



Impact of Nano Fertilizer and Seaweed extracts on Growth, Heavy Metals and Nutrient content of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Sarbast Hekmat Muhammad¹

Ramadhan Omer Hussain²

Kurdistan Hassan Yousif²

¹Bachelor of Horticulture, Aqrah College of Technology, Duhok Polytechnic University, 2019 • Master of Agricultural Sciences, Horticulture, University of Duhok..

² Department of Horticulture, College of Agriculture Engineering sciences, University of Duhok, IRAQ.

*Corresponding Author: serbestb4@gmail.com.

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ABSTRACT

This study was aimed to evaluate the effect of Hybrids, nano, foliar application of seaweed extracts, on broccoli leaves (*Brassica oleracea* var. *italica*). The findings demonstrated that both Hybrids mofed and Agassi have significant differences in terms of vegetative growth characters, All studied traits in both Hybrids were significantly increased by the Agassi RZ cultivar during the study seasons. It was also observed that adding seaweed extract significantly increased all investigated traits in both Hybrids. The interactions between nano and seaweed extract were marked by the elevation of most detected traits. Combination between them significantly impacted most measures, whereas 6g.L⁻¹ and 8g.L seaweed extract produced the greatest overall result in all vegetative growth parameters (Number of leaf.plant⁻¹, plant high (cm), stem length (cm) , branch number. Plant⁻¹ and chlorophyll contents (SPAD). Regarding nutrients contents, significant differences were showed. The combination among three factors was significant enhanced all studied traits. The levels of Pb and Cd in the heads of two broccoli hybrids were within the acceptable limits for these metals in vegetables.

Keywords: Hybrids, nano fertilizers, seaweed extract, broccoli, agriculture.

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INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*) is considered one of the winter vegetables crops, it belongs to the Brassicaceae family, It is an annual herbaceous plant similar morphology of cauliflower plant, it is considered one of the few plants in Iraq, it ranks 31 globally in terms of production, which is from a crops of cold season cultivated throughout the year in cold regions, It is also a vegetable rich in chemical compounds that have shown anti-cancer properties, where it was noted that eating more than one meal during the week reduces the risk of this disease with a ratio of (45%), It also helps prevent eye diseases[1]; [2].

In nutrient terms, it is a critical winter crop and it contains (3.3%) protein and high content of vitamin A, C, Iron and calcium carbohydrates and minerals such as calcium, iron, phosphorus. Potassium, and sodium [3].

Broccoli holds significant economic value across all Iraqi governorates due to its relatively high market price, often reaching four to five times that of cabbage or cauliflower. This premium pricing is largely due to limited local production, with approximately 90% of broccoli being imported from neighboring countries. Despite the crop's ease of cultivation and care, its production remains constrained, possibly due to farmers' lack of knowledge about its specific growing requirements (6). Globally, annual production of broccoli and cauliflower stands at approximately 22,833,619 tons, with China leading the way, accounting for 43% of total production. In contrast, Iraq's production amounts to only 31,178 tons, representing just 0.14% of global output (11).

The United States Department of Agriculture [5]. reported that 10g of Broccoli might contain protein (2.82g), total lipids (0.37g), and carbohydrates (6.64g), In addition to the above. Broccoli is wealthy in minerals which are illustrated by the bioavailability of, Ca (47.0) Fe (0.73), Mg (21), P (66), and K (316) mg/100g, and many other healthy-chemical compounds were confirmed to be found in broccoli. such as. vitamin A, thiamine. niacin. riboflavin and high

concentrations of carotenoids, which are believed to have 33 preventative qualities about human cancer.

The fertilizers are very important in plants growth, but the excessive use of chemical fertilizers for plant production on a large-scale increases production per unit area, but the result is environmental degradation. Excessive use of these fertilizers causes harmful effects to the soil and beneficial organisms that enhance soil fertility as well as to the environment in genera [6].

To reduce the negative effects resulting from the use of these chemical fertilizers, many studies have proven that the use of organic fertilizers, biofertilizers, and nano-fertilizers instead of chemical fertilizers is highly effective in increasing productivity with side effects and environmental pollution that are less or almost non-existent.

In a study conducted on Broccoli (*Brassica oleracea var Italica*) grown in the Vegetable Research Farm, College of Agricultural Engineering Sciences. University of Dohuk. Kurdistan Region/ Iraq. Seeds were planted during two growing years (2021-2022), (2022-2023), aims at investigating the effect of two broccoli hybrids (Wisdom and Agassi RZ hybrids), three Mulching types (without. Straw of wheat. and black plastic mulch), and four concentrations of licorice root extract (0, 6, 12 and 18 g.L⁻¹) and their interactions., the results showed that, second hybrids Agassi RZ significantly dominated over first hybrid Wisdom, in first growing year, in (Leaves number before head initiation, dry matter percentage of leaves),

Therefore, we decided to implement this study and use fertilizers that have a lower environmental impact and at the same time have a positive impact on the ecosystem.

The hybrids effected on various broccoli vegetative parameters; such. as plant height. leaf number. leaf area., plant dry matter percentage and chlorophyll content. [8], [9], [10], [11].

An organic farming system is a holistic production management system to improve and develop agro-ecosystem health, including biodiversity, biological cycle, and soil biological activity. Organic farming emphasizes the application of management practices that prioritize the use of inputs from the waste of cultivation activities on the land.

Nano-fertilizers are nanomaterials responsible for delivering one or more nutrients to plants to increase and improve their growth and production. It is extracted from various parts of the plant by using physical, chemical, biological and mechanical techniques by applying nanotechnology. Depending on plant nutrient requirements, Nano fertilizers are divided into macro fertilizers, micro fertilizers, and nanoparticle fertilizers [6].

Due to the fact that algae extracts contain nutrients like N, P, K, Ca, Mg, and S in addition to Zn, Fe, Mn, Cu, Mo, and Co, some growth regulators, polyamines, vitamins, cytokinin's, auxins, abscisic acid, vitamins, and nutrient test, they can be applied topically to improve vegetable growth [15]. [16].

Nanomaterial called nano fertilizers can include a carrier matrix of mineral elements. According to [12].

Seaweed extracts are a type of bio stimulant extracted from seaweed (red algae) that can enhance crop growth, improve crop quality, and increase crop resistance to stress [13].

