Effect of seaweed extract on growth and productivity of wheat *Triticum aestivum* L.

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Abstract:

An experiment was applied during the 2025/2026 winter season to study the effect of seaweed extract applied at four concentrations (0, 10, 20, and 30 g/L) on the growth, yield characteristics, leaves, and grains of a local wheat variety *Triticum aestivum* L. Two samples were taken 100 and 140 days after planting. At the time of the first sampling, plant height, number of leaves per stem, number of stems per plant, shoot fresh weight, root length, root fresh weight, and total chlorophyll content were measured. The number of spikes per plant and spike length were also studied. At the time of the second sampling (harvest), spike weight, number of grains per spike, grain weight per spike, and 100-grain weight were recorded. The results showed that spraying with seaweed extract had a stimulating effect on most morphological characteristics and yield components compared to the control plants. In general, treatment with SWE has a greater stimulating effect on most growth parameters and crop components compared to the wheat control treatment.

Keywords: seaweed extracts, wheat, *Triticum aestivum*, grains

Introduction:

Wheat (*Triticum aestivum*) is the world's primary cereal crop in terms of both cultivated area and total production. It provides approximately 20% of the food energy for the world's population, including Iraq. Increasing wheat production is the ultimate goal for reducing the significant gap between production and consumption [1]. Wheat is the most important cereal crop for most of the world's population. It is cultivated on 217 million hectares, with a production of approximately 731 million tons and a yield of 3.27 tons/ha [2]. The excessive use of pesticides and chemical fertilizers by farmers to increase crop yields causes significant damage to the environment and human health. The use of biostimulants in agriculture, such as seaweed extract, may prove to be a sustainable and cost-effective alternative to inorganic fertilizers. Biostimulants are naturally degradable chemical compounds [3]. When used with fertilizers, they supply crops with nutrients and may improve their growth and productivity. Since most soil types lack sufficient nitrogen, urea and other chemical fertilizers are used as nitrogen supplements. Plants store nitrogen as nitrates, which, when ingested by humans, are converted into nitrites, a toxic substance that causes methemoglobinemia [4]. Furthermore, these chemical fertilizers harm the ecosystem by releasing greenhouse gases into the atmosphere, polluting surface and groundwater, and more. Therefore, finding a suitable alternative to chemical fertilizers is crucial [5].

Seaweed extracts are known to have numerous beneficial effects on plants. They contain growth-promoting hormones such as indole-3-acetic acid (IAA) and indole-3-

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butyric acid (IBA), cytokinins, as well as trace elements (iron, copper, zinc, cobalt, molybdenum, manganese, and nickel), vitamins, and amino acids [6]. Spraying with seaweed extract resulted in several positive effects, including reduced soil compaction, increased water retention capacity, and increased content of certain nutrients (such as total nitrogen and available phosphorus, potassium, magnesium, copper, and zinc) [7]. These effects also led to increased microroot proliferation, increased specific root length, reduced root tissue density, enhanced crop growth, increased net growth and uptake rates, increased aboveground biomass, and increased yield by improving the physicochemical and biochemical properties of the cultivated soil. Reports indicate that seaweed extracts stimulate plant growth and productivity, enhance environmental stress tolerance, and improve nutrient availability and uptake from the soil [8]. Therefore, this study aimed to investigate the effect of spraying with seaweed extract on wheat growth and yield.

Materials and Methods

The field experiment was applied during the winter season of 2025-2026 to study the effect of seaweed extract on the vegetative growth, yield, its components, and the chemical composition of a local wheat variety. Plants were sprayed with a seaweed extract solution three times: the first time during the elongation stage, the second time 25 days after the first, and the third time three days after the second. The design was a randomized complete block design (RCBD) with four treatments (control, 10, 20, and 30 ml/L) and three replicates per treatment. Spraying was carried out in the morning or evening to avoid high temperatures.

Recorded trials:

Vegetative Growth

- Plant Height (cm)
- Leaf Area (cm²)
- Total Chlorophyll (SPAD)
- Fresh Weight of Buds/Plant (g)
- Number of Branches/Plant

Yield and Components

- Spike Length (cm)
- Number of Spikes/m²
- Weight of 100 Grain (g)
- Grain yield (tons/hectare)
- Biological yield (tons/hectare)
- Harvest index (%)

Statistical Analysis

The experiments were designed according to a completely randomized block design with three replications. Data were statistically analyzed using the GenStat12 statistical software, and statistical means were compared using the LSD test at a probability level of 5% [6].

