EVALUATION OF FOLIAR SPRAY WITH EXTRACT OF MARINE ALGAE AND YEAST AND MOWING DATE ON GROWTH, YIELD, AND ACTIVE COMPONENTS OF WATERCRESS.

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ABSTRACT

The experiment was implemented in the fields of the College of Agricultural Engineering Sciences / University of Baghdad during the agricultural season 2021-2022 as a factorial experiment (2 x 3 x 3) with within Randomized Complete Block Design using 3 replcates, The spraying with marine algae extract (0, 4, and 6ml.l^{-1}) represented the first factor symbolized by K_0, K_1, and K_2; the second factor involved spraying with the yeast extract (0, 2, and 4 mg.l^{-1}) referred to as Y_0, Y_1, and Y_2; while the third factor was mowing date as tow mows were applied with 15 days interval between them. The research was aimed to examine the effect of the three mentioned factors and their interaction on the vegetative growth and leaf biochemical traits of watercress plants. The research objectives Results showed a significant superiority of the interaction treatment Y_2K_2 in increasing number of leaves, leaf area, fresh weight, and dry weight in the second mow (62.80 leaves.plant^{-1}, 131.77cm.plant^{-1}, 265.30g, and 113.5g) as well as increasing the biochemical traits in leaves including the content of carbohydrates, protein, N, P, K, Glucosinolates, total Glucosinolates, total phenolic compounds, and total flavonoids in the second mow.

Key words: sustainability, Glucosinolates, phenolic compounds, biochemical.

تقييم استخدام الرش الورقي بمستخلصي الطحالب البحرية والخميرة ومواعيد الحش في نمو وحاصل والمكونات الفعالة لنبات الجرجير.

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المستخلص

نفذت تجربة حقلية في حقول كلية علوم الهندسة الزراعية/جامعة بغداد للموسم الزراعي2021 – 2022 ، طُبقت التجربة باستعمال تصميم القطاعات الكاملة المعشاة (RCBD) حسب ترتيب التجارب العاملية (2X3X3) وبثلاث مكررات مَثل الرش بمستخلص الطحالب البحرية (0، 4، 6 مل .لتر $^{-1}$) العامل الاول والذي رمزله (K_0، K_1، K_2) ، اما العامل الثاني فتضمن الرش بمستخلص الخميرة (0، 2، 4 ملغم.لتر $^{-1}$) والذي رمز لـه(Y_0،Y_1، Y_2) ويشتمل العامل الثالث مواعيد الحش ،اذ اجريت حشتين الفرق بين الحشة الاولى والثانية 15يوم ، يهدف البحث الى اختبار تاثير بعض العوامل وتداخلاتها في مؤشرات النمو الخضري والمؤشرات الكيموحيوية لاوراق نبات الجرجير . اظهرت النتائج التفوق المعنوي لمعاملة التداخل K_2Y_2 في زيادة عدد الاوراق والمساحة الورقية والوزن الرطب والجاف للحشة الثانية (62.80ورقة $^{-1}$،131.77سم.نبات$^{-1}$،265.30 غم ، 113.5غم) ومؤشرات الكيموحيوية في الاوراق منها الكاربوهيدرات ونسبة الزيت وN وP و K وGlucosinolates وGlucosinolates الكلية والفينولات الكلية والفلافينويدات الكلية للحشة الثانية.

