achieved the highest plant qualities of the height and number of leaves and diameters of stems, and that the increase in concentration from 5 ml.l⁻¹ does not add moral benefit. In a study conducted by the researcher [1] at the Faculty of Agriculture University of Baghdad, the extract of seaweed was used on the tomato plant in different concentrations inside greenhouses, and the results showed a concentration of 4 ml⁻¹ in increasing the height of the plant and the number of leaves, and this is due to the containment of the extract on natural growth organizations that contribute to activating cell division and elongation. A study revealed [6] that the application of algae extract increased tomato production by 4.6-6.9% compared to the witness, and the researchers attributed this mainly to the improvement in the photo representative capacity of the leaves and their higher chlorophyll content. Emphasized by [10] that the extract of seaweed has caused a significant increase in the level of chlorophyll in tomato leaves at the flowering stage, indicating the role of algae components in reducing chlorophyll decomposition and enhancing its composition. A study on tomato hybrids indicated that spraying with *A. nodosum* extract led to a marked increase in the SPAD index with a concentration of 0 to 5 mL/L. This effect is due to the fact that betaine found in algae acts as an osmotic dielectric that reduces chlorophyll degradation and improves photosynthesis efficiency. Proved [2] that the treatment of tomato plants with

seaweed extract with a concentration of 5 ml l⁻¹ soil spray achieved the highest fruit crop of 523.3 g plant⁻¹ compared to the witness. The researchers attributed this increase to the role of the extract in improving the nodes, increasing the percentage of fertilization and developing fruits, because it contains natural growth hormones that stimulate reproductive growth.[9] explained that spraying with algae extract (Acadian) on cherry tomato led to a moral increase in all vegetable processes, including the number of fruits and the total crops compared to the witness. In a study using Nizamuddinina zanardinii algae extract A, the 20% spray level showed the highest level of total carbohydrates, total dissolved solids and fruit production in tomato. The variety is one of the most influential factors in the productivity of tomatoes and its response to agricultural transactions. Studies have used several different hybrid species and showed a clear variation in the response to marine algae extract, as some varieties are characterized by faster response to bio stimuli due to their genetic nature and....nutrient....absorption...efficiency, In a study conducted [4] on two varieties of tomatoes, v1: bari class 2

and v2 bari class 15. The researcher observed the superiority of the bari class 15, in most vegetative, floral and productive indicators.

Research...Objectives

- Studying the effect of hybrid jawahir and jasmine in the qualities of growth and production.
- Determine the best concentration of seaweed extract that achieves the highest productivity..for..both..hybrids.
- Studying the overlap between the concentration factors x hybrid and its effect on the studied qualities.

2-Methods and materials:

1-2 Location of the experiment

The experiment was conducted in a plastic greenhouse belonging to a local farmer in Al-Gharraf District, Nasiriyah, Dhi Qar Governorate, Iraq, located at approximately 46°24' E longitude and 31°17' N latitude, during the 2025–2026 growing season. The study aimed to investigate the effect of foliar application of different concentrations of seaweed extract on the growth and yield of two tomato hybrids.

"Table 1: Physical and chemical properties of the soil"

Characteristic	Standard Unit	Value
PH	—	7.6
Ec	dS.m ⁻¹	5.8
CaCO ₃	%	46
N	mg.Kg ⁻¹	22.2
P	mg.Kg ⁻¹	0.5
K	mg.Kg ⁻¹	163
Sand / Silt / Clay (%)	19.6 / 59.3 / 21.1	Texture: Silt loam

2-2 Experimental design and transactions

The data was analyzed according to the design of the divided sectors (Split-Plot Design) according to the design of the complete random sectors (RCBD) in three times, and included the following factors:

•**Main factor (Main Plot):**
concentrations of marine algae extract,

which are: (S0) = 0 ml.l⁻¹ (S1) = 2.5 ml.l⁻¹ (S2) = 5 ml.l⁻¹

•**Secondary factor (Sub Plot):**
Tomato hybrid : Jawahir (V1) - yasmine (V2).

The total of the transactions was 6 transactions with 3 repeaters, bringing the total units of the experiment to 18 experimental units, each unit containing 5 plants.

2-3 Seaweed extract

Use the extract of Alga (Alga - Zone) algae containing more than (30) natural compounds, and also containing elements (K₂O 4% - P₂O₅ 4% - N 4%). Natural growth triggers, major and micro elements, vitamins, amino and organic acids, similar compounds and multiple sugars. Dissolve the extract in water to obtain the required concentrations, and sprinkle three times on the plant: the first after 21 days of planting, followed by the second and third sprays with a two-week interval between each spray and another.

2-4 Used hybrids

Jawahir (V1): An early ripe hybrid, fruits of medium-sized spherical, light red in color, with high productivity and good disease resistance.

yasmine (V2): A hybrid that is slightly late in maturity, its fruits are larger spherical, its color is dark red, characterized by a long production period.

