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Effect of spraying humic acid and sea algae extracts on growth and chemical content of cress plants (*Lepidium sativum* L.).

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ABSTRACT

A field experiment was conducted on cress plants grown in plots with 1*2 m dimensions, during the year2021. It was factorial experiment with two factors. The first was with and without spraying humic acid (H1 spraying 4 ml L^{-1}, H0 without spraying). The second factor was spraying sea Algae extract (E1 spraying with 2 ml L^{-1} of Kelpak, E2 spraying with 2 ml L^{-1} of UltraKelp40, E3 spraying with a mixture of 2+2 ml L^{-1} of Kelpak and ultraKelp40) as well as without spraying the extract. The experiment was designed with RCBD. The treatments were replicated 4 times and Duncun's multiple range test at p=5% was used. Humic acid, sea algae extracts and their interactions causes significant effects on the plants. These treatments increased all vegetative growth characteristics compared to control treatment. The spraying also caused significant increases in macro nutrient (N, P, K) and micro nutrient concentrations (Fe, Cu, Zn). The treatmen L-¹ humic acid and mixture of 2+2 ml L^{-1} of Kelpak and ultrakelp40 extracts (H1E3) gave highest concentration of N (2.25%) phosphorus (0.375%) potassium (2.95%) Fe (109.8 mg. kg^{-1}) Cu (18.60 mg. kg^{-1}) and Zn (18.80 mg. kg^{-1}). The lowest of these parameters were 1.75%, 0.290%, 1.85%,

, 75.10 mg. kg^{-1}, 12.60 mg. kg^{-1}, 13.50 mg. kg^{-1}) in the treatment of control (not sprayed plants). Spraying humic acid, sea algae extracts and their interactions also caused significant increases in all physiological characteristics. Volatile oil was increased in sprayed plants specially H1E3 compared to plants in control treatments.) This treatment recorded the highest values of specific gravity of volatile oil (0.856 mg. 100 g^{-1} fresh matter). Highest refractive Index of volatile oil (1.516), highest oil quantity (0.199 mg. g^{-1}) was also increased. The lowest of these parameters were in control treatment.

KEYWORDS: Cress plant; Chemical content; Humic acid; Sea algae; Kelpak.

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تأثير الرش بحامض الهيوميك ومستخلصات الطحالب البحرية في النمو والمحتوى الكيميائي لنبات الرشاد *Lepidium sativum* L.

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الملخص

أجريت تجربة ميدانية على فدان مزروعة في قطع أرض مساحتها 1 × 2 م، في موسم 2021. أجريت تجربة عاملية مع عاملين. الأول هو الرش بحمض الهيوميك (H_0 بدون رش، H_1 رش ب 4 مل لتر$^{-1}$). العامل الثاني هو الرش بمستخلص الاعشاب البحرية (E_0 بدون رش، E_1 رش بـ 2 مل لتر$^{-1}$ من الكيلباك، E_2 رش بـ 2 مل لتر$^{-1}$ من الترا-كيلب40، E_3 رش بمزيج من 2+2 مل لتر$^{-1}$ من الكيلباك والترا-كيلب40. تم تصميم التجربة باستخدام (RCBD). تم تكرار المعاملات 3 مرات وتم استخدام اختبار المدى المتعدد لدنكن عند احتمال 5٪ وكانت النتائج على النحو التالي:

سبب حمض الهيوميك ومستخلصات الاعشاب البحرية وتفاعلها زيادة معنوية في جميع خصائص النمو الخضري، مقارنة بنبات المقارنة الذي لم يتم رشه بأي مواد. حمض الهيوميك ومستخلصات الاعشاب البحرية وتفاعلها ادى أيضا الى زيادة كبيرة في تركيزات المغذيات الكبرى (N، P، K) وتركيزات المغذيات الصغرى (Fe، Cu، Zn) خاصة في المعاملة H_1E_3 الذي يرش ب 4 مل لتر$^{-1}$ من حمض الهيوميك وخليط 2+2 مل لتر$^{-1}$ من مستخلصات الكيلباك والالترا-كيلب40 حيث اعطت أعلى تركيز للنيتروجين (2.25٪) الفوسفور (0.375٪) البوتاسيوم (2.95٪) الحديد (109.8 ملغ كجم$^{-1}$) النحاس (18.60 ملغ كجم$^{-1}$) الزنك (18.80 ملغ كجم$^{-1}$) مقارنة بالنباتات التي لم يتم رشها.