الكلمات المفتاحية: استدامة، Glucosinolates، المركبات الفينولية، الكيموحيوية

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INTRODUCTION

Watercress *Eruca sativa* Mill is an annual herbaceous plant belonging to the family *Brassicaceae*. This plant is highly valued for its nutritional and medicinal properties, and it can be grown all year round in temperate regions except for extremely hot or cold areas (34). It leaves are simple or lobed, lyre-shaped to pinnate, collected two to three times during the vegetative growth season. They taste somewhat pungent and are used in a salad or as a spice. The nutritional value of watercress leaves is attributed to their content of calories, oil, carbohydrates, protein, and vitamins, in addition to their content of medicinally effective compounds, including Glucosinolates that regulate blood sugar, prevent cancer, and reduce blood lipids (10, 17, 19), Watercress leaves contain glutathione and a group of flavonoids that work to curb free radicals that damage DNA and cell membranes, causing cancerous diseases. They contain phenolic compounds that act as antibacterial and antifungal (12, 24, 25), Improving the performance and yield of the watercress plant is crucial for its nutritional and medicinal benefits. Agricultural practices such as nourishment with natural extracts (environmentally friendly), specifically extracts that are dense in phytonutrients and bioavailable hormones (5, 35, 46). Marine algae, which are large groups that grow in the seas such as Rockweeds, Kelps, and Sea lettuce, in which their liquid extracts of dried or fresh parts, help to increase the production of horticultural crops of various types as a result of its significant impact on increasing plant tolerance to serious stresses (4, 16). Among the most important components found in the extract of marine algae are polysaccharides, laminarin, alginates, and carrageenans, in addition to their degradation products; moreover, they contain compounds related to inducing plant growth, including micro and macro elements, as well as sterols and nitrogen-containing compounds such as betaines, and hormones such as cytokinins, auxins, abscisic acid, and Gibberellins (8, 18). The study carried out by ahmad (3) reveals that spraying watercress plants with marine algae extract, especially the concentration of 6ml.l^{-1}, affected the studied traits, by significantly increasing the plant height, number of leaves, fresh weight, dry weight, and total yield, achieving: 45.00 cm, 53.33 leaves. plant-1, 213.10 g. plant^{-1}, 49.80 g. plant^{-1}, 113.40 cm2, and 2.59kg.experimental unit^{-1}, on average, respectively, as well as increasing the secondary compounds in the plant. Yeast extract is considered a natural source for thiamine (B_1), riboflavin (B_2), niacin (B_3), pyridoxine (B_6), and cobalamin (B_{12}) vitamins in addition to growth regulators such as cytokinins as well as several nutrients and organic compounds such as proteins, carbohydrates, nucleic acids, and lipids which stimulate the cell division and elongation, leading to a balance between physiological and biological processes, an increase in photosynthesis, and an improvement in the plant growth traits plants in general (11, 36, 41, 44). Yeast is a biostimulant and a natural source of cytokinin, which is responsible for stimulating the process of cell division and elongation, as well as the synthesis of protein and nucleic acids and chlorophyll formation (20) Furthermore, it can produce a group of enzymes. It has many agricultural applications, including increasing vegetative growth through enhancing nutrient absorption and producing several plant hormones, as well as it has the ability to phosphorus conversion from an insoluble to a soluble form, which enhanced the phosphorus availability to plants (39, 43). According to a study by Abraham et al (2), Adding yeast extract to the nutritional medium increased the amount of secondary metabolite compounds, including phenols, total phenols, and total flavinoids, especially concentrations from 3.5 mg.l^{-1} and above. Heikal (29) noticed a significant increase in plant height, number of branches, fresh weight, dry weight, and total carbohydrates when thyme plants sprayed with a concentration higher than 40g.L^{-1}. In another study on *Ruta graveolens* plants, yeast at the concentration of 2500 ppm produced the highest plant height, number of branches, fresh and dry weights of leaves, stem, roots, and flowers, in addition to the volatile oils and Coumarin (39).mentioned that marine algae extract , yeast extract and mowing date enhanced plant yield and content of medical compounds (*Eruca sativa* Mill). Consequently; this study was aimed to improve growth, yield traits, and medicinal compounds accumulation of watercress by using clean and sustainable extracts.

MATERIALS AND METHODS

The experiment was conducted in the fields of the College of Agricultural Engineering Sciences/University of Baghdad during the agricultural season 2021-2022 to investigate the effect of the foliar spray with marine algae and yeast extracts and cutting dates on the growth, yield, and active ingredients of watercress plant. A Factorial experiment within randomized complete block design (RCBD) of three replicates was used, involving 18 experimental units in each. The experimental land was divided into three plots. The planting was in five rows separated from each other by 20cm, with a 10cm distance between plants, leaving 75 cm between plots as passages and as barriers to prevent treatments from mixing. Next, humus was added to the experimental units which were irrigated relying on the dripping system and the recommended mineral fertilizer amounts (145kg $N.ha^{-1}$, 80kg$P.ha^{-1}$, and 120kg$K.ha^{-1}$) were added in two batches: the first, two weeks after planting and the second, a month after the first. In each pit, three seeds of watercress were planted on 25/9/2021; once the first true leaf emerged, the plants were thinned to only one per pit. All recommended service practices were carried out (10). The experiment involved spraying the plant leaves with marine algae extract at three concentrations (0, 3, and 6 $ml.l^{-1}$) and yeast extract at three concentrations (0, 2, and 4 $g.l^{-1}$). During the season, there were three sprays of each. All sprays were carried out during early morning with the extracts, reaching full wetness, except for the control treatment, which was sprayed with distilled water only. The plants were mowed twice, with 15 days intervals between them. Results were statistically analyzed by using ANOVA and the means compared using least significant difference (L.S.D) at the probability level 0.05 using the software Genstat. From each experimental unit, ten plants were chosen randomly and flagged for measuring the following traits:

First: Growth traits: Plant height (cm): It was measured with a tape measure from the base of the stem at the contact with the soil to the shoot tip of the marked plants.

