

## **Response Of Growth And Yield Of Broccoli (*Brassica oleracea var. italica*) Plant to Algae Seaweed, *Urtica dioica* L. Extract and Zinc Sulfate Spraying**

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### **Abstract**

This experiment was carried out at the unheated plastic house of the vegetable research farm of the Protected Cultivation Department in Zakho Technical Institute/Dohuk Polytechnic University on Broccoli (*Brassica oleracea var. italica*) during the growth seasons (2021 and 2022) from 1<sup>st</sup> September to 1<sup>st</sup> April, to study the effect of three concentrations of Algae Seaweed extract (0, 4 and 8) ml.L<sup>-1</sup> three concentrations of *Urtica dioica* extract (0, 4 and 8) ml.L<sup>-1</sup> and three concentrations of Zinc Sulfate (0, 5 and 10) g.L<sup>-1</sup>. The results showed that there were no significant differences between seasons in leaf area (cm<sup>2</sup>), number of secondary heads.plant<sup>-1</sup>, secondary head weight.plant<sup>-1</sup> (g), plant yield (kg.plant<sup>-1</sup>), total yield (ton.ha<sup>-1</sup>), and head weight (g). Using 8 ml.L<sup>-1</sup> of algae seaweed and 8 ml.L<sup>-1</sup> of *Urtica dioica* with spraying 10 g.L<sup>-1</sup> of zinc sulphate produced a highest total yield of 57.50 (ton.ha<sup>-1</sup>). The triple interaction among the three factors had a significant difference, the best interaction was observed among Algae Seaweed 8 ml L<sup>-1</sup>, *Urtica dioica* 8 ml.L<sup>-1</sup> and Zinc Sulfate 10 g.L<sup>-1</sup> for all vegetative growth and yield characteristics of broccoli.

**Keywords:** broccoli, Algae Seaweed, *Urtica dioica*, Zinc Sulfate.



## Introduction

Broccoli (*Brassica oleracea* var. *italica*) is a Brassicaceae vegetable that has been grown and eaten for millennia and is varied and full of nutrients. Broccoli, being a crop with thin roots, requires regular irrigation to preserve plant health and productivity (10). Broccoli is often transplanted as seedlings. Broccoli is becoming increasingly popular due to its numerous applications and high nutritional value (20). It has a good nutritional value since it contains various vitamins, minerals, proteins, beta-carotene, niacin, and fulvic acid while being low in free fats, salt, and calories (17). As it reduces high blood pressure, aids in blood sugar regulation, builds bones, guards against heart disease, urinary and reproductive diseases, reduces cancer, and lowers blood cholesterol levels, it is regarded as a potent regulator and antibiotic for many common diseases (12). Broccoli's cardioprotective qualities are hypothesized to be due to its fiber concentration, potassium content, and bioactive compounds. Broccoli has been demonstrated to minimize oxidative stress and protect against chronic diseases due to its high antioxidant content (11).

Chemical fertilizers have an indirect or direct influence on the air, soil, water, and living beings. Marine algal extract, according to (7), is a new generation of extremely nutritious natural organic fertilizers that boost growth, seed germination, and crop yield. According to

(9), adding a seaweed extract to broccoli may increase the quality and average weight of the curds. Chemical fertilizers have an indirect or direct influence on the air, soil, water, and living beings. Marine algal extract, according to (7), is a new generation of extremely nutritious natural organic fertilizers that boost growth, seed germination, and crop yield. According to (9), adding a seaweed extract to broccoli may increase the quality and average weight of the curds.

Herbaceous perennial plants known as stinging nettle, or *Urtica dioica* L. (15), are found in temperate and tropical wasteland regions across the world. (8) have presented an overview of the stinging nettle's potential industrial uses. According to (15), the chemical composition of several green solid manures, including nettle, was compared. They determined that nettle manure had significant amounts of boron (B), and that the low C:N ratios of green manures had a stronger influence on plant development than the total amount of N gave as solid soil (22). The presence of bioactive substances in this plant may lead to enhanced nutrient absorption and assimilation, thus improving broccoli plant development characteristics. Increased nutritional availability is also likely a factor in broccoli's better production features, such as larger heads and higher overall yield. Micronutrients have the potential to improve macronutrient



utilization (16). As a result, *Urtica dioica* may improve the quality of broccoli.