كما أن الرش بحامض الهيوميك ومستخلصات الاعشاب البحرية وتفاعلها سبب زيادة معنوية في جميع الخصائص الفسيولوجية للزيت الطيار لنبات الرشاد مقارنة بنبات المقارنة الذي لم يتم رشه بهذه المواد وخاصة في المعاملة (H_1E_3) التي رشت ب 4 مل.لتر$^{-1}$ من حمض الهيوميك وخليط 2+2 مل.لتر$^{-1}$ من الكيلباك و الالترا-كيلب40 مستخلصات الطحالب البحرية التي تعطي أعلى قيم للوزن النوعي للزيت الطيار (0.856 مجم.100 جم$^{-1}$ مادة طرية) واعلى معامل انكسار للزيت الطيار (1.516) واعلى كمية زيت (0.199 مج.جم$^{-1}$) مقارنة بأدنى قيم لهذه الصفات في معاملة المقارنة التي اعطت (0.781 مجم.100

جم$^{-1}$ مادة طرية) من الوزن النوعي للزيت الطيار و(1.380) من معامل الانكسار و (0.171 مجم.جم$^{-1}$) من كمية الزيت الطيار.
الكلمات المفتاحية: نبات الرشاد، المحتوى الكيميائي، حمض الهيوميك، الطحالب البحرية

INTRODUCTION

Cress plant, *Lepidium sativum* L., belongs to the Asteraceae family. Its origin is the Middle East, where it is found in Golan- Syria, and it is growing in Turkey. The plant contains many minerals such as iron, phosphorous, manganese, calcium, potassium, vitamins C, B, A, as well as carotenoids, volatile oil, and glucose. It is the most iodine-rich plant, which makes it easier to digest as it contains sulfur and anti-bacterial properties. Its oil is medically important as it is a laxative for urine and an

expectorant. The plant is sedative and hypotensive, activates hair follicles, and improves breathing. Cress plant can moderate skin diseases, diarrhea, spleen enlargement, and bleeding hemorrhoids. Fertilizing plant is important, but adding chemical fertilizers is harmful to the environment and human and animal health. Fertilizing is considered economically costly and polluting to the environment (Al-Bayati, 2012).Therefore, it can be used by using organic nutrition, including humic acid, which is rich in humic substances, major and minor elements, and plant hormones, in addition to improving soil conditions and retaining moisture by reducing the amount of bush around the plant (Bhargava,1999).In a study done by (Al-Bayati,2012) on *Rosmarinus officinalis* L., humic acid and marine algae extracts were used. The results showed that the organic acid and algal extracts had significant effects on the growth of the plant, the amount of macro- and micronutrients in the plant, and all of the oil's physical properties.

The results that he obtained (AL-bayrak,2005) when adding humic acid to lemongrass plants, *Cymbopogon citratus* L. resulted in significant increases in the characteristics of vegetative growth and the plant's content of nutrients. As for (A.O,1995), positive results were obtained for the anise plant *Pimpinella anisum* L. when humic acid was added to the plant. It had a significant effect on growth and the physical propertiesof the volatile oil. Marine algae extracts or other so-called seaweeds are rich in natural elements and hormones and are an aid to fertilization and reduce or replace nutritious chemicals as plant fertilizers, and this was confirmed by the results (Amin,2010) on celery plant *Apium graveolens* L., where marine algae extract 40 Kelpak ultrakelp caused significant increases. On growth characteristics, nutrient concentrations and physical properties of the oil. The results of (Al-Tamimi, 2012) on lemongrass plants when adding seaweed extract 40 Kelpak. ultrakelp were consistent with the foregoing significant increases in the characteristics of vegetative growth, concentrations of large and small elements and physical oil characteristics. Because of how important these materials are, a lot of research and studies have been done on them and are still being done. Given the importance of these studies, they aimed to do this study on the cress plants to know the extent of the impact of these materials on the growth and content of the cress of nutrients and oils.