The use of seaweed extracts has been shown to improve the nutrient uptake in broccoli. This is particularly important in organic and sustainable farming systems where soil fertility is managed without synthetic inputs. A study by [14]. found that seaweed extract applications increased the uptake of essential nutrients such as nitrogen, phosphorus, and potassium, leading to better growth and development of broccoli plants. we decided to implement this study and use fertilizers that have a lower environmental impact and at the same time have a positive impact on the ecosystem.

Objectives of the Study:

- 1- Studying the effect of organic and Nano fertilizers a on the growth, and nutrient content of Broccoli.
- 2- Reducing pollution of environment by reducing using chemical fertilizers.
- 3- Study behavioral of hybrids of broccoli under the Akre city conditions as productivity and qualities.
- 4- Find best interaction among three factors (Hybrids, Nano fertilizers and Seaweeds extract).

Seaweed extracts also play a significant role in enhancing the stress resistance of broccoli plants. The bioactive compounds in seaweed extracts help plants cope with abiotic stresses such as drought, salinity, and extreme temperatures. Additionally, the quality of broccoli, including factors such as size, color, and nutrient content, was improved with seaweed extract treatment, as reported by [18].

Materials and Methods

The experiment was carried out during growing seasons 2024-2025 in the plant research fields of Akre Technical College, Akre University of Applied Sciences, Kurdistan Region/Iraq. The study site is located at an elevation of 635 meters above sea level, positioned at latitude 43°89'65"6 N and longitude 36°74'69"7 E. The area experiences a combination of Mediterranean and continental climate patterns. Summers are characterized by warmth and dryness, while winters vary from cool to cold, occasionally bringing snowfall. The average humidity is 40%, average precipitation amounts to 699.8 mm, and the mean maximum and minimum temperatures are 26.3° C and 15.3° C,

respectively.

This experiment was carried out on (500 m²), to investigate the response of two cultivars of Broccoli (*Brassica oleracea* var. *italica*.) to different levels of Nano fertilizers (three levels) and seaweeds extracts (3 levels) on growth, productivity, nutrient content and yield of Broccoli.

The land was be ploughed and the soil well be softened, then it will divide into lines, irrigation of the field were be done before planting. Transplants will transport to the farm. Two Hybrids were be sowing at 20August inside lath house two seed per pots a transplant will transfer to the field and planted at distance of 40 cm between the plant and 70 cm between rows in September 2024. Other agricultural practices were similarly carried out to each experimental unit as followed by farmers in the area. Physicals and chemical properties of soil and irrigation water were be taken before transplanting. As showed in table below.

Table Some physical and chemical properties of the studied soil in the field during study season 2024-2025

No.	Parameters	Value	Measuring Units
1	Ph	7.8	-----
2	EC,	0.253	dS.m ⁻¹
3	Available Potassium,	170	mg/Kg
4	Available Phosphorous,	1.7	mg/Kg
5	Available Nitrogen,	63	mg/Kg
6	Organic Matter	1.34	%
7	Clay	9.9	%
8	Silt	34.5	%
9	Sand	55.6	%
10	Soil Texture	Sandy Loam	-----
11	CaCO ₃	14.24	%

* The analysis was carried out soil and water science laboratory. College of Agriculture Engineering Science. University of Duhok.

Experimental Design And Analysis:

1- The experiment were conducted under farm conditions.

2- The experiment was factorial Randomized Complete Block Design (RCBD) with three factors:

The **first factor** were be of two hybrids of Broccoli (Agassi RA hybrid were produced by Rijk zwaan ® originated from Chile which were delayed hybrid and Mofed F1. From United stat of America (US)

The **second factor** was Nano fertilizer; 3 levels, (0, 4, 8 g.l⁻¹)

The **third factor** was Seaweeds extract; 3 levels, (0, 3, 6 m.l⁻¹)

Which be sprayed after month of transplanting, fitting days as batch between each spraying.

It means it was (2*3*3=18) treatments with three replicates.

Therefore, number of experimental units = 2 (Hybrids) X 3 (Nano fertilizer) X 3Treatments, (Seaweeds extract) X 3 Blocks (replicates) = 54 experimental units.

3- Irrigation of studied plants by contents.

4- Foliar Sprayings were applied three times within ten days intervals, starting after a month from transplanting.

5- Each experimental treatment will consist of 8 plants, and measurements were be taken from six plants, and the two plants located on the edges of the experimental unit were be neglected.

The results were be analyzed statistically by using Duncan test at 0.05 level to verify the differences between mean of treatments [19].

4. Measurements:

Vegetative Growth Characters

Which include these characters (Number of leaves (Leaf/pl⁻¹, Plant Hight, Leaf area (cm), Stem length (cm), Stem diameter(cm)and Chlorophyll content (SPAD).

Nutrient content in head:

N.P.K B Cd and Lead Pb in heads.

Results And Discussions

Effect of Nano fertilizer and seaweed extracts on vegetative growth

The table (1) shows the effect of hybrids; Nano fertilizers and seaweeds extract and some of their interactions on broccoli leaves number per plant. It was showed that there were maximum significant value recorded by Agassi RZ hybrid, regarding to Nano fertilizers recorded highest significant value When the three factors were interacted led to significant effect on plant leaves number in both-years, in 2021 while Agassi RZ hybrid combine with soil mulch by black plastic and maximum concentration of licorice root extract highest value was recorded, in 2022 same interaction except the mulching material by straw gave maximum value. In 2021 the lowest value recorded when Wisdom hybrid plant not-mulched and not-treated by licorice root extract. **Table (1)** Showed the effect of Nano, Seaweed extract and some of their interaction on number of leaf, it was showed that there were no significant effect between Hybrid, the higher number of leaved was recorded with Agassi Hybrid compared to Mofed Hybrid. Regarding the effect of nano it were appeared no significant on the number of leaves. Concerning the mean effect of seaweeds extract it showed significant different as compared with untreated once which recorded lowest number of leaves which recorded (75.39) leaf per plant.