It is a necessary nutrient for plant development and involves in a variety of critical functions, such as improving oxidative reactions in plant cells. It is also necessary for the synthesis of tryptophan, an amino acid comprised of auxin IAA (24). Because Iraqi soils are distinctive in that micronutrient availability, particularly zinc, is reduced in the soil solution, zinc foliar spraying is an effective strategy for supplementing zinc deficiency (5; 14). Zn spray in foliage promotes growth, yield, development, quality, and height in broccoli, according to studies (3) and (25), while reducing hollow stem infection. This research focused on the growth and development of broccoli sprouts under zinc sulfate stress. The results showed that under zinc sulfate, sprout growth and development were severely hindered. One of the foliar mineral supplements that (23) had a good effect on improving the quality of broccoli heads was zinc sulfate. Zinc is an essential element for cellular, physiological, and biological growth and development, according to (6). Zinc deficiency causes reduced stem elongation, reduced auxin action, and low amino acid levels.

The specific objectives of the study are to investigate the effect of different concentrations of Algae Seaweed, *Urtica dioica* and Zinc Sulfate levels on the vegetative growth and head production of

broccoli plants under the environmental conditions of Kurdistan Region.

### Material and methods

This Experiment was performed in an unheated plastic house (459 m<sup>2</sup>) provided with a drip irrigation system at the Vegetable Research Farm of Protected Cultivation Department in Zakho Technical Institute/Dohuk Polytechnic University in two seasons (2021) and (2022) from 1<sup>st</sup> September to 1<sup>st</sup> April for the two seasons to study the effect of three concentrations of Algae Seaweed extract (0, 4, and 8) ml L<sup>-1</sup>, three concentrations of *Urtica dioica* extract (0, 4, and 8) ml.L-1 and three levels of Zinc Sulfate (0, 5, and 10) g.L-1. The plastic house land was well ploughed in July for improved aeration of the soil and to disrupt the shelter of pests and pathogens. The poly house soil was leveled and divided into three terraces and 11 lines of drip irrigation system were distributed on them, then the soil was irrigated and the doors were closed for a few days for further disinfection. The seedlings were transplanted on 2<sup>nd</sup> October in a perforated hole, with distance (50 × 60) cm between plant and rows. The chemical characteristics of the growing soil were pH 7.10, Ec 0.065 ds.m<sup>-1</sup>, K 27.440 %, P 2.140 %, N 1.040, organic matter 1.685%.

The extract concentrations of the Algae Seaweed, *Urtica dioica* and Zinc sulphate levels were sprayed three times at ten days intervals. The first spray was done on November 15<sup>th</sup>. In the end of the



experiment, the following data were recorded Leaf area (cm<sup>2</sup>) vegetative dry matter weight (g), head weight (g), head diameter (cm), plant yield (kg.plant<sup>-1</sup>), total yield (ton.ha<sup>-1</sup>), number of secondary heads.plant<sup>-1</sup>, secondary head weight.plant<sup>-1</sup> (g). The experiment was performed in a factorial randomized complete block design (RCBD) with 3 × 3 × 3 = 27 treatments with three replicates and nine plants for each experimental unit. The data analysis was performed using SAS program and the mean comparison was done by using Duncan's multiple range test at 5% level of probability. (SAS 2013).

### Results and Discussion

The results in table (1) showed that there were no significant effects in head weight and head diameter parameters between the two seasons. The triple interaction among the three factors concentrations of (Algae Seaweed, *Urtica dioica* and Zinc sulphate) had significant differences, the highest head

weight for the two seasons reached 1062.8 and 993.5 g respectively for the treatment (Algae Seaweed 8 ml.L<sup>-1</sup> + *Urtica dioica* 8 ml.L<sup>-1</sup> + Zinc Sulfate 10 g.L<sup>-1</sup>) with increasing percentages reached to 60.10% and 48.31% respectively, compared to the control treatment for the two seasons. the best treatment for the head diameter was observed among (Algae Seaweed 4 ml.L<sup>-1</sup> + *Urtica dioica* 8 ml.L<sup>-1</sup> + Zinc Sulfate 10 g.L<sup>-1</sup>) it gave 22.167 cm for the first season compared with the least diameter (17.30) cm which obtained in the treatment (Algae Seaweed 0 ml.L<sup>-1</sup> + *Urtica dioica* 4 ml.L<sup>-1</sup> + Zinc Sulfate 10 g.L<sup>-1</sup>). Whereas the best head diameter (21.95) for the second season was shown in the (Algae Seaweed 8 ml.L<sup>-1</sup> + *Urtica dioica* 8 ml.L<sup>-1</sup> + Zinc Sulfate 10 g.L<sup>-1</sup>) treatment compared with the least value (18.08) cm which obtained in the treatment (Algae Seaweed 0 ml.L<sup>-1</sup> + *Urtica dioica* 0 ml.L<sup>-1</sup> + Zinc Sulfate 0 g.L<sup>-1</sup>).