MATERIALS AND METHODS

This field experiment was conducted at the Horticultural Research Station, College of Agriculture, Tikrit University, during 2021. Cress plants were examined in this study. Randomized complete block design was used to lay out the experiment. It was factorial experiment with two factors. The first factor was spraying humic acid at 4 ml. Liter^{-1} (H1) as well as without spray (H0). The second factor was spraying marine algae extracts at three levels; 2 ml.liter^{-1}of Kelpak (E1), 2 ml .L^{-1} of ultrakelp(E2), 2 ml Kelpak+2 ml of ultrakelpa ml.Liter^{-1}(E3), in addition to no spraying level (E0).

The plant seeds were sown in plots with dimensions of 1 x 2 m (experimental unit dimension), Each block had 8 plots representing the interactions of the factors used with three replications of each treatment. After seed germinations and seedlings reached about 5 cm, the acid was sprayed. Two weeks after, the spraying operation was repeated. Marine algae extracts were sprayed two days after the first and second sprays of humic acid. All measurments studied were taken and All data were statistically analyzed based on ANOVA. The averages were compared using Duncan's polynomial test at the level of 5% probability (Al-Sahaf,1989).

Characteristics studied:Vegetative growth parameters:

1. Plant height (cm): was measured from plant-soil contact area to the highest point for ten plants to take the average.
2. Number of leaves Plant^{-1}: Ten plants from each experimental unit were included, then their average was taken.
3. Number of branches plant^{-1}: was measured for ten plants from each experimental unit, then their average was taken.
4. Dry weight (g plant^{-1}): Ten plants were taken and weighed freshly. Then they placed in oven at temperature of 65-70 C for 48-72 hours until weight was stable (Habib,2012). The average was calculated.
5. Chlorophyll concentration (SPAD) : At the last third of growth phase, random readings were taken for ten plants with full physiological growth from each experimental unit. Manual measuring device (spad / Chlorophyll Meter 502 model, MINTOLA CO, LTD, Japan) was used for total chlorophyll percentage and the average was measured.

Nutrient estimationsleaves samples were taken and washed well. , then they were air-dried under laboratory atmosphere to be placed in oven at temperature of 65-70 C for 48-72 hours until the weight

was stable. (Black,1985) The samples were then crushed well using a hand grinder. A weight of 0.4 g was taken,placed in volumetric bottles for wet digestion with a mixture of concentrated sulfuric acid and perchloric acid. This was placed in digestion hood at high temperature to evaporate the solution for a period till the solution changed to a clear color. Upon completion of digestion, the samples were transferred to another canal, and the volume was completed to 50 ml with distilled water. The nutrients were then estimated (Al-Tamimi,2009).

1. Nitrogen: was made using Micro Kjeldahl according to the method shown by (Habib,2012) and based on (Garcia,2008).

2. Phosphorous: was determined by the method of aluminum molybdate and ascorbic acid by

(Spectrophotometer) at a wavelength of 620 nm (Sangwan,2001).

3. Potassium: was determined by means of a flame photometer.

4. Microelement concentrations: the concentrations of iron, copper, and zinc were measured using an atomic absorption device (Guenth,1972) (Atomic absorption spectrophotometer).

Volatile oil extracting: The volatile oil of the cress plant was extracted by steam distillation. Clevenger device attached to a one liter conical flask was used. The dried samples were pneumatically ground for 4-8 days at temperature of 25-30 °C. 50 g of these were placed in a beaker, to which 100 ml of water was added.The distillation process was conducted until the volatile oil was separated, its physical properties were studied.

1. Specific weight of oil: It represented the degree of saturation of the oil (Butier,2006) and was measured by:taking a volume of 100 microliters of volatile oil. Then the weight of that volume was estimated

by the weight of the same volume of distilled water at the same temperature (Ruwaiha,1983).

2. Oil refractive index: It represented the ratio between the sine of the angle of incidence of light

to the sine of the angle of refraction at a given temperature (Butier,2006).

3. Percentage of oil: The refractive factor was measured using a German Abberefractometer, Abb Type Universal, with a temperature of 20.

4. Amount of volatile oil: It was estimated by taking 100 gm of dried plant in laboratory atmosphere. The extraction process was carried out by Clevenger device and the amount of oil was calculated (Saadi,2013).

RESULT AND DISCUSSION

Effect of humic acid and marine algae extracts and their interactions on vegetative growth.

Table (1) showed the effects of humic acid and marine algae extracts and their interactions on thevegetative growth characteristics of the cress plant.