Data in Table (1) showed the effect of dual interaction on number of leaves per plant., it showed that interaction between Hybrid *nano had significant effect on leaves number which recorded largest value on interaction between Agassi *spraying highest concentration of nano which gave (87.78 leaf. Plant⁻¹) compared interaction between Mofed and no spraying with nano fertilizers which recorded lowest number of leaves 71.67 leaf. plant⁻¹. On the other hand, interaction between hybrid Agassi with spraying plant with (4g.L⁻¹) nano levels recorded significant difference as compared with other interaction. The combination between nano and seaweed extract showed significant defenses between them the highest number of leaves were appeared between interaction spraying plant with concentration of nano (4g. L⁻¹) and spraying plant with concentration of nano at (higher level 6g.L⁻¹) which recorded (87.00 leaf per plants compared with untreated plant which gave the lowest value 62.17 leaf. plant⁻¹.

The results in Table (1) also indicate that combination among Agassi Hybrid *spraying plant with nano at level (4g.L⁻¹) an spraying plant with concentration (6g.L of nano and with level 4g.L⁻¹ of seaweeds extract. Which gave the higher number of leaves as compared with untreated plant which recorded the lowest value if leaves 59.00 leaf. plant⁻¹.

Table (2) The data in Table 4 revealed, that there were no significant between two Hybrids. Spraying nano boron on plant resulted significant differences in the plant length as compared with untreated plant. Foulter application of seaweeds extract appeared no significant differences.

Concerning the dual combination between Hybrid and nano fertilizers it were appeared significant differences the highest plant length was recorded when plant sprayed with concentration (4g.L⁻¹) nano and with Agassi. regarding the combination between Hybrid and seaweeds extract it was showed significant differences as compared with untreated plant.

Regarding the interaction between (nano and seaweed extract) the effects were significant the lowest means of plant length 35.17 cm was obtained from the interaction between no spraying (nano and seaweeds extract).

Perhaps the triple interaction among three factors (Hybrid, nano fertilizers and seaweed extract), the effect were significant the lowest length of plant was appeared in combination among Mofed cultivar a with no spraying nano and Seaweed extract which recorded (37.00 cm).

Table (3) shows the effect of Nano, Seaweed extract and some of there interaction on leaf area (cm) , it was showed that their were no significant among both Hybrids. Regarding the effect of nano it were appeared no significant on the leaf area (cm) the same was shoed with spraying with seaweed extract which recorded no significant effect ,

Concerning the mean effect of seaweeds extract it showed significant different as compared with untreated once which recorded lowest number of leaves which recorded 75.39) leaf per plant.

Data in Table (3) shows the effect of dual interaction on leaf area (cm) ., it showed that interaction between Hybrid *nano ,and dual combination between Hybrid and seaweed extract and the combination between nano and seaweeds extract were appeared no significant differences On the other hand interaction the triple combination between Hybrids *nano and seaweed extract showed significant defenses between them the highest leaf area (cm) appeared among Hybrids Agassi with spraying plant with concentration of nano (4g.L⁻¹)and spraying plant with concentration of seaweed extract at (8) gave higher leaf area which recorded (668.11cm).

Table (4) The data in Table 6 revealed, that their were no significant between two Hybrids. Spraying nano boron on plant resulted no significant differences in the stem length (mm). Foulter application of seaweeds extract appeared significant differences, as compared with untreated plant with seaweeds.

Concerning the dual combination between Hybrid and nano fertilizers it were appeared significant differences the highest plant **stem length (mm)** was recorded when plant sprayed with concentration (4g.L⁻¹) nano and with Mofed regarding the combination between Hybrid and seaweeds extract it was showed significant differences as compared

with untreated plant.

Regarding the interaction between (nano and seaweed extract) the effects were significant the lowest means of stem length was obtained (22.17 cm), was obtained from the interaction between no spraying (nano and seaweeds extract). Perhaps the triple interaction among three factor (Hybrid, nano fertilizers and seaweed extract), the effect were significant the largest stem length was appeared in combination among Mofed cultivar with spraying concentration (4g.L^{-1}) nano and seaweeds extract with (4g.L^{-1}) which recorded 31.00 mm .as compared with the combination among three factors(Hybrids Mofed+ no spraying nano +no spraying seaweed extract which recorded lower value (21.67mm).

Table (5) The data in Table 6 revealed, that their were significant between two Hybrids on **Stem diameter (mm)** **Agassi cv recorded highest value on stem dimeter which gave (4.79mm)**. Spraying nano boron with concentration 8g.L^{-1} recorded highest dimeter compared with treatments. Fouler application of seaweeds extract appeared significant differences, as compared with untreated plant with seaweeds.

Concerning the dual combination between Hybrid and nano fertilizers it were appeared significant differences the highest plant **stem dimeter (mm)** was recorded when plant sprayed with highest concentration (4g.L^{-1}) of nano fertilizers and with **Agassi Hybrid**. Regarding the combination between Hybrid and seaweeds extract it was showed significant differences as compared with untreated plant.

Perhaps the interaction between (nano and seaweed extract) the effects were significant the highest value where between spraying nano with 8g.L and with the high level of seaweeds extract which recorded the maximum value of stem dimeter(5.74mm), the lowest means of stem dimeter was obtained (3.55cm) was obtained from the interaction between no spraying (nano and seaweeds extract).

Aswellas the triple interaction among three factor (Hybrid, nano fertilizers and seaweed extract), the effect were significant the largest dimeter was appeared in combination among **Agassi Hybrid** cultivar with spraying concentration (8g.L) nano and seaweeds extract with (8g.L) which recorded (6.10 mm).as compared with the combination among three factors (Hybrids Mofed+no spraying nano +no spraying seaweed extract which recorded lower value (3.38mm) table (7).

Table (6) The data in Table (8) revealed, that their were no significant between two Hybrids on Chlorophyll (SPAD). Spraying nano boron on plant resulted no significant differences in the Chlorophyll (SPAD). Fouler application of seaweeds extract appeared no significant differences.

Concerning the dual combination between Hybrid and nano fertilizers it were appeared no significant differences the highest value was recorded when plant sprayed with concentration (7089SPAD) nano and with **Agassi Hybrid**. Regarding the combination between Hybrid and seaweeds extract it was showed no significant differences as compared with untreated plant.

Regarding the interaction between (nano and seaweed extract) the effects were no significant the lowest means of plant length (68.96SPAD) was obtained from the interaction between spraying (nano 6g.L^{-1} and 4g.L^{-1} seaweeds extract).