**Table 1. Effect of Algae Seaweed, *Urtica dioica* and Zinc Sulfate on the head weight (g) and head diameter (cm) of broccoli plants.**

Algae Seaweed ml.L <sup>-1</sup>	Urtica dioica ml L <sup>-1</sup>	Zinc sulfate g.L <sup>-1</sup>	head weight (g)		head diameter (cm)	
			season 1	season 2	season 1	season 2
0	0	0	663.49 <sup>i</sup>	669.89 <sup>f</sup>	18.67 <sup>f-1</sup>	18.08 <sup>d</sup>
		5	796.78 <sup>e-h</sup>	774.11 <sup>e</sup>	18.07 <sup>i-1</sup>	18.57 <sup>b-d</sup>
		10	803.56 <sup>e-h</sup>	864.78 <sup>b-e</sup>	17.30 <sup>l</sup>	18.60 <sup>b-d</sup>
	4	0	678.65 <sup>hi</sup>	820.67 <sup>c-e</sup>	19.03 <sup>f-k</sup>	18.85 <sup>b-d</sup>
		5	804.74 <sup>e-h</sup>	876.89 <sup>b-e</sup>	20.63 <sup>b-e</sup>	18.48 <sup>b-d</sup>



	8	10	874.77 <sup>c-f</sup>	865.61 <sup>b-e</sup>	17.70 <sup>j-l</sup>	19.60 <sup>b-d</sup>	
		0	848.52 <sup>c-f</sup>	824.25 <sup>c-e</sup>	18.13 <sup>h-l</sup>	19.40 <sup>b-d</sup>	
		5	866.8 <sup>c-f</sup>	876.90 <sup>b-e</sup>	19.63 <sup>d-g</sup>	19.80 <sup>a-d</sup>	
		10	899.36 <sup>c-f</sup>	928.96 <sup>a-d</sup>	19.83 <sup>d-g</sup>	20.72 <sup>ab</sup>	
4	0	0	697.41 <sup>hi</sup>	864.97 <sup>b-e</sup>	17.57 <sup>kl</sup>	18.00 <sup>d</sup>	
		5	804.69 <sup>e-h</sup>	876.89 <sup>b-e</sup>	19.90 <sup>d-g</sup>	19.60 <sup>b-d</sup>	
		10	898.07 <sup>c-f</sup>	890.59 <sup>a-e</sup>	20.90 <sup>a-d</sup>	19.76 <sup>a-d</sup>	
	4	0	711. <sup>82g-i</sup>	812.13 <sup>de</sup>	18.23 <sup>h-l</sup>	18.63 <sup>b-d</sup>	
		5	796.95 <sup>e-h</sup>	894.94 <sup>a-d</sup>	19.83 <sup>d-g</sup>	19.40 <sup>b-d</sup>	
		10	930.74 <sup>b-e</sup>	930.61 <sup>a-c</sup>	18.53 <sup>g-l</sup>	20.22 <sup>a-d</sup>	
	8	0	922.73 <sup>b-e</sup>	906.01 <sup>a-d</sup>	18.67 <sup>f-l</sup>	19.80 <sup>a-d</sup>	
		5	950.65 <sup>a-c</sup>	829.05 <sup>c-e</sup>	19.17 <sup>e-j</sup>	19.88 <sup>a-d</sup>	
		10	956.61 <sup>a-c</sup>	959.13 <sup>ab</sup>	22.17 <sup>a</sup>	20.53 <sup>ab</sup>	
	8	0	0	714.15 <sup>g-i</sup>	853.69 <sup>b-e</sup>	19.30 <sup>e-i</sup>	18.80 <sup>b-d</sup>
			5	772.38 <sup>f-i</sup>	870.19 <sup>b-e</sup>	19.67 <sup>d-h</sup>	18.20 <sup>b-d</sup>
			10	934.92 <sup>b-d</sup>	953.85 <sup>ab</sup>	21.63 <sup>ab</sup>	20.16 <sup>a-d</sup>
4		0	832.25 <sup>c-g</sup>	864.13 <sup>b-e</sup>	20.17 <sup>c-f</sup>	19.00 <sup>b-d</sup>	
		5	837.18 <sup>c-g</sup>	921.55 <sup>a-d</sup>	19.90 <sup>d-g</sup>	20.56 <sup>ab</sup>	
		10	926.64 <sup>b-e</sup>	936.54 <sup>a-c</sup>	19.53 <sup>d-h</sup>	20.47 <sup>a-c</sup>	
8		0	950.65 <sup>a-c</sup>	863.93 <sup>b-e</sup>	20.17 <sup>c-f</sup>	19.92 <sup>a-d</sup>	
		5	1034.06 <sup>ab</sup>	932.10 <sup>a-c</sup>	19.80 <sup>d-g</sup>	20.21 <sup>a-d</sup>	
		10	1062.81 <sup>a</sup>	993.47 <sup>a</sup>	21.57 <sup>a-c</sup>	21.95 <sup>a</sup>	
		season effect		850.79 <sup>a</sup>	876.14 <sup>a</sup>	19.47 <sup>a</sup>	19.52 <sup>a</sup>
*Means with the same letter for each interaction are not significantly different at 5% level based on Duncan's Multiple Range Test.							