Results and Discussion

Effect of Seaweed Extract on Vegetative Characteristics of Wheat (*T. aestivum*)

The results indicated that the effect of using seaweed extract at concentrations of 0, 10, 20, and 30 ml/L on the vegetative growth of a local wheat variety. These results included plant height, leaf area (cm²), total chlorophyll, fresh weight of the vegetative parts per plant, and number of branches per

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plant. In general, increasing the concentration of seaweed extracts led to an increase in all studied vegetative growth values, with the extract recording the highest Seaweed at a concentration of 10 ml/L showed the following results: plant height was (66.40 cm), leaf area was (38.90 cm²), total chlorophyll was (SPAD) 44.90, fresh weight was (32.80 g/plant), and number of branches was (3.89/plant). This was followed by a concentration of 20 ml/L, where plant height was recorded (69.68 cm), leaf area (41.65 cm²), total chlorophyll was (SPAD) 47.87, fresh weight was (37.65 g/plant), and number of branches was (4.40/plant).

The treatment using a concentration of 30 g/L of seaweed extract showed the following results: plant height was (77.70 cm), leaf area was (44.80 cm²), total chlorophyll (SPAD) was 49.09, fresh weight was (39.10 g/plant), and number of branches was recorded (6.70/plant). The control treatment recorded the lowest results, average plant height was (64.20 cm), leaf area was (35.65 cm²), total chlorophyll was 44.60 (SPAD), fresh plant weight was (33.60 g/plant), and number of branches recorded (4.80/plant) (Table 1).

Table (1) Effect of different concentrations of seaweed extract on the vegetative trials of wheat

No. of branches/plant	Fresh weight (g)	Total chlorophyll (spad)	Leaf area (cm²)	Plant height (cm)	Treatments (ml/L)
66.40	38.90	44.90	32.80	3.89	**10**
69.98	41.65	47.87	37.65	4.70	**20**
77.70	44.80	49.09	39.10	6.70	**30**
64.20	35.65	44.60	33.60	4.80	**Control**
1.02	0.91	1.04	1.01	0.59	**LSD 0.05**

Effect of Seaweed Extract on Yield trials of Wheat (*T. aestivum*)

The results showed the effect of using seaweed extract (SWE) at concentrations of (0, 10, 20, and 30 ml/L) on the total yield of wheat. These results included spike length (cm), number of spikes/m², 100-grain weight (g), grain yield (t/ha), biological yield (t/ha), and harvest index (%). The results showed that spraying with seaweed extract led to an increase in all studied yield values, as the seaweed extract at a concentration of 10 ml/L recorded the following: spike length was (13.99 cm), number of spikes was (166.70/m²), weight of 100 grains was 33.90 (g), grain yield was (2.22 tons/hectare), biological yield was (7.90 tons/hectare) and harvest index was recorded (36.20%).

This was followed by a concentration of 20 ml/L, where spike length was recorded (14.89 cm), number of spikes was (189.70/m²), weight of 100 grains was

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recorded at 34.50 (g), grain yield was (2.87 t/ha), biological yield was (7.89 t/ha) and harvest index was (37.65%), while the treatment using a concentration of 30 g/L of seaweed extracts recorded the following: spike length (14.93 cm), number of spikes/(m²) was (197.90/m²), weight of 100 grains was 38.70 (g), grain yield was (2.78 t/hectare), biological yield was (8.10 t/hectare) and harvest index was (38.60%), while the control treatment recorded the lowest average spike length was (13.67 cm), number of spikes was ((165.80/m²), weight of 100 grains was 31.90 (g), grain yield was (2.10 t/ha), biological yield was (7.10 t/ha), and harvest index (35.29%) (Table 2).

Table (2) Effect of different concentrations of seaweed extract on the yield characteristics and components of wheat.

Harvest Index (%)	Biological Yield (t/ha)	Grain Yield (t/ha)	Weight of 100 grains (g)	No. of spikes/m²	Spike length (cm)	Treatments (ml/L)
13.99	166.70	33.90	2.22	7.90	36.20	**10**
14.89	189.70	34.50	2.87	7.89	37.65	**20**
14.93	197.90	38.70	2.78	8.10	38.60	**30**
13.67	165.80	31.90	2.10	7.10	35.29	**Control**
0.80	6.90	1.03	0.87	1.01	1.10	**LSD 0.05**

The data revealed that plant height and chlorophyll content increased significantly in all treatments compared to the control group after 100 days of cultivation. Furthermore, all studied treatments showed significant increases in vegetative fresh weight, main spike length, and 100-grain weight compared to the control plants. Overall, the addition of seaweed extract improved all morphological characteristics of wheat growth and yield components compared to the control plants. Moreover, the addition of seaweed extract had a stimulating effect on most of the studied growth parameters and wheat yield characteristics compared to the control plants. Specifically, the 30 ml/L concentration resulted in a significant increase in plant height, number of branches per plant, chlorophyll content, vegetative fresh weight, main spike length, and number of spikes per plant compared to the control plants.