Table 1. The effect of humic acid and marine algae extracts and their interactions on vegetative growth of cress plant

Adjectives Transactions	plant height (cm)	The number of leaves (Leaf Plant^{-1})	Number of branching plant^{-1}	dry weight gm plant^{-1}	chlorophyll concentration (SPAD)
H_0	15.95b	13.7b	4.55 b	2.57 b	29.62 b
H_1	17.95 a	18.85 a	6.15 a	2.92 a	35.25 a
E_0	15.5 d	15.8 d	4.2 c	2.45 c	28.45 c
E_1	16.55 c	15.8 c	5.4 d	2.70 d	32.3 d
E_2	17.7 b	17.54 b	5.65 b	2.90 a	33.5 b
E_3	18.5 a	18.45 a	6.15 a	2.95 a	35.5 a
H_0E_0	14.2 e	10.6 f	3.2 d	2.3 e	26.5 f
H_0E_1	15.6 d	13.2 e	4.6 c	2.7 b	28.3 e
H_0E_2	16.8 c	14.6 d	4.8 bc	2.7 b	30.5 d
H_0E_3	17.2 b	16.4 c	5.6 b	2.7 b	33.2 d
H_1E_0	16.8 c	16.2 c	5.2 b	2.6 b	30.4 d
H_1E_1	17.5 b	18.4 b	6.2 a	2.8 ab	36.3 b
H_1E_2	18.6 a	20.3 a	6.5 a	3.1 a	36.5 a
H_1E_3	18.9 a	20.5 a	6.7 a	3.2 a	37.8 a

Different letters within column indicating of significant differences (p<0.05)

The spraying of humic acid caused significant increases in all vegetative growth characteristics of cress plants compared to no sprayed plants. It isalso shown that spraying marine algae extracts led to positive results in all vegetative growthcharacteristics. The plants that were sprayed with a mixture of Kelpak and 40 Ultralkelp extractswere distinguished by the highest values of these traits compared to other plants, especially the plants under control treatment. The rest of the plants were significantly superior to the othertreatments. The interaction between humic acid and marine algae extracts was significant. Thetreatment H1E3 that (sprayed with humic acid and a mixture of Kelpak and 40 Ultrakelp extracts)were distinguished by the highest values of plant height (18.9 cm), number of leaves plant $^{-1}$ (20.5), number of branches plant - 1 (6.7), dry weight of the plant (2.3 g), and the concentration of chlorophyll (37,8 spad unit). The lowest values of plant height (14.2 cm), number of leaves plant $^{-1}$ (10.60), number of branches plant^{-1} (3.2), plant dry weight (2.30 mm), and chlorophyllconcentration (26.5 Spad unit) were recorded in the treatment of control.

2- Effect of humic acid and marine algae extracts and their interactions on mineral content of Cress Plant.

Table (2) displayed that humic acid led to significant positive differences in nitrogen concentrationsin the leaves, compared to plants without spray. The plants sprayed with marine algae extracts increased their nitrogen concentrations compared to plants with no spray. The treatment H_1E_3 (sprayed with humic acid and a mixture of marine algae extracts) contained the highest concentrations of nitrogen in their leaves (2.25%) compared to the treatment of H_0E_0, that had the lowest concentration (1.75%).

Table (2) also displayed the effect of humic acid and marine algae extracts and their interactions onphosphorous percentage in the plant leaves. Humic acid led to positive significant differences in phosphorous compared to unsprayed plants. Spraying of marine algae extracts also led to positive significant differences in the concentrations of Kelpak and 40 Ultrakelp. The plants that were sprayed with a mixture of Kelpak and 40 Ultrakelp gave the highest values in phosphorous compared to the other plants. The interaction between spraying the acid and marine algae extracts had a significant effect on phosphorous in cress leaves. There were positive significant differences for all treatments compared to the control treatment. The plants under H_1E_3 treatment also contained the highest percentage of phosphorous (0.375 %) compared to the lowest in the control treatment (H0E0), which gave (0.290 %).

The table showed that adding each of the humic acid or marine algae extracts separately caused positive significant effects in potassium content the leaves. The percantage was increased comparedto plants neither sprayed with humic acid nor with any of marine algae extracts. The table also illustrated that interaction of humic acid and marine algae extracts had positive significant effect onpotassium of cress leaves. All interacted treatments gave significant increases. The treatment H_1E_3 gave the highest potassium concentrations (952%) compared to the control treatment that gave the lowest values (1.85%).