The results in table (2) showed that there were no significant effects on plant yield (kg.plant<sup>-1</sup>) and total yield (ton.ha<sup>-1</sup>) parameters between the two seasons. The triple interaction among three factors concentrations of (Algae Seaweed, *Urtica dioica* and Zinc sulphate) had significant

differences, the plant yield for the two seasons reached to (1.96) kg.plant<sup>-1</sup> and (1.78) kg.plant<sup>-1</sup> respectively for the treatment (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) with increasing percentage reached to 25.82 % and 44.72 % than the control treatment



for the two seasons respectively. The best treatment for the total yield (ton.ha<sup>-1</sup>) was observed among (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) it gave (57.5) ton.ha<sup>-1</sup> for the first season compared with the lowest total yield (30.46) ton.ha<sup>-1</sup> obtained in the treatment (Algae Seaweed 0 ml.L-1 + *Urtica dioica* 0 ml.L-1 + Zinc Sulfate 0 g.L-1). Whereas the

highest total yield in hectare (52.30) ton.ha<sup>-1</sup> for the second season was shown in the (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) treatment compared with the lowest value (35.02) ton.ha<sup>-1</sup> obtained in the treatment (Algae Seaweed 0 ml.L-1 + *Urtica dioica* 4 ml.L-1 + Zinc Sulfate 0 g.L-1).

**Table 2. Effect of Algae Seaweed, *Urtica dioica* and Zinc Sulfate on the plant yield (kg.plant<sup>-1</sup>) and total yield in hectare (ton.ha<sup>-1</sup>) of broccoli plants.**

Algae Seaweed ml.L-1	Urtica dioica ml L <sup>-1</sup>	Zinc sulfate g.L-1	plant yield (kg.plant <sup>-1</sup> )		total yield (ton.ha <sup>-1</sup> )	
			season 1	season 2	season 1	season 2
0	0	0	1.04 <sup>k</sup>	1.23 <sup>fg</sup>	30.46 <sup>k</sup>	36.15 <sup>e</sup>
		5	1.16 <sup>jk</sup>	1.45 <sup>c-g</sup>	34.08 <sup>gh</sup>	42.47 <sup>c-g</sup>
		10	1.28 <sup>h-k</sup>	1.32 <sup>fg</sup>	37.58 <sup>g-k</sup>	38.86 <sup>e-g</sup>
	4	0	1.17 <sup>jk</sup>	1.19 <sup>g</sup>	34.28 <sup>jk</sup>	35.02 <sup>g</sup>
		5	1.34 <sup>f-j</sup>	1.41 <sup>d-g</sup>	39.23 <sup>f-j</sup>	41.27 <sup>d-g</sup>
		10	1.44 <sup>d-j</sup>	1.43 <sup>d-g</sup>	42.16 <sup>c-j</sup>	41.83 <sup>de</sup>
	8	0	1.41 <sup>d-h</sup>	1.35 <sup>d-g</sup>	41.24 <sup>d-j</sup>	39.72 <sup>d-g</sup>
		5	1.45 <sup>c-j</sup>	1.70 <sup>a-c</sup>	42.44 <sup>c-j</sup>	49.93 <sup>a-c</sup>
		10	1.49 <sup>c-i</sup>	1.50 <sup>b-f</sup>	43.83 <sup>c-i</sup>	44.00 <sup>b-f</sup>
4	0	0	1.17 <sup>jk</sup>	1.42 <sup>d-g</sup>	34.46 <sup>jk</sup>	41.60 <sup>d-g</sup>
		5	1.26 <sup>h-k</sup>	1.46 <sup>c-g</sup>	37.02 <sup>h-k</sup>	42.91 <sup>c-f</sup>
		10	1.40 <sup>d-j</sup>	1.42 <sup>d-g</sup>	41.01 <sup>d-j</sup>	40.69 <sup>c-g</sup>
	4	0	1.24 <sup>i-k</sup>	1.41 <sup>d-g</sup>	36.35 <sup>i-k</sup>	41.39 <sup>d-g</sup>
		5	1.38 <sup>e-j</sup>	1.48 <sup>b-f</sup>	40.54 <sup>e-j</sup>	43.50 <sup>b-f</sup>
		10	1.57 <sup>c-g</sup>	1.40 <sup>d-g</sup>	45.93 <sup>c-g</sup>	41.07 <sup>d-g</sup>
	8	0	1.45 <sup>c-j</sup>	1.42 <sup>d-g</sup>	42.39 <sup>c-j</sup>	41.75 <sup>d-g</sup>