Number of leaves.plant^{-1}: The average number of the total leaves was calculated for the selected plants.

Leaf area (dm^2.plant^{-1}): It was calculated by taking 30 known-area disks from three leaves of three plants and drying them in an electric oven at 65 °C until their weight stabilized. Then, the leaf area was calculated according to the following equation (40)

$$le = \frac{one\ leaf\ area(cm^2)}{100} x\ number\ of\ leaves\ per\ plant$$

Fresh weight (g.plant^{-1}): The average weight of the shoot system of five plants from each experimental unit was calculated.

Dry weight (g.plant^{-1}): After estimating the fresh weight, the plants were dried with an electric oven at 70 °C for 48 hours until the weight stabilized, and then the average dry weight was calculated.

Second: Biochemical traits: Having the plants from each experimental unit mowed, they were dried in a shaded place with good ventilation and then ground to estimate the following traits:

Nitrogen content in the leaves: Total nitrogen was estimated by distillation with Micro Kjeldahl after adding sodium hydroxide and titration with 0.04 N hydrochloric acid (51).

Phosphorous content in the leaves: It was estimated relying on the blue ammonium molybdate method modified by John (30) after adjusting the solutions pH and using the para-nitrophenol dye as an indicator, and then measured by a spectrophotometer at wavelength 882 (37).

Potassium content in the leaves: It was estimated according to the Flame photometer method (14, 22).

Oil percentage: Using a Soxhlet extractor, 100g was taken from the dried leaves of each experimental unit and 300 ml of the solvent, petroleum Spirit, and allowed to sit for 48 hours according to the procedure mentioned by A.O.A.C (1, 50).

Total soluble carbohydrates percentage in the leaves: It followed the procedure mentioned by Hedge. (28).

Protein percentage in the leaves

Nitrogen percentage was estimated relying on the Kjeldahl method (25), and then the protein percentage was calculated according to the equation used by A,O.A.C. (15) as follows: protein % = nitrogen % x 6.25.

Glucosinolates concentration (mg. g dry weight^{-1}): From each experimental unit, three samples were chosen randomly, and Glucosinolates were estimated according to HPLC method described by Doheny-Adams et al. (21) (fig 2).

Total Phenolic compounds (mg. g dry weight^{-1}):

Three randomly chosen samples from each experimental unit were used for extraction with 80% methanol and a water bath for 20 minutes, next centrifuging the extract at a temperature of 60°C at a speed of 14000 rpm for five minutes, then the total phenolic compounds were estimated using the Ciocalteu-Folin detector and measuring the optical absorption at the wavelength of 750 nm and calibrating the reads on the standard curve of gallic acid (38) and finally the average was calculated.

Total Flavonoids (mg. g dry weight^{-1}):

The aluminum chloride colorimetric method was used to estimate the total flavonoids in the above extracts, and the light absorption was measured at the wavelength of 510 nm and the reads were calibrated on the standard curve of the standard catechin solution as described by (53) and then the average was calculated.

RESULTS AND DISCUSSION

First: growth traits:

Results in Table 1. illustrate that spraying watercress plants with extracts of marine algae and yeast and the interaction between these two factors significantly impacted the growth parameter in both mows. The plants treated with the concentration of 6ml.L^{-1} of algae extract recorded an increase in the plant height in the first mow, number of leaves, leaf area, fresh weight, and dry weight in the second mow (50.78 cm, 59.46 leaves.plant^{-1}, 115.6, 252.03g, and 106.5g, respectively). This increases could be due to the nourishment influence of the marine algae for their content of micro and macronutrients, leading to an increase in the element absorption and the roots and stem capability to grow, in addition to most other traits (30). The results are consistent with the research of Salama et al. (41), which concluded that spraying seaweeds onto the shoot system significantly enhanced the vegetative growth traits. Plants treated with the yeast extract at the concentration of 4mg.L^{-1} in the first mow recorded an increase in the plant height, number of leaves, leaf area, fresh weight, and dry weight (47.36 cm, 55.99 leaves. Plant^{-1}, 83.89 cm2. Plant^{-1}, 231.73 g, and 95.3 g, respectively). These results are due to the fact that yeast comprises amino acids (peptides) and carbohydrates, well as is a source of B-Complex vitamins, including B1, B2, B6, and B12, and a source for plant hormones such as cytokinins, which are crucial for cell division and elongation (13, 33).