2.5 Agricultural Operations

Seeds of the hybrids were sown in polystyrene seedling trays. on January 15, 2025, using peat moss as a growing medium to ensure a high germination rate. Fifteen days after germination, upon reaching the stage of 4-5 true leaves, the seedlings were transplanted into the greenhouse. This was done after the field soil was prepared with two perpendicular plowings, followed by harrowing and leveling. Each block contained agricultural rows (raised beds) measuring 25 m in length, 0.5 m in width, and 15 cm in height, with a spacing of 1 m between the beds. These rows were divided into experimental units allocated for the random distribution of treatments, with each unit containing 10 plants [8]. A drip irrigation system was adopted to water the plants daily until saturation (field capacity). As for chemical fertilization, a balanced compound fertilizer (NPK 20:20:20) was applied at a rate of 20-30 kg.ha⁻¹ weekly. Once the plants entered the flowering stage, the application rate of the balanced fertilizer was reduced and replaced with high-potassium fertilizers to improve fruit set and quality, in accordance with the recommendations of the Food and Agriculture Organization [5]. All other agricultural practices, including weeding, pest control, and disease prevention, were carried out according to the standard recommendations for tomato cultivation.

2-6 qualities studied

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1. Plant height (cm): Measure the height from the soil surface level to the developing top using the measuring tape at the age of 90 days of planting.

2. Chlorophyll content (SPAD): measured with SPAD-502 in the third leaf of the plant top at the complete flowing phase.

3. Yield per plant (kg). It is calculated according to the as follows:

$$\frac{\text{Yield per plant (kg)}}{\text{Number of plants in the experimental unit}} = \frac{\text{Total yield per experimental unit (kg)}}{\text{Number of plants in the experimental unit}}$$

4- The percentage of total dissolved solids (%) T.S.S estimated in fruit juice in the ripening stage Red rip using manual crusher. Hand. Refractometer.

5- The content of vitamin C (mg / 100 grams of weight). Estimate Vit.C and according to the method explained by [10] by calibrating the leach of tomato juice with 6-2 Dichlorophenol indophenol dye.

2.7 Statistic analysis

The data were analyzed using the Genstat statistical analysis program in the Variance Analysis Method (ANOVA) according to the design of the divided sectors, and the averages were compared by the minimum difference test (LSD) at the probability level of .5%

3- Result and discussion

3.1 Plant height (cm)

The analysis of the variance showed that there are moral differences between the coefficients studied in the height of the plant table. 1) The concentration of 5 ml/l achieved the highest average plant height of (98.4cm) morally superior to a concentration of 2.5 ml/l (89.7cm) and the control of (72.3cm). This finding is explained by the fact that the extract contains gibberellins and cytokine's that activate cell division and elongation and stimulate apical growth areas, which is consistent with what he reported [2] and [7] At the level of hybrids, hybrids exceed jawahir of (90.6cm) morally over the yasmine hybrid (83.0cm), which is attributed to the genetic differences between the two hybrids in growth rates. The overlap between the concentration of 5 mL/L and the hybrid jawahir showed the highest height of (102.7cm).

Table (2) Effect of concentrations of seaweed extract and species and their overlap on plant height (cm)

Hybrid/Concentration	S0	S1	S2	Hybrid Mean
V1	75.2	93.8	102.7	90.6
V2	69.4	85.6	94.1	83.0
Concentration Mean	72.3	89.7	98.4	

LSD (0.05) Hybrids: 4.12, Concentrations: 5.36, Hybrid × Concentration: 7.58.

3.2 Chlorophyll Content (SPAD)

Hg exceeds the concentration of 5 ml/L in the chlorophyll content of (52.6SPAD) over the rest of the transactions. The researchers attribute this effect to the role of magnesium and nitrogen found in algae that enter the construction of the chlorophyll molecule, in addition to the role of beaten in reducing chlorophyll decomposition. This result was in line with what [11] and [6]. As for the hybrid effect, the hybrid exceeded the

jawahir and gave the highest chlorophyll content of (48.2SPAD) compared to the jasmine hybrid, which gave the lowest percentage of (44.2 SPAD). The interference effect was certain, as the treatment exceeded the extract with a concentration of 5 milliliter's for the jewel hybrid, as it gave the highest chlorophyll content of (55.8SPAD) compared to the lowest percentage given by the comparison treatment of the jasmine hybrid amounted to (37.8SPAD).

Table (3): Effect of seaweed extract and variety concentrations and interference in chlorophyll content (SPAD)

Hybrid/Concentration	S0	S1	S2	Hybrid Mean
V1	40.2	48.6	55.8	48.2
V2	37.8	45.4	49.4	44.2
Concentration Mean	39.0	47.0	52.6	

LSD (0.05) Hybrids: 3.5, Concentrations: 4.9, Hybrid × Concentration: 7. 8.