Perhaps the triple interaction among three factors (Hybrid, nano fertilizers and seaweed extract), the effect were no significant the lowest value of chlorophyll was appeared in combination among **Agassi Hybrid concentration (3g.L) nano +no spraying seaweeds extracts.**

Table (1) Impact of Nano Fertilizer, Seaweed extracts and their combination on Number of leaves (Leaf/pl⁻¹.) of Two Broccoli Hybrids (*Brassica oleracea* var. italica.)

Hybrids	Nnano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	65.33 d-f	87.33 a-c	88.00 a-c	80.22 a-c	83.74 a
	4	92.67 ab	84.33 a-d	72.67 c-f	83.22 ab	
	8	89.00 a-c	98.00 a	76.33 b-f	87.78 a	
Mofed F1Hybrid	0	59.00 f	84.33 a-d	71.67 c-f	71.67 c	75.15 a
	4	81.00 a-e	87.33 a-c	63.00 ef	77.11 bc	
	8	65.33 d-f	76.00 b-f	88.67 a-c	76.67 bc	
Hybrid +seaweeds	Agassi Hybrid	82.33 ab	89.89 a	79.00 b	Mean effect of Nano boron	

extracts	Mofed F1	68.44 c	82.56 ab	74.44 bc	
Mean effect of	0	62.17 c	85.83 a	79.83 ab	75.94 a
Nnao+	4	86.83 a	85.83 a	67.83 bc	80.17 a
seaweeds(g.L ⁻¹)	8	77.17 ab	87.00 a	82.50 a	82.22 a
Mean effect of Seaweeds extracts		75.39 b	86.22 a	76.72 b	
(g.L ⁻¹)					

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (2) Impact of Nano Fertilizer, Seaweed extracts and their combination on plant height (cm) of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	37.00 fg	40.33 d-g	45.00 c-f	40.78 c	49.19 a
	4	50.67 a-d	59.33 a	52.67 a-c	54.22 a	
	8	47.33 b-e	57.33 ab	53.00 a-c	52.56 ab	
Mofed F1Hybrid	0	33.33 g	41.67 d-g	48.67 b-d	41.22 c	46.30 a
	4	40.67 d-g	49.67 a-d	55.33 a-c	48.56 b	
	8	37.67 e-g	54.67 a-c	55.00 a-c	49.11 ab	
Hybrid +seaweeds extracts	Agassi Hybrid	45.00 b	52.33 a	50.22 ab	Mean effect of Nano boron	
	Mofed F1	37.22 c	48.67 ab	53.00 a		
Mean effect of	0	35.17 c	41.00 bc	46.83 b	41.00 b	
Nnao+	4	45.67 b	54.50 a	54.00 a	51.39 a	
seaweeds(g.L ⁻¹)	8	42.50 b	56.00 a	54.00 a	50.83 a	
Mean effect of Seaweeds extracts (g.L ⁻¹)		41.11 a	50.50 a	51.61 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (3) Impact of Nano Fertilizer ,Seaweed extracts and their combination on leaf area (cm) of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	294.73 ab	322.12 ab	308.81 ab	308.55 a	311.41 a
	4	299.32 ab	301.16 ab	295.89 ab	298.79 a	
	8	273.73 b	338.83 ab	368.11 a	326.89 a	
Mofed F1Hybrid	0	313.31 ab	299.32 ab	301.16 ab	304.60 a	309.08 a
	4	317.93 ab	322.12 ab	318.36 ab	319.47 a	
	8	301.16 ab	309.76 ab	298.65 ab	303.19 a	
Hybrid +seaweeds extracts	Agassi Hybrid	289.26 a	320.70 a	324.27 a	Mean effect of Nano boron	
	Mofed F1	310.80 a	310.40 a	306.05 a		

Mean effect of	0	304.02 a	310.72 a	304.99 a	306.58 a
Nnao+	4	308.63 a	311.64 a	307.13 a	309.13 a
seaweeds(g.L ⁻¹)	8	287.44 a	324.29 a	333.38 a	315.04 a
Mean effect of Seaweeds extracts (g.L ⁻¹)		300.03 a	315.55 a	315.16 a	

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (4) Impact of Nano Fertilizer ,Seaweed extracts and their combination on stem length (mm) of Two Broccoli Hybrids (*Brassica oleracea* var. italica.)

Hybrids	Nano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	22.67 bc	25.67 a-c	24.00 bc	24.11 b	26.00 a
	4	26.33 a-c	28.67 ab	26.33 a-c	27.11 ab	
	8	24.67 a-c	28.67 ab	27.00 a-c	26.78 ab	
Mofed F1Hybrid	0	21.67 c	27.00 a-c	24.67 a-c	24.44 b	26.48 a
	4	26.67 a-c	31.00 a	28.33 ab	28.67 a	
	8	22.67 bc	27.67 a-c	28.67 ab	26.33 ab	
Hybrid +seaweeds extracts	Agassi Hybrid	24.56 bc	27.67 ab	25.78 a-c	Mean effect of Nano boron	
	Mofed F1	23.67 c	28.56 a	27.22 ab		
Mean effect of Nnao+ seaweeds(g.L ⁻¹)	0	22.17 d	26.33 a-c	24.33 a-c	24.28 b	
	4	26.50 a-c	29.83 a	27.33 a-c	27.89 a	
	8	23.67 cd	28.17ab	27.83a-c	26.56 a	
Mean effect of Seaweeds extracts (g.L ⁻¹)		24.11 b	28.11 a	26.50 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (5)Impact of Nano Fertilizer ,Seaweed extracts and their combination on Stem diameter (mm) of Two Broccoli Hybrids (*Brassica oleracea* var. italica.)

Hybrids	Nano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	3.71 de	4.31 c-e	4.45 c-e	4.16 bc	4.79 a
	4	4.63 c-e	4.81 b-d	4.79 b-d	4.74 b	
	8	4.46 c-e	5.86 ab	6.10 a	5.47 a	
Mofed F1Hybrid	0	3.38 e	4.34 c-e	4.34 c-e	4.02 c	4.37 b
	4	3.82 de	4.55 cd	4.74 cd	4.37 bc	
	8	3.94 de	4.85 b-d	5.39 a-c	4.73b	
Hybrid +seaweeds	Agassi Hybrid	4.27 bc	4.99 a	5.11 a	Mean effect of Nano boron	

extracts	Mofed F1	3.71 c	4.58 ab	4.82 ab	
Mean effect of Nnao+ seaweeds(g.L ⁻¹)	0	3.55 d	4.33 c	4.39 c	4.09 c
	4	4.23 cd	4.68 bc	4.77 bc	4.56 b
	8	4.20 cd	5.36 bc	5.74 a	5.10 a
Mean effect of Seaweeds extracts (g.L ⁻¹)		3.99 b	4.79 a	4.97 a	

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (6) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Chlorophyll (SPAD) of Two Broccoli Hybrids (*Brassica oleracea* var. italica.)