		5	1.64 <sup>b-e</sup>	1.42 <sup>d-g</sup>	48.20 <sup>b-e</sup>	41.64 <sup>d-g</sup>
		10	1.64 <sup>b-e</sup>	1.56 <sup>a-e</sup>	48.23 <sup>b-e</sup>	45.66 <sup>a-d</sup>
8	0	0	1.29 <sup>h-k</sup>	1.56 <sup>a-e</sup>	37.96 <sup>g-k</sup>	45.75 <sup>a-e</sup>
		5	1.37 <sup>e-i</sup>	1.47 <sup>c-g</sup>	40.33 <sup>e-j</sup>	42.99 <sup>c-f</sup>
		10	1.53 <sup>c-i</sup>	1.57 <sup>a-e</sup>	44.95 <sup>b-f</sup>	46.03 <sup>a-e</sup>
	4	0	1.54 <sup>c-h</sup>	1.38 <sup>d-g</sup>	45.09 <sup>c-g</sup>	40.49 <sup>d-g</sup>
		5	1.68 <sup>b-d</sup>	1.73 <sup>ab</sup>	49.20 <sup>a-d</sup>	50.88 <sup>ab</sup>
		10	1.73 <sup>a-c</sup>	1.61 <sup>a-d</sup>	50.87 <sup>a-c</sup>	47.22 <sup>a-d</sup>
	8	0	1.60 <sup>c-f</sup>	1.36 <sup>d-g</sup>	46.81 <sup>b-e</sup>	39.92 <sup>d-g</sup>
		5	1.90 <sup>a-b</sup>	1.46 <sup>c-g</sup>	55.63 <sup>ab</sup>	42.69 <sup>c-g</sup>
		10	1.96 <sup>a</sup>	1.78 <sup>a</sup>	57.50 <sup>a</sup>	52.30 <sup>a</sup>
season effect			1.45 <sup>a</sup>	1.46 <sup>a</sup>	42.51 <sup>a</sup>	42.92 <sup>a</sup>
* Means with the same letter for each interaction are not significantly different at 5% level based on Duncan's Multiple Range Test.						

The results in table (3) showed that there were no significant effects in the number of secondary heads.plant<sup>-1</sup> and secondary head weight.plant<sup>-1</sup>(g) parameters between the two seasons. The triple interaction among three factors concentrations of (Algae Seaweed, *Urtica dioica* and Zinc sulphate) had significant differences, the highest number of secondary heads.plant<sup>-1</sup> for the two seasons reached 11.97 and 15.00 respectively for the treatment (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) and (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 4 ml.L-1 + Zinc Sulfate 5 g.L-1) with increasing percentage reached to 93.06 % and 150 % than the lowest value of treatment for the two

seasons respectively. The best treatment for the secondary head weight.plant<sup>-1</sup> (g) was observed among (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 5 g.L-1) it gave 897.50 g for the first season compared with the lowest value (365.00) g obtained in the treatment (Algae Seaweed 0 ml.L-1 + *Urtica dioica* 0 ml.L-1 + Zinc Sulfate 5 g.L-1). Whereas the best secondary head weight.plant<sup>-1</sup> (825.17) g for the second season was shown in the (Algae Seaweed 4 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) treatment compared with the lowest value (373.25) g which obtained in the treatment (Algae Seaweed 0 ml.L-1 + *Urtica dioica* 0 ml.L-1 + Zinc Sulfate 0 g.L-1).



**Table 3. Effect of Algae Seaweed, *Urtica dioica* and Zinc Sulfate on the number of secondary heads, plant<sup>-1</sup> and weight of secondary head. plant<sup>-1</sup> (g) of broccoli plants.**