The same treatment also achieved significant increases in leaf area and number of grains per spike compared to the control plants. On the other hand, the highest values for plant height, number of branches per plant, fresh weight of the vegetative mass, total chlorophyll, number of spikes per plant, grain weight per spike, and 100-grain weight were observed for the seaweed extract at all concentrations compared to the control plants. The data in Tables 1 and 2 demonstrate the synergistic effect of the seaweed extract on most morphological and yield characteristics of wheat plants, which is attributed to the stimulatory effect of the

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extract, as shown in the tables. This may also be a result of changes in soil properties and/or nutrient availability. However, improving the soil's water retention capacity by adding the seaweed extract can maintain better moisture levels between irrigations, which is a key factor for achieving a good grain yield in wheat.

The effect of spraying the seaweed extract on wheat plant growth characteristics and yield components is also shown in Tables 1 and 2. They reported that spraying wheat plants with seaweed extract at a concentration of 2000 parts per million led to a significant increase in the weight of 100 grains, and achieved the highest significant values for grain yield per plant under conditions [9]. This superiority is attributed to the beneficial components of seaweed, which are an excellent source of bioactive compounds such as macro- and micronutrients, essential fatty acids, amino acids, vitamins, cytokinins, and auxins. These growth-promoting substances influence cellular metabolism in treated plants, leading to improved growth and productivity [10].

The stimulation of growth, crop characteristics, root development, photosynthetic capacity, and stress tolerance in various plants treated with seaweed extracts has been attributed to plant growth regulators and possibly micronutrients. Furthermore, the addition of seaweed extracts, a biostimulant, is used as a soil amendment or foliar spray to improve plant growth, yield, quality, and activate the antioxidant system [11]. The use of seaweed extracts from Sargassum or Ulva species counteracts the detrimental oxidative effects of drought, not only directly by activating the antioxidant system, such as catalase, peroxidase, and ascorbate, but also by providing hormones and micronutrients essential for wheat growth, particularly root depth, stem height, and leaf area. Individual treatments address drought-induced stress. On the other hand, demonstrate the benefits of using seaweed extract treatments combined with 2% biochar to increase the concentration of most macro- and micronutrients in wheat tissues. The hormonal content of the seaweed extract, as shown in Table 1, particularly cytokinins, indole-3-acetic acid (IAA), and certain organic compounds, especially betaines, was sufficient to induce biological engulfment in wheat plants. Furthermore, the seaweed extracts enhance nutrient uptake via the roots, resulting in overall vigorous plant growth.

The positive effects of using seaweed extracts are attributed to plant growth regulators that stimulate root growth, mineral uptake, and photosynthesis. Foliar spraying with an extract of the seaweed Ascophyllum nodosum stimulated plants to utilize soil-based mineral nitrogen, and possibly other available nutrients, more efficiently, leading to increased potassium uptake in grains and a 25% increase in wheat yield [12]. In this regard, the use of the seaweed extract resulted in a significant increase in potassium, magnesium, and calcium concentrations in the leaves of plants like lettuce that received adequate nutrient supply, but had little effect on nutrient-deficient plants [13]. Furthermore, nitrogen, phosphorus, and magnesium levels increased significantly, while calcium levels decreased (0.1%) with the seaweed extract compared to treated and untreated plants [14]. The use of biostimulants in small quantities affects numerous metabolic processes, promoting plant growth and development by increasing photosynthesis, endogenous hormones, nutrient uptake, and protein synthesis, as well as its relatively high capacity to increase the availability of micronutrients in the soil [15].

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Conclusions:

The study concludes that the use of a certain biostimulant, specifically seaweed extract, positively improved the growth, development, yield, and mineral content of the local wheat variety. The stimulating effect of these treatments on enhancing wheat growth, development, and yield is attributed to improved soil utilization efficiency in sandy soils through increased water retention, ion exchange capacity, and nutrient availability, thus reducing the need for chemical fertilizers.

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