Hybrids	Nano boron (g.L ⁻¹)	Seaweeds extracts (g.L ⁻¹)			Mean effect of Hybrid+Nano	Mean effect of Hybrids
		0	3	6		
Agassi Hybrid	0	71.92 a	71.58 a	69.34 a	70.95 a	70.67 a
	4	64.41 a	73.27 a	72.82 a	70.17 a	
	8	68.85 a	72.72 a	71.10 a	70.89 a	
Mofed F1Hybrid	0	68.97 a	71.24 a	71.27 a	70.49 a	70.16 a
	4	73.51 a	67.97 a	69.14 a	70.21 a	
	8	71.41 a	66.43 a	71.48 a	69.77 a	
Hybrid +seaweeds extracts	Agassi Hybrid	68.39 a	72.52 a	71.09 a	Mean effect of Nano boron	
	Mofed F1	71.30 a	68.54 a	70.63 a		
Mean effect of Nnao+ seaweeds(g.L ⁻¹)	0	70.44 a	71.41 a	70.31 a	70.72 a	
	4	68.96 a	70.62 a	70.98 a	70.19 a	
	8	70.13 a	69.58 a	71.29 a	70.33 a	
Mean effect of Seaweeds extracts (g.L ⁻¹)		69.85 a	70.53 a	70.86 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Effect of Nano fertilizer and seaweed extracts on nutrient contents in the heads.

Table (7) shows the effect of Nano, Seaweed extract and some of their interaction on Nitrogen percentage in head of broccoli, it was showed that their were no significant effect between Hybrid the higher percentage of nitrogen was recorded with Mofeed Hybrid compared to Agassi hybrid. Regarding the effect of nano it were appeared no significant on the nitrogen percentage. Concerning the mean effect of seaweeds extract it showed no significant different.

Data in Table (7) also shows the effect of dual interaction on nitrogen percentage in head., it showed that interaction between Hybrid *nano had significant effect on nitrogen percentage which recorded largest value on interaction between Mofeed Hybrid* no spraying of nano which gave (1.63%) compared with interaction between Agassi and no spraying nano fertilizers. On the other hand interaction between hybrid with spraying plant with nano levels recorded no significant difference. The combination between nano and seaweed extract showed significant defenses between them the highest percentage of nitrogen were appeared between interaction between spraying plant with concentrations of nano (4g.L⁻¹) and spraying plant with no nano which recorded (1.67%) compared with other treatments. the lowest value (1.24%) which appeared in combination between spraying plant with nano fertilizers concentration (4g.L with spraying 6g.L seaweed extract which gave lowest value of nitrogen (1.24%).

Table (8) shows the effect of Nano, Seaweed extract and some of their interaction on **Phosphorus percentage** in head of broccoli, it was showed that their were no significant effect between Hybrid the higher **Phosphorus percentage** was recorded with Mofeed Hybrid compared to Agassi hybrid. Regarding the effect of nano it were appeared no significant on the **Phosphorus percentage**. Concerning the mean effect of seaweeds extract it showed no significant different.

Data in Table (8) also shows the effect of dual interaction on **Phosphorus percentage** in head., it showed that

interaction between Hybrid +nano had significant effect on **Phosphorus percentage** which recorded largest value on interaction between Mofeed Hybrid* spraying of nano (4g.L^{-1}) which gave (0.38%) compared with interaction between Agassi and spraying nano fertilizers with 4g.L^{-1} which gave lowest value of phosphorus (0.070%). On the other hand, interaction between hybrid with spraying plant with seaweeds extract recorded significant difference. The combination between nano and seaweed extract showed no significant defenses between them the highest percentage of phosphorus were appeared between interaction between spraying plant with concentrations of nano (8g.L^{-1}) and spraying plant with nano (3g.L^{-1}) which recorded (0.241%) compared with other treatments.

Regarding the triple combination it were appeared that their was significant defenses among them., the maximum combination were showed among Mofeed hybrid +spraying plant with concentration (4g.L) nano and with seaweeds extract at concentration zero which gave highest value of phosphorus which record(0.701%).

Table (9) shows the effect of Nano, Seaweed extract and some of their interaction on **Potassium percentage** in head of broccoli, it was showed that their was significant effect between Hybrid the higher percentage of **Potassium percentage** was recorded with **Agassi Hybrid** compared to Mofeed hybrid. Regarding the effect of nano, it were appeared no significant on the **Potassium percentage**. Concerning the mean effect of seaweeds extract it showed no significant different.

Data in Table (9) also shows the effect of dual interaction on **Potassium percentage** in head., it showed that interaction between Hybrid *nano had significant effect on **Potassium percentage** which recorded largest value on interaction between Mofeed Hybrid* no spraying of nano which gave (1.63%) compared with interaction between Agassi and no spraying nano fertilizers. On the other hand interaction between hybrid with spraying plant with nano levels recorded no significant difference. The combination between nano and seaweed extract showed significant defenses between them the highest percentage of **Potassium percentage** were appeared between interaction between spraying plant with concentrations with no nano which recorded (1.61%). perhaps the dual combination between nano and seaweed extract it were no significant

Concerning the triple interaction among three factors it were appeared significant differences among the largest value of phosphorus were appeared among Mofeed hybrid with no nano and with spraying concentration of seaweed extract (3g.L^{-1}) which recorded largest value of phosphorus (1.68%).

It was indicated significant enhance in most of vegetative growth of broccoli, The enhancement in vegetative growth in table (1-6) is attributable to the fact that (nano and seaweeds extract). This can be attributed to the genotype differences between the two Hybrids and the increase in the vegetative growth of the Fajr cv. due to the increase in absorption of the nutrient in the soil. In addition to the differences in the root system and RCEC (Root cation exchange capacity) which varies among Hybrids. Another reason can be differences in the growth habit of genotypes, or that the cultivar differs in their potential growth and productivity. This depends mainly on the physiological processes controlled by the interaction of both genetic and environmental variance. The reason for this diversification can be attributed to the adaptability of genes and morphological characteristics, and physiological factors during the growth period of the crop according to (Olaniyi et al., 2010).