Table 1. Effect of spraying with seaweed extract and yeast extract and their interaction on vegetative growth indicators of watercress plants for the first and second mows.

	Plant height (cm)		number of leaves		leaf area $(cm)^2$		wet weight (g)		dry weight (g)	
	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
K_0	40.02	30.06	21.46	47.02	64.8	39.99	126.9	187.86	33.12	66.8
K_1	42.59	34.13	24.39	52.94	96.2	64.83	183.1	220.36	53.50	88.2
K_2	50.78	39.07	31.44	59.46	144.9	115.06	218.0	252.03	65.39	106.5
L.S.D 0.05	1.952	2.228	1.572	1.051	1.626	3.524	2.250	3.200	2.891	1.589
Y_0	41.41	31.60	22.48	49.97	88.6	60.98	157.5	208.40	45.17	77.6
Y_1	44.62	34.52	24.90	53.47	103.2	75.01	177.7	220.11	50.49	88.5
Y2	47.36	37.13	29.91	55.99	114.2	83.89	192.7	231.73	56.36	95.3
L.S.D 0.05	1.952	2.228	1.572	1.051	1.626	3.524	2.250	3.200	2.891	1.589
K_0Y_0	38.70	28.27	19.40	44.17	51.2	36.07	96.3	178.77	29.40	55.4
K_0Y_1	39.87	30.57	21.37	47.33	69.5	40.60	131.1	186.33	33.50	69.5
K_0Y_2	41.50	31.33	23.60	49.57	73.8	43.30	153.3	198.47	36.47	75.6
K_1Y_0	38.87	31.47	22.30	49.73	83.3	50.40	173.5	210.23	49.60	80.3
K_1Y_1	43.60	33.80	24.33	53.50	96.5	67.50	183.2	219.40	53.50	87.4
K_1Y_2	45.30	37.13	26.53	55.60	108.7	76.60	192.5	231.43	57.40	96.7
K_2Y_0	46.67	35.07	25.73	56.00	131.2	96.47	202.8	236.20	56.50	97.2
K_2Y_1	50.40	39.20	29.00	59.57	143.6	116.93	219.0	254.60	64.47	108.7
K_2Y_2	55.27	42.93	39.60	62.80	160.0	131.77	232.3	265.30	75.20	113.5
L.S.D 0.05	3.381	3.859	2.723	1.820	2.817	6.103	3.897	5.543	5.007	2.752
$P(T< 0.05)$	44.46	34.42	25.76	53.14	72.52	98.73	169.2	212.8	50.67	87.16

The interaction between algae extract and yeast extract produced a significant increase in the number of leaves, leaf area, and fresh and dry weights in the second mow of the watercress plants, reaching 62.80 $leaves.plant^{-1}$, 131.77 cm2, 265.30 g, and 113.5 g, respectively. Results of the same Table show that the first mow was significantly superior to the second one in the plant height, which may be due to the fact that the implemented treatment increased the photosynthesis and efficiency of the plants at the vegetative growth stage. In contrast, for the second mow, the photosynthesis processes stimulated to some extent the number of leaves, the leaf area, and the wet and dry weight of the plant, and thus, the growth rates are more than what it is in the first mow.

Second: Biochemical traits: Results in Table 2 show that the treatments of spraying with algae and yeast extracts significantly affected the leaf content of some biochemical traits for the two mows. The plants treated with algae extract at the concentration of $6ml.L^{-1}$ produced the highest percentage of carbohydrates and oil as well as the highest content of the nutrients: N, P, and K soluble

Table 2. Effect of spraying with seaweed extract and yeast extract and their interaction on some indicators of the content of watercress leaves of biochemical substances for the first and second mows.