Table (2) exhibited that spraying cress plants with humic acid caused positive significant differencesin iron concentration compared to unsprayed plants. Also, spraying with marine algae extractscaused significant increases in potassium concentrations compared to unsprayed plants.

The table also included the interaction between spraying organic acid and marine algae extracts. Theplants were significantly distinguished in the treatment H_1E_3which was sprayed with organic acid and the mixture of algal extracts. The plants had the highest concentrations of iron (109.2 $mg.kg^{-1}$) compared to the rest of the other treatments. The control treatment gave the lowest iron

concentration (1.75 mg. kg^{-1}).

Table (2) also showed that spraying humic acid and marine algae extracts, separately, caused significant increases in copper concentrations compared to unsprayed plant. The interaction of the organic acid and the extracts was significant. The plants received both acid and the extracts or either of them had a significant increase over the control plants (H_0E_0).Copper percentages were at their maximum in the leaves of plants treated with H_1E_3 (18.6% mg.kg^{-1}) compared to the lowest in the control (12.6 mg.kg^{-1}).

The table also showed that the organic acid had significant positive effect on zinc concentrations in the leaves compared to the plants that had no organic acid.Farther, the table displayed that spraying marine algae extracts had significant positive effect on zincconcentrations in the plant compared to those were not sprayed. The interaction between the spraying humic acid and marine algae extracts was significant. The plants in the treatment H_1E_3 werecharacterized by the highest concentrations of zinc (18.8% mg.kg^{-1}) compared to the lowest in the control (H_0E_0) (13.40 mg.kg^{-1}).

Table 2. Effect of humic acid and marine algae extracts and their interactions on the concentrations of nutrients in cress plant

Adjectives Transactions	N%	P%	K%	Fe mg .kg^{-1}	Cu mg .kg^{-1}	Zn mg.kg^{-1}
H_0	1.91b	0.315b	2.18b	88.70b	15.12b	16.25b
H_1	1.12a	0.359a	2.77a	102.02a	17.57a	18.00a
E_0	1.85b	0.315c	2.14c	85.35c	14.25b	15.15c
E_1	2.00a	0.331b	2.50ab	94.20b	16.10a	17.35b
E_2	2.06a	0.345ab	2.60a	98.25ab	17.35a	17.80ab
E_3	2.14a	0.358a	2.67a	103.7a	17.70a	18.20a
H_0E_0	1.75c	0.290d	1.85d	75.10d	12.60f	13.40d
H_0E_1	1.91b	0.311c	2.20c	88.20c	14.90e	16.80c
H_0E_2	1.95b	0.321c	2.29bc	93.40bc	16.20c	17.20bc
H_0E_3	2.03ab	0.341b	2.40b	98.20b	16.80c	17.60b
H_1E_0	1.95a	0..340b	2.43b	95.60b	15.90d	16.90c
H_1E_1	2.10ab	0.351b	2.80a	100.2ab	17.30b	17.90b
H_1E_2	2.18a	0.370a	2.91a	103.1a	18.50a	18.40a
H_1E_3	2.25a	0.375a	2.95a	109.2a	18.60a	18.80a

Different letters within column indicating of significant differences (p<0.05)

3- Effect of spraying humic acid and marine algae extracts and their interactions on volatile oil:

Table (3) showed the effect of spraying each of humic acid and marine algae extracts and their

interactions on the specific weight of the oil. Spraying plants with humic acid caused significant increase in the specific weight of that oil compared to not spraying. The table showed that spraying the extracts also caused significant increases in the specific weight of the oil compared to not spraying. The interaction between organic acid spray and algae extracts was significant. All treatments were characterized by significant increases in the values of the specific weight of volatile oil compared to no spraying (control treatment). The treatment H1E3 was characterized by the highest specific weight of the oil (856.0) compared to the lowest the control (H0E0) (0.781).

Table (3) shows that humic acid when sprayed on cress plant caused positive, significant differences in therefractive index of oil compared to not spraying. The table also displayed that spraying algae extractsalso caused significant increases in the refractive index of the oil compared to the plants that were not sprayed.