Algae Seaweed ml.L-1	Urtica dioica ml L <sup>-1</sup>	Zinc sulfate g.L-1	number of secondary heads .plant <sup>-1</sup>		secondary head weight .plant <sup>-1</sup> (g)	
			season 1	season 2	season 1	season 2
0	0	0	6.20 <sup>i</sup>	8.83 <sup>bc</sup>	375.00 <sup>f</sup>	373.25 <sup>e</sup>
		5	6.27 <sup>i</sup>	8.00 <sup>bc</sup>	365.00 <sup>f</sup>	460.07 <sup>de</sup>
		10	6.87 <sup>g-i</sup>	9.00 <sup>bc</sup>	477.50 <sup>d-f</sup>	673.67 <sup>a-d</sup>
	4	0	6.67 <sup>g-j</sup>	8.50 <sup>bc</sup>	490.00 <sup>d-f</sup>	529.77 <sup>ed</sup>
		5	6.47 <sup>hi</sup>	7.67 <sup>bc</sup>	532.50 <sup>d-f</sup>	530.15 <sup>de</sup>
		10	7.47 <sup>d-i</sup>	9.33 <sup>bc</sup>	562.50 <sup>d-f</sup>	562.58 <sup>b-e</sup>
	8	0	7.00 <sup>f-i</sup>	6.00 <sup>c</sup>	557.50 <sup>d-f</sup>	560.53 <sup>c-e</sup>
		5	7.67 <sup>c-i</sup>	6.33 <sup>bc</sup>	580.00 <sup>c-f</sup>	571.08 <sup>b-e</sup>
		10	7.23 <sup>f-i</sup>	8.50 <sup>bc</sup>	595.00 <sup>c-f</sup>	597.33 <sup>a-e</sup>
4	0	0	7.73 <sup>c-i</sup>	7.50 <sup>bc</sup>	477.50 <sup>d-f</sup>	469.52 <sup>de</sup>
		5	7.67 <sup>i</sup>	8.67 <sup>bc</sup>	457.50 <sup>e-f</sup>	530.83 <sup>de</sup>
		10	8.47 <sup>c-i</sup>	10.67 <sup>a-c</sup>	500.00 <sup>d-f</sup>	585.82 <sup>a-e</sup>
	4	0	8.33 <sup>c-i</sup>	7.17 <sup>bc</sup>	527.50 <sup>d-f</sup>	599.00 <sup>a-e</sup>
		5	8.20 <sup>c-i</sup>	8.67 <sup>bc</sup>	585.00 <sup>c-f</sup>	587.98 <sup>a-e</sup>
		10	9.87 <sup>a-e</sup>	10.83 <sup>a-c</sup>	635.00 <sup>b-e</sup>	553.15 <sup>a-e</sup>
	8	0	7.20 <sup>f-i</sup>	7.83 <sup>bc</sup>	522.50 <sup>d-f</sup>	517.25 <sup>de</sup>
		5	9.77 <sup>a-e</sup>	7.00 <sup>bc</sup>	692.50 <sup>a-e</sup>	590.33 <sup>a-e</sup>
		10	9.07 <sup>b-h</sup>	15.00 <sup>a</sup>	687.50 <sup>a-e</sup>	825.17 <sup>a</sup>
8	0	0	7.93 <sup>c-i</sup>	7.67 <sup>bc</sup>	580.00 <sup>c-f</sup>	595.43 <sup>a-e</sup>
		5	7.73 <sup>c-i</sup>	8.33 <sup>bc</sup>	602.50 <sup>c-f</sup>	615.42 <sup>a-e</sup>
		10	9.33 <sup>b-g</sup>	10.67 <sup>a-c</sup>	597.50 <sup>c-f</sup>	706.08 <sup>a-d</sup>
	4	0	9.17 <sup>b-h</sup>	8.78 <sup>bc</sup>	705.00 <sup>a-d</sup>	516.25 <sup>de</sup>
		5	10.20 <sup>a-c</sup>	10.5 <sup>a-c</sup>	840.00 <sup>ab</sup>	673.17 <sup>a-d</sup>
		10	10.00 <sup>a-d</sup>	11.50 <sup>ab</sup>	807.50 <sup>a-c</sup>	812.94 <sup>ab</sup>
	8	0	9.67 <sup>a-f</sup>	10.00 <sup>a-c</sup>	645.00 <sup>b-e</sup>	496.83 <sup>de</sup>
		5	11.53 <sup>ab</sup>	10.33 <sup>a-c</sup>	862.50 <sup>ab</sup>	523.33 <sup>de</sup>



		10	11.97 <sup>a</sup>	10.67 <sup>a-c</sup>	897.50 <sup>a</sup>	789.45 <sup>a-c</sup>
season effect			8.36 <sup>a</sup>	9.03 <sup>a</sup>	598.43 <sup>a</sup>	586.90 a
*Means with the same letter for each interaction are not significantly different at 5% level based on Duncan's Multiple Range Test.						

The results in table (4) showed that there were no significant effects in leaf area (cm<sup>2</sup>) while it there were significant difference effects in the vegetative dry matter weight (g) between the two seasons.