Increasing vegetative growth may be as a result to the seaweeds extracts and humic acid that attributed to the influence of humic acid which provides nutrient minerals that involve in plants bioactivities and finally leads to growth induction (Abdel Mawgaud et al., 2007). Furthermore, humic acid increases the porosity of soil and improve growth of root system which leads to increase the shoot system of crop (Garcia et al, 2008). Humic acid degrade soil, improve its physical, chemical, biological and nutritional characteristics by degrading clay particles and increasing holding water capacity.

Table (10) shows the effect of Nano, Seaweed extract and some of their interaction on **Boron percentage** in head of broccoli, it was showed that their was no significant effect between Hybrid the higher percentage of **Boron percentage** was recorded with Mofeed hybrid compared to **Agassi Hybrid**. Regarding the effect of nano it were appeared no significant on the **Boron percentage**. Concerning the mean effect of seaweeds extract it showed significant different between them.

Data in Table (10) also shows the effect of dual interaction on **Boron percentage** in head., it showed that the interaction between Hybrid *nano had no significant effect on **Boron percentage**. On the other hand interaction between hybrid with spraying plant with seaweeds extract levels recorded no significant difference. The combination between nano and seaweed extract showed significant defenses between them the highest percentage of **Boron percentage** were appeared between interaction between spraying plant with concentrations with 8g.L nano and spraying plant with no seaweed extract which recorded (65.62%%).

Concerning the triple interaction among three factors it were appeared significant differences among them, the largest value of **Boron percentage** were appeared among Agassi hybrid with spraying plant with concentration (8g.L) nano and with no spraying seaweed extract which recorded largest value of **Boron percentage** (69.23%).

Table (7) Impact of Nano Fertilizer, Seaweed extracts and their combination on Nitrogen percentage of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	1.18 b	1.38 ab	1.29 ab	1.29 b	1.42 a
	4	1.64 ab	1.57 ab	1.30 ab	1.50 ab	
	8	1.33 ab	1.48 ab	1.61 ab	1.47 ab	
Mofed F1	0	1.61 ab	1.71 a	1.57 ab	1.63 a	1.49 a
	4	1.70 a	1.40 ab	1.17 b	1.42 ab	
	8	1.44 ab	1.41 ab	1.40 ab	1.42 ab	
Hybrid* Seaweed	Agassi	1.38 a	1.48 a	1.40 a	Mean effect of Nano fertilizer	
	Mofed F1	1.58 a	1.50 a	1.38 a		
Nano fertilizer* Seaweed	0	1.39 ab	1.55 ab	1.43 ab	1.46 a	
	4	1.67 a	1.48 ab	1.24 b	1.46 a	
	8	1.39 ab	1.44 ab	1.51 ab	1.44 a	
Mean effect of seaweed		1.48 a	1.49 a	1.39 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (8) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Phosphorus percentage of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	0.117 b	0.185 ab	0.064 b	0.122 ab	0.131 a
	4	0.074 b	0.082 b	0.055 b	0.070 b	
	8	0.071 b	0.425 ab	0.104 b	0.200 ab	
Mofed F1	0	0.073 b	0.277 ab	0.373 ab	0.241 ab	0.268 a
	4	0.701 a	0.107 b	0.330 ab	0.380 a	
	8	0.403 b	0.056 b	0.091 b	0.183 ab	
Hybrid* Seaweed	Agassi	0.087 b	0.231 ab	0.074 b	Mean effect of Nano fertilizer	
	Mofed F1	0.392 a	0.147 ab	0.265 ab		
Nano fertilizer* Seaweed	0	0.095 a	0.231 a	0.218 a	0.181 a	
	4	0.387 a	0.095 a	0.193 a	0.225 a	
	8	0.237 a	0.241 a	0.097 a	0.192 a	
Mean effect of seaweed		0.240 a	0.189 a	0.170 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (9) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Potassium percentage of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	1.45 b-d	1.39 d	1.42 cd	1.42 c	1.49 b
	4	1.42 cd	1.55 a-d	1.39 d	1.45 c	
	8	1.55 a-d	1.58 a-d	1.64 ab	1.59 ab	
Mofed F1	0	1.62 a-c	1.68 a	1.59 a-d	1.63 a	1.57 a
	4	1.58 a-d	1.58 a-d	1.57 a-d	1.58 ab	
	8	1.63 a-c	1.47 b-d	1.42 cd	1.51 bc	
Hybrid* Seaweed	Agassi	1.47 b	1.51 ab	1.48 b	Mean effect of Nano fertilizer	
	Mofed F1	1.61 a	1.58 ab	1.53 ab		
Nano fertilizer* Seaweed	0	1.53 a	1.54 a	1.51 a	1.53 a	
	4	1.50 a	1.57 a	1.48 a	1.51 a	
	8	1.59 a	1.53 a	1.53 a	1.55 a	
Mean effect of seaweed		1.54 a	1.54 a	1.50 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (10) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Boron percentage of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	66.47 ab	29.03 b	51.14 ab	48.88 a	51.75 a
	4	52.72 ab	45.91 ab	52.95 ab	50.53 a	
	8	69.23 a	50.60 ab	47.72 ab	55.85 a	
Mofed F1	0	46.57 ab	42.93 ab	59.43 ab	49.64 a	52.49 a
	4	57.23 ab	56.33 ab	61.56 ab	58.37 a	
	8	62.00 ab	36.78 ab	49.56 ab	49.45 a	
Hybrid* Seaweed	Agassi	62.81 a	41.85 a	50.60 a	Mean effect of Nano fertilizer	
	Mofed F1	55.27 a	45.35 a	56.85 a		
Nano fertilizer* Seaweed	0	56.52 ab	35.98 b	55.28 ab	49.26 a	
	4	54.97 ab	51.12 ab	57.26 ab	54.45 a	
	8	65.62 a	43.69 ab	48.64 ab	52.65 a	
Mean effect of seaweed		59.04 a	43.60 b	53.73 ab		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Effect of Nano fertilizer and seaweed extracts on heavy metals in the heads.