3.3 Yield per plant (kg.plant¹)

The 5 ml/L concentration recorded the highest yield of (4.3 kg), surpassing the 2.5 ml/L concentration (3.2 kg) and the

control (2.6 kg). This quantitative increase in yield is attributed to the role of the seaweed extract in activating enzymes, enhancing metabolism, and supplying the plant

with the necessary elements for flower formation, development, and subsequent fruit set, as indicated by several studies, including [11]. The jawahir hybrid outperformed the

yasmin hybrid, yielding (3.6 kg) compared to yasmin's (3.2 kg). The 5 ml/L $\times$ jawahir interaction resulted in the highest increase in yield per plant (4.6 kg).

Table (4): Effect of seaweed extract concentrations, variety, and their interaction on yield per plant (kg.plant⁻¹)

Hybrid/Concentration	S0	S1	S2	Hybrid Mean
V1	2.8	3.4	4.6	3.6
V2	2.5	3.1	4.0	3.2
Concentration Mean	2.6	3.2	4.3	

LSD (0.05) Hybrids: 0.3, Concentrations: 2.6, Hybrid $\times$ Concentration: 3.7

3.4 The percentage of total soluble solids (TSS) %

The 5 mL L⁻¹ concentration recorded the highest total soluble solids (TSS) content (4.63%), whereas the 2.5 mL L⁻¹ concentration recorded (4.03%), compared with (3.28%) in the control. This increase may be attributed to the role of the algae extract in stimulating vital activities within the plant and its role in the formation of the green pigment, in addition to the importance of some environmental factors, including light, which is important in the photosynthesis process and

increases the synthesis of carbohydrates in the leaves, which are then transferred to the fruits, thus leading to an increase in the percentage of total soluble solids in the fruits [3]. No significant differences were recorded between the hybrids. However, the interaction effect was significant, as the treatment with the extract at a concentration of 5 ml/L for the yasmin hybrid resulted in a percentage of solids of (4.80%), compared to the lowest percentage given by the control treatment for the yasmin hybrid (3.21%).

Table (5): Effect of seaweed extract concentrations and variety, and their interaction, on the percentage of total soluble solids (TSS) (%)**LSD (0.05) Hybrids: 0.6, Concentrations: 1.4, Hybrid × Concentration: 1. 7.**

Hybrid/Concentration	S0	S1	S2	Hybrid Mean
V1	3.36	94.0	4.64	3.97
V2	3.21	3.98	4.80	4.00
Concentration Mean	3.28	4.03	4.63	

3.5 Fruit content of vitamin C (Mg / 100 g fresh weight)

The concentration of 5 ml/l exceeds a moral superiority in the fruit content of vitamin C with an average of (22.13 mg / 100 g) compared to a concentration of 2.5 ml/l (15.45 mg / 100 g) and the witness (13.73 mg / 100 g).

As for the hybrid effect, the hybrid surpassed jawahir and gave the highest concentration of (17.71 mg / 100 g).

Compared to the yasmine hybrid, which gave the lowest concentration of (16.50 mg / 100 g). As for the interference effect, it was important, as the treatment with the extract was superior to a concentration of 5 ml/l for the hybrid jawahir and gave the highest concentration of vitamin C (23.41 mg / 100 g) compared to the lowest concentration given by the comparative treatment of the yasmine hybrid amounted to (13.43 mg / 100 g).

Table (6) Effect of concentrations of marine algae extract and variety and their interference in the fruit content of vitamin C (mg / 100 g fresh weight)

Hybrid/Concentration	S0	S1	S2	Hybrid Mean
V1	14.04	16.69	23.41	17.71
V2	13.43	14.22	21.86	16.50
Concentration Mean	13.73	15.45	22.13	

LSD (0.05) Hybrids: 1.9, Concentrations: 7.9, Hybrid × Concentration: 9. 99.**4- Recommendations**

In light of the results obtained from this study, we recommend the following:

1. **Adopting a 5 ml/L concentration of seaweed extract:** It is recommended to apply this concentration as a foliar spray to tomato plants three times during the growing season. This is due to its high

efficiency in improving vegetative growth parameters (plant height and leaf chlorophyll content), increasing yield quantity, and enhancing fruit quality (T.S.S. percentage and Vitamin C).

2. **Cultivating the "Jawaher" tomato hybrid:** We recommend that farmers in Dhi Qar Governorate (Al-Gharraf district) and areas with similar environmental conditions adopt the cultivation of the "Jawaher" hybrid inside greenhouses. This hybrid has proven its high adaptability and suitability to the region's conditions, showing clear superiority in growth and yield characteristics compared to the "Yasmin" hybrid.
3. **Utilizing the positive interaction:** To achieve the maximum possible yield and the best qualitative specifications for the fruits, it is advisable to combine both factors by cultivating the "Jawaher" hybrid and treating it with a foliar spray of seaweed extract at a concentration of 5 ml/L.
4. **Conducting future studies:** Further research should be conducted to test higher concentrations of seaweed extract (greater than 5 ml/L) to determine the optimal concentration that might yield a better response.

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