The triple interaction among the three factors concentrations of (Algae Seaweed, *Urtica dioica* and zinc sulphate) had significant differences, the highest leaf area (cm<sup>2</sup>) for the two seasons reached (766.16) and (846.16) cm<sup>2</sup> respectively for the treatment (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) with increasing percentage reached 25.80 % and 35.20 % respectively, than the lowest value of treatment for the two seasons

respectively. The best treatment for the vegetative dry matter weight (g) was observed among (Algae Seaweed 4 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) gave 262.43g for the first season compared with the lowest value (171.47) g obtained in the treatment (Algae Seaweed 4 ml.L-1 + *Urtica dioica* 0 ml.L-1 + Zinc Sulfate 0 g.L-1). Whereas the best vegetative dry matter weight (276.47) g for the second season was shown in the (Algae Seaweed 8 ml.L-1 + *Urtica dioica* 8 ml.L-1 + Zinc Sulfate 10 g.L-1) treatment compared with the least value (181.45) g which obtained in the treatment (Algae Seaweed 4 ml.L-1 + *Urtica dioica* 0 ml.L-1 + Zinc Sulfate 10 g.L-1).

**Table 4. Effect of Algae Seaweed, *Urtica dioica* and Zinc Sulfate on the leaf area (cm<sup>2</sup>) and vegetative dry weight (g) of broccoli plants.**

Algae Seaweed ml.L-1	Urtica dioica ml L <sup>-1</sup>	Zinc sulfate g.L-1	leaf area (cm <sup>2</sup> )		vegetative dry matter weight (g)	
			season 1	season 2	season 1	season 2
0	0	0	609.06 <sup>h</sup>	625.89 <sup>g</sup>	181.83 <sup>f-i</sup>	194.83 <sup>e-h</sup>
		5	643.21 <sup>f-h</sup>	650.04 <sup>e-g</sup>	175.60 <sup>hi</sup>	197.30 <sup>e-h</sup>
		10	644.31 <sup>e-h</sup>	665.62 <sup>c-g</sup>	184.10 <sup>f-i</sup>	189.28 <sup>f-h</sup>
	4	0	622.04 <sup>gh</sup>	633.94 <sup>fg</sup>	183.10 <sup>f-i</sup>	204.25 <sup>d-h</sup>



		5	669.58 <sup>c-g</sup>	705.06 <sup>c-g</sup>	188.40 <sup>f-i</sup>	194.95 <sup>e-h</sup>	
		10	704.13 <sup>a-f</sup>	718.30 <sup>b-f</sup>	195.80 <sup>e-i</sup>	191.07 <sup>f-h</sup>	
	8	0	643.81 <sup>c-h</sup>	658.57 <sup>e-g</sup>	183.60 <sup>f-i</sup>	190.60 <sup>f-h</sup>	
		5	692.59 <sup>a-g</sup>	683.68 <sup>c-g</sup>	194.60 <sup>e-i</sup>	203.13 <sup>d-h</sup>	
		10	702.92 <sup>a-f</sup>	718.39 <sup>b-f</sup>	184.20 <sup>f-i</sup>	189.73 <sup>f-h</sup>	
4	0	0	663.00 <sup>e-h</sup>	671.86 <sup>d-g</sup>	171.47 <sup>i</sup>	187.55 <sup>gh</sup>	
		5	671.35 <sup>c-h</sup>	683.98 <sup>c-g</sup>	176.40 <sup>h-i</sup>	184.95 <sup>h</sup>	
		10	705.31 <sup>a-f</sup>	721.70 <sup>b-e</sup>	178.63 <sup>g-i</sup>	181.45 <sup>h</sup>	
	4	0	660.74 <sup>d-h</sup>	674.70 <sup>c-g</sup>	173.93 <sup>i</sup>	216.02 <sup>d-h</sup>	
		5	705.54 <sup>a-f</sup>	717.08 <sup>b-f</sup>	211.07 <sup>c-h</sup>	224.33 <sup>c-f</sup>	
		10	712.90 <sup>a-f</sup>	727.25 <sup>b-e</sup>	203.27 <sup>e-i</sup>	185.40 <sup>h</sup>	
	8	0	686.11 <sup>b-g</sup>	699.68 <sup>c-g</sup>	177.37 <sup>hi</sup>	184.95 <sup>h</sup>	
		5	687.41 <sup>c-g</sup>	701.27 <sup>c-g</sup>	240.07 <sup>a-c</sup>	264.18 <sup>ab</sup>	
		10	711.59 <sup>a-f</sup>	721.96 <sup>b-e</sup>	262.43 <sup>a</sup>	272.20 <sup>a</sup>	
	8	0	0	643.91 <sup>c-h</sup>	660.41 <sup>e-g</sup>	193.23 <sup>e-i</sup>	196.08 <sup>e-h</sup>
			5	684.28 <sup>b-g</sup>	728.81 <sup>b-e</sup>	227.40 <sup>b-e</sup>	237.28 <sup>b-d</sup>
			10	743.64 <sup>a-c</sup>	759.80 <sup>bc</sup>	213.67 <sup>c-g</sup>	221.48 <sup>c-g</sup>
4		0	620.57 <sup>gh</sup>	633.87 <sup>fg</sup>	216.80 <sup>c-f</sup>	223.33 <sup>c-g</sup>	
		5	721.29 <sup>a-d</sup>	734.85 <sup>b-e</sup>	217.37 <sup>c-f</sup>	233.97 <sup>b-d</sup>	
		10	736.84 <sup>a-d</sup>	748.71 <sup>b-d</sup>	243.97 <sup>a-c</sup>	252.80 <sup>a-c</sup>	
8		0	681.13 <sup>b-h</sup>	696.20 <sup>c-g</sup>	217.77 <sup>c-f</sup>	230.30 <sup>c-e</sup>	
		5	752.08 <sup>ab</sup>	798.21 <sup>ab</sup>	234.07 <sup>a-d</sup>	251.67 <sup>a-c</sup>	
		10	766.16 <sup>a</sup>	846.16 <sup>a</sup>	255.87 <sup>ab</sup>	276.47 <sup>a</sup>	
season effect			684.65 <sup>a</sup>	703.18 <sup>a</sup>	203.24 <sup>b</sup>	214.06 <sup>a</sup>	
* Means with the same letter for each interaction are not significantly different at 5% level based on Duncan's Multiple Range Test.							