Table (11) shows the effect of Nano, Seaweed extract and some of their interaction on Cadmium ($\text{Cd mg.kg}^{-1} \text{ d. wt.}$) in head of broccoli, it was showed that their was significant effect between Hybrid the higher percentage of Cd was recorded with Agassi Hybrid compared to Mofeed hybrid ($0.89 \text{ mg.kg}^{-1} \text{ d. wt.}$) compared to Mofed hybrid ($0.495 \text{ mg.kg}^{-1} \text{ d. wt.}$). Regarding the effect of nano it were appeared no significant on the Cadmium, the highest value were appeared with untreated plants Concerning the mean effect of seaweeds extract it showed no significant different between them.

Data in Table (11) also shows the effect of dual interaction on in head., it showed that the interaction between Hybrid *nano had significant effect on Cd. On the other hand interaction between hybrid with spraying plant with seaweeds extract levels recorded no significant difference. The combination between nano and seaweed extract showed significant defenses between them the highest percentage of Cd were appeared between interaction between spraying plant with concentrations with 8 g.L^{-1} nano and spraying plant wit no seaweed extract,

Concerning the triple interaction among three factors it were appeared significant differences among them, the largest value of Cd were appeared among Agassi hybrid with spraying plant with concentration (8 g.L^{-1}) nano and with no spraying seaweed extract which recorded largest value of Cd ($69.23 \text{ mg.kg}^{-1} \text{ d. wt.}$).

Data in Table (11) also shows the effect of dual interaction on Cd in head., it showed that the interaction between Hybrid *nano had significant effect on Cd. On the other hand interaction between hybrid with spraying plant with seaweeds extract levels recorded no significant difference. The combination between nano and seaweed extract showed significant defenses between them.

Concerning the triple interaction among three factors it were appeared significant differences among them, the largest value of Ca were appeared among Aggaci hybrid with spraying plant with concentration no praying nano and with spraying (6 g.L) seaweed extract which recorded largest value of Cd ($1.20 \text{ mg.kg}^{-1} \text{ d. wt.}$) as compared with the combination among Mofed hybrid with spraying plant with nano fertilizer (4 and 8 g.L^{-1}) with aspiring concentration of seaweed extract with concentration (6 g.L^{-1}) which gave the lowest value of cadmium which was ($0.25 \text{ mg.kg}^{-1} \text{ d. wt.}$) respectively.

Table (12) shows the effect of Nano, Seaweed extract and some of their interaction on Lead ($\text{Pb mg.kg}^{-1} \text{ d. wt.}$) in head of broccoli, it was showed that their was no significant effect between Hybrid the higher Pb content was recorded with Agassi Hybrid compared to Mofeed hybrid ($0.565 \text{ mg.kg}^{-1} \text{ d. wt.}$) compared to Mofed hybrid ($0.542 \text{ mg.kg}^{-1} \text{ d. wt.}$). Regarding the effect of nano, it were appeared no significant on the Lead percentage, the highest value were appeared with spraying plant with concentration of nano (4 g.L^{-1}) which recorded largest value ($0.638 \text{ mg.kg}^{-1} \text{ d. wt.}$). Concerning the mean effect of seaweeds extract it showed no significant different between them.

Data in Table (12) also shows the effect of dual interaction on Lead in head., it showed that the interaction between Hybrid *nano had no significant effect on Lead percentage.

On the other hand interaction between hybrid with spraying plant with seaweeds extract levels recorded no significant difference. The combination between nano and seaweed extract showed no significant defenses between them the highest content of Pb ($\text{mg.kg}^{-1} \text{ d. wt.}$) .

Perhaps the triple interaction among three factors it were appeared significant differences among them, the largest value of Lead percentage were appeared among combination Agassi*spraying plant concertation of nano with (4 G.L) and with spraying plant with concentration of seaweed extract at (3 g.L) which gave the maximum value of lead which was ($0.804 \text{ mg.kg}^{-1} \text{ d. wt.}$)

The minimum value of lead (Pb) were appeared in combination among ,

Mofed hybrid with spraying plant with concentration (6 g.L seaweed extract and no spraying nano fertilizers which gave lowest value ($0.278 \text{ mg.kg}^{-1} \text{ d. wt.}$), table (12).

As a results, the Pb and Cd concentration in the heads of two broccoli Hybrids fell within the safe limits for Pb ($0.5\text{--}2.0 \text{ mg.kg}^{-1} \text{ d. wt.}$) and for Cd ($0.2\text{--}1.0 \text{ mg.kg}^{-1} \text{ d. wt.}$) in vegetables established by the World Health Organization and the Food and Agriculture Organization [21].

Also, Both of Nano Fertilizer and Seaweed extracts have no significant effects on Cd and Pb concentration in the heads of two broccoli Hybrids, in other word application of these two compounds is safe.

Table (11) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Cadmium(Cd mg.kg⁻¹ d. wt.) of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	0.89 a-e	0.93 a-d	1.20 a	1.01 a	0.89 a
	4	1.10 ab	0.98 a-c	0.90 a-e	0.99 a	
	8	0.62 b-f	0.70 a-f	0.70 a-f	0.67 b	
Mofed F1	0	0.66 b-f	0.72 a-f	0.25 f	0.54 b	0.49 b
	4	0.45 d-f	0.68 b-f	0.25 f	0.46 b	
	8	0.40 ef	0.56 c-f	0.47 c-f	0.48 b	
Hybrid* Seaweed	Agassi	0.87 ab	0.87 ab	0.93 a	Mean effect of Nano fertilizer	
	Mofed F1	0.50 cd	0.65 bc	0.33 d		
Nano fertilizer* Seaweed	0	0.78 a	0.83 a	0.72 a	0.78 a	
	4	0.77 a	0.83 a	0.58 a	0.73 ab	
	8	0.51 a	0.63 a	0.58 a	0.57 b	
Mean effect of seaweed		0.69a	0.76 a	0.63 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

Table (12) Impact of Nano Fertilizer ,Seaweed extracts and their combination on Lead (Pb mg.kg⁻¹ d. wt.) of Two Broccoli Hybrids (*Brassica oleracea* var. *italica*.)