Table 3. Effect of humic acid and marine algae extracts and their interactions on the physiological properties of volatile oil in cress plant

Adjectives Transactions	Specific weight	oil refractive index	% for volatile oil	Amount of volatile oil. mg .kg^{-1}
H_0	0.805b	1.410b	0.225b	0.184b
H_1	0.844a	1.494a	0.251a	0.197a
E_0	0.808c	1.424d	0.228b	0.183c
E_1	0.820b	1.443c	0.236ab	0.189bc
E_2	0.829b	1.456b	0.240a	0.193ab
E_3	0.841a	1.486a	0.211a	0.197a
H_0E_0	0.781e	1.380e	0.211e	0.170d
H_0E_1	0.801d	1.395e	0.223d	0.183c
H_0E_2	0.811cd	1.411d	0.230ed	0.189b
H_0E_3	0.826bc	1.456c	0.239c	0.195a
H_1E_0	0.835b	1.468c	0.246bc	0.196a
H_1E_1	0.840b	1.492b	0.249b	0.195a
H_1E_2	0.848ab	1.501a	0.251ab	0.198a
H_1E_3	0.856a	1.516a	0.258a	0.199a

Different letters within column indicating of significant differences (p<0.05)

Table (3), explained that interaction between humic acid and marine algae extracts was significant inthe characteristics of the oil refractive index. Plants in the treatment of H_1E_3 were characterized by the highest refractive index values (1.516) compared to the lowest in H_0E_0 (1.380). The table showed that humic acid caused significant increases in the percentage of oil compared to the treatment without adding the acid. This table also displayed that spraying plants with marine algae extracts also led to positive significant differences in the percentage of oil compared to not spraying. The interaction of humic acid and marine algae extracts was significant, and all treatments had

significant positive effect over the comparison treatments. The treatment $H_1E_3$was characterized by the highest percentage of oil (0.258 %) compared to the lowest (0.211%) in the control treatment. Spraying humic acid caused a significant increase in the amount of oil compared to not spraying. Table (3) also shows that spraying cress plants with marine algae extracts led to consecutive significant increases compared to plants that were not sprayed. In addition, the table also showed that interaction between humic acid and marine algae extracts was significant. Plant in the treatmentH_1E_3 were distinguished by the highest amount of oil (0.199 $mg.g.^{-1}$) compared to the lowest the

control (0.170 $mg.g.^{-1}$).The increase in vegetative growth characteristics of cress plants may be due to the action of humic acid. It contains many macro and micronutrients, which may contributed to increases in vegetative growth by encouraging physiological and biochemical processes such as photosynthesis. This resulted in processed food that induced the plant to growth and increase cell divisions (Norman, 2013).

This may also be due to humic acid-containing auxins, cytokines and types of gibberellins that pushed the plant to grow, increase cell divisions, and expand cell sizes. (Farcuk *et al.,* 2011) This may be due to the fact thathumic acid helps in improving chemical and physiological properties of the soil, fertility, and vitality. It is also improving the exchange capacity. The acid increases the readiness of nutrients, composition of the soil and its ventilation. In turn, the respiration of roots, and its ease of penetration into the soil are also enhanced. All of this reflected on the effectiveness and positive plant growth (Rafeeq,2014). This increase in vegetative growth may be the reason for the increased need of the plant to replace the state of equilibrium. This increases the absorption of nutrients and their accumulation within the tissues of the plant to keep pace with the physiological activities resulting from the increase in vegetative growth (Table 3). This in turn leads to an increase in the concentrations of important macro and micronutrients (Sarheed,2012). The reason may be boring humic acid for nitrogen-fixingOzotobacter bacteria, as well as the surface area of root hairs, and then increasing nitrogen andpotassium concentrations and improving plant growth for the ability of these bacteria to secretecytokinins, gibberellins, and auxins (Zhang,2004). Also, marine algae extracts may also have an important role because they contain macro and micronutrients and natural plant hormones, which contribute to increasing vegetative growth through improving physiological activities and its positive impact on plant growth and nutrient absorption (Al-Rawi,2000) and these results agree (A.O,1995) and (Bhargava,1999) and (Al-Tamimi,2009).

CONCLUSION

1- Spraying humic acid and seaweed extracts positively influenced the growth characteristics and nutrient content of cress plants.

2- The treatment H1E3 resulted in the highest nutrient concentrations compared to control plants.

3- The use of humic acid and seaweed extracts enhanced physiological characteristics and volatile oil content in the plants.

4- The study highlighted the importance of organic nutrition and suggested the use of humic acid and seaweed extracts as alternatives to chemical fertilizers.

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