The purpose of this study was to determine how the chemicals under discussion influenced the vegetative growth and head yield of broccoli plants. Broccoli plants treated with algal seaweed extract improved

the most in vegetative growth indices across the treatment groups. A considerable rise was seen after applying 8mL<sup>-1</sup> of algae seaweed. Head weight, head diameter, plant yield, overall yield, quantity of side heads,



side head weight, leaf area, and vegetable dry matter weight are indicators that a nutrient may be absorbed more readily. This suggests that an algae and seaweed extract may effectively increase the growth of broccoli plants during the vegetative stage. Seaweed extract has been used to promote plant tolerance to pests, diseases, and stresses by increasing soil absorption of essential macro- and micronutrients. Seaweed extract has a significant effect on plant cellular metabolism. Using seaweed extracts improves sprouting, chlorophyll content, crop quality and quantity, and plant nutrient absorption from the soil (13). (9) found that adding a kelp extract to broccoli curds may increase the average weight and quality of the curds. When we applied algal seaweed, the weight of the broccoli head. Algae seaweed has been demonstrated to improve plant yield, growth, and physiological properties. Seaweed extracts are being used as nutritional supplies, plant stimulants, and biofertilizers (26). Algae-based biofertilizers are less harming to plants and the environment than synthetic chemicals (11).

Similar to this, *Urtica dioica* extract promoted vegetative growth. It had a considerable impact on vegetative and yield parameters, especially at level  $8\text{mL}^{-1}$ . This might be related to nutrients that increase enzyme activation, chlorophyll production, protein synthesis, root growth, and cell division when organic manures are

administered. *Urtica dioica* stimulated plant growth and output by increasing chlorophyll content, photosynthetic efficiency, and antioxidant activity. *Urtica dioica* extract shows potential as an organic supplement for increasing broccoli growth. Because minerals and other nutrients can increase nutritional availability and absorption, the presence of minerals and other nutrients in *Urtica dioica* L. extract may result in improved growth and development (19). Organic farmers have access to a growing selection of natural materials for crop management and enhancement (4). They concluded that nettle manure had high amounts of boron (B), and that the low C:N ratios of green manures had a greater impact on plant development than the total amount of N provided as solid soil (21).

Zinc sulfate, at a concentration of  $10\text{gL}^{-1}$ , significantly improved the growth parameters and yield of broccoli plants. (2) found that zinc sulfate enhanced plant height, stem diameter, and leaf area, indicating higher vegetative growth. According to (1), feeding broccoli with different nitrogen fertilizers increased plant height, the number of leaves per plant, the area of the leaves, the circumference and weight of the heads, and overall head production significantly.

## Conclusion

The research on the impact of zinc sulfate, algae seaweed, and *Urtica dioica* on broccoli plant vegetative development and



head production offers important insights into sustainable farming methods. These extracts are interesting options for organic farming and horticulture since they have been demonstrated to encourage vegetative development and boost head production in broccoli plants. *Urtica dioica*, zinc sulfate, and algae seaweed extracts are also promising. Overall, this research advocates the use of sustainable techniques in contemporary farming and adds to the body of information on environmentally friendly alternatives to traditional agricultural operations.

### Conflict of interest

The authors declare no conflict of interest.

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