Hybrids	Nano fertilizer (g L ⁻¹)	Seaweed (ml L ⁻¹)			Hybrid *Nano fertilizer	Mean effect of Hybrids
		0	3	6		
Agassi	0	0.333 c	0.715 a-c	0.584 a-d	0.544 a	0.565 a
	4	0.503 a-d	0.804 a	0.729 ab	0.679 a	
	8	0.741 ab	0.293 cd	0.381 a-d	0.471 a	
Mofed F1	0	0.514 a-d	0.608 a-d	0.278 d	0.467 a	0.542 a
	4	0.635 a-d	0.586 a-d	0.569 a-d	0.597 a	
	8	0.426 a-d	0.603 a-d	0.658 a-d	0.562 a	
Hybrid* Seaweed	Agassi	0.526 a	0.604 a	0.565 a	Mean effect of Nano fertilizer	
	Mofed F1	0.525 a	0.599 a	0.502 a		
Nano fertilizer* Seaweed	0	0.424 a	0.661 a	0.431 a	0.505 a	
	4	0.569 a	0.695 a	0.649 a	0.638 a	
	8	0.583 a	0.448 a	0.519 a	0.517 a	
Mean effect of seaweed		0.525a	0.601 a	0.533 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

The reason may be due to that the vegetative growth characteristic of plant (leaf area, increase stem diameter, increase in numbers of secondary branches, number of leaves per branch, leaf dry matter percentage, shoots length, Total chlorophyll, leaf protein content, Total carbohydrates of leaves, leaf nitrogen percentage, leaf phosphorus percentage, leaf potassium percentage, leaf magnesium percentage, leaf iron concentration, leaf zinc concentration) were affected significantly by soil application of organic fertilizers.

The reason of the growth improvement of plants might be due to that Nano fertilizers help increase crop growth up to optimal levels; However, excessive concentrations can prevent growth due to nutritious poisoning. This fertilizer provides a large surface area for metabolic reactions in the plant, and promotes photosynthetic speeds, increases dry materials and increases crop productivity. They also help mitigate the effects of biotic and abiotic stresses, and to the fact that fertilizer contains nitrogen and phosphorous. as for the element phosphorus, it is involved in most vital processes for its essential role in building gluten membranes and contributing to the coloring of ATP and phospholipids and enzymatic conjugates and controlling the reactions of photosynthesis and respiration and increasing the number of absorbent roots, it also activates the process of photosynthesis and the increase in plant size (Table 8) may be due to the role of nitrogen in increasing the total chlorophyll (Table 10) and the activity of the photosynthesis process, which It is positively reflected in a strong vegetative group, represented by an increase in leafy area. Additionally, the extracts enhance roots' ability to absorb nutrients, leading to improved water and nutrient efficiency in the root systems. Furthermore, the extracts promote cell division and extension, as well as their role in maintaining the balance of biological processes within plant tissues, ultimately producing increased plant height and vigor [22]. The hybrids effect on broccoli yield might be a product of environment and genotype. The growing habits of different broccoli genotypes vary which in turn affects crop output. The significant increase in the weight of main yield, secondary yield and total yield of the broccoli plant (7, 8 and 9 Tables) when spraying seaweed and liquid organic fertilizers the reason for this could be that the extract has a high concentration of macro and micronutrients, which play a crucial role in the plant's viral construction, carbon metabolism, and the leaves' synthesis of sugars. Following their transfer and storage, these nutrients increase the curds' weight and, eventually, the plant's overall output [23].

Conclusion:

From the above-mentioned results, it can be concluded that using nano and seaweeds extract and combination between them leads to the enhancement of vegetative growth, nutrient uptick. Furthermore, the interaction between treatments also showed improvement in vegetative growth characters. Substantially, soil application of DAP was surpassed on foliar spray of organic fertilizer and irrigation type, also foliar spray of organic fertilizer was surpassed on soil application with seaweed extract in most studied parameters. Additionally, neither Nano Fertilizer nor Seaweed extracts demonstrated any significant impact on the concentrations of Cd and Pb in the heads of the two broccoli Hybrids; in other words, using these two substances as fertilizers is safe.

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تأثير الأسمدة النانوية ومستخلصات الأعشاب البحرية على النمو و محتوى العناصر الثقيلة و الغذائية في هجيني من البروكلي : (*Brassica oleracea* var. *italica*)

سريست حكمت محمد¹

كرديستان حسن يوسف²

¹ طالب ماجستير علوم الزراعة، البستنة، جامعة دهوك
² قسم البستنة، كلية العلوم الهندسية الزراعية، جامعة دهوك، العراق

الخلاصة

هدفت من هذه الدراسة هو تقييم تأثير الهجن، والتسميد النانوي، والرش الورقي لمستخلصات الأعشاب البحرية على أوراق البروكلي (*Brassica oleracea* var. *italica*). أظهرت النتائج أن كلا الهجينين (*Mofed*) و (*Agassi*) لهما اختلافات معنوية من حيث صفات النمو الخضري، حيث زادت جميع الصفات المدروسة في كلا الصنفين بشكل ملحوظ بواسطة هجين (*Agassi RZ*) خلال مواسم الدراسة. كما لوحظ أن إضافة مستخلص الأعشاب البحرية قد زاد بشكل ملحوظ من جميع الصفات المدروسة في كلا الهجينين تميزت التفاعلات بين النانو ومستخلص الأعشاب البحرية بارتفاع معظم الصفات المكتشفة. أثر الجمع بينهما بشكل كبير على معظم القياسات، بينما أنتج مستخلص الأعشاب البحرية بتركيز 6 غم/لتر و 8 غم/لتر أعلى نتيجة إجمالية في جميع معايير النمو الخضري (عدد أوراق النبات¹، ارتفاع النبات (سم)، طول الساق (سم)، عدد الفروع، محتوى النبات¹ والكلوروفيل (*SPAD*). فيما يتعلق بمحتويات العناصر الغذائية، ظهرت فروق معنوية. عزز الجمع بين العوامل الثلاثة بشكل كبير جميع الصفات المدروسة. وكانت مستويات الرصاص والكاديوم في رؤوس هجيني البروكلي ضمن الحدود المقبولة لهذه المعادن في الخضروات.

الكلمات المفتاحية: الهجن، الأسمدة النانوية، مستخلص الأعشاب البحرية، البروكلي، الزراعة.