	K		P		N		protin%		Oil %		Carbohydrates %	
	M_2	M_1	M_2	M_1	M_2	M_1	M2	M1	M_2	M_1	M_2	M_1
K_0	0.533	0.396	0.064	0.057	0.481	0.406	3.006	2.548	0.695	0.550	3.820	3.381
K_1	0.660	0.520	0.082	0.074	0.623	0.486	3.895	3.041	0.803	0.660	4.187	3.578
K_2	0.786	0.633	0.098	0.093	0.746	0.576	4.666	3.617	0.923	0.776	4.520	4.060
L.S.D 0.05	0.003	0.004	0.010	0.0004	0.001	0.003	0.011	0.020	0.004	0.003	0.158	0.148
Y_0	0.613	0.476	0.075	0.068	0.570	0.463	3.562	2.902	0.772	0.626	4.003	3.541
Y_1	0.660	0.516	0.081	0.076	0.621	0.493	3.881	3.089	0.806	0.663	4.229	3.648
Y2	0.706	0.556	0.089	0.081	0.660	0.513	4.124	3.214	0.843	0.696	4.294	3.830
L.S.D 0.05	0.003	0.004	0.010	0.0004	0.001	0.003	0.011	0.020	0.004	0.003	0.158	0.148
K_0Y_0	0.480	0.360	0.059	0.052	0.430	0.380	2.687	2.395	0.666	0.520	3.750	3.323
K_0Y_1	0.530	0.400	0.064	0.058	0.483	0.410	3.020	2.562	0.690	0.550	3.820	3.390
K_0Y_2	0.590	0.430	0.071	0.063	0.530	0.430	3.312	2.687	0.730	0.580	3.890	3.430
K_1Y_0	0.620	0.480	0.076	0.070	0.580	0.460	3.625	2.875	0.760	0.630	3.950	3.503
K_1Y_1	0.660	0.520	0.083	0.075	0.630	0.490	3.937	3.062	0.800	0.660	4.380	3.590
K_1Y_2	0.700	0.560	0.088	0.079	0.660	0.510	4.125	3.187	0.850	0.690	4.230	3.640
K_2Y_0	0.740	0.590	0.090	0.083	0.700	0.550	4.375	3.437	0.890	0.730	4.310	3.797
K_2Y_1	0.790	0.630	0.098	0.095	0.750	0.580	4.687	3.645	0.930	0.780	4.487	3.963
K_2Y_2	0.830	0.680	0.010	0.102	0.790	0.600	4.937	3.770	0.950	0.820	4.763	4.420
L.S.D 0.05	0.006	0.006	0.018	0.0006	0.003	0.005	0.020	0.035	0.007	0.006	0.274	0.256
P(T< 0.05)	0.6611	0.5181	0.0769	0.0753	0.617	0.4911	3.856	3.069	0.663	0.807	4.184	3.673

in the leaves (4.520%, 0.923%, 0.746, 0.098, and 0.7867). The reason behind this increase may be due to its act as fertilizer besides other roles represented by hormone and semi-hormone effects, which are the primary active bio-inducers in plants, including sterols, polyamines, Cytokinins, Gibberellins, Auxins, and Abscisic acid (6, 7, 18). The plants treated with the yeast extract achieved the highest percentage averages of increases in the leaves' soluble carbohydrate, oil, and nutrients, recording 4.294%, 0.843%, 0.660, 0.089, and 0.706, respectively. This increment could be due to the yeast content of amino acids, peptides as well as it is an excellent source of B-complex vitamins (B1, B2, B6, and B12), carbohydrates, and plant hormones such as Cytokinins essential for cell division and elongation (13, 33). The treatments of the interaction between the algae extract, and yeast extract produced the highest increase in percentage of N, P, and K and the percentage of soluble carbohydrates and oil in the leaves (4.763%, 0.950%, 0.790, 0.010, and 0.830, respectively). The Table also demonstrates that the second mow was significantly superior to the first in all the traits above, which may be attributed to the fact that these traits are the outcome of growth traits and a reflection of them (31, 45). Statistical analysis results listed in Table 3. show that the plants treated with the algae extract at the concentration of 6ml.L^{-1} produced the highest increase in the leaves' content of Glucosinolate, total Glucosinolates, phenolics, and total flavonoids (11.653 PPM, 2.777 µmol/g, 235.8 g / mg, and 141.31 g / mg).

Table 3. Effect of spraying with seaweed extract and yeast extract and their interaction on some indicators of watercress leaves regarding the biochemical substances of the first and second mows

	T.phlaphenods (mg / g)		T.Phenolic compounds (mg / g)		T.Glucosinolates (µmol/g))		Glucosinolates (ppm)	
	M_2	M_1	M2	M1	M_2	M_1	M_2	M_1
K_0	116.11	97.76	208.83	190.92	2.053	1.362	9.913	9.047
K_1	126.80	108.66	224.94	197.96	2.317	1.683	10.677	9.470
K_2	141.31	122.29	235.89	212.51	2.777	2.151	11.653	10.190
L.S.D 0.05	4.628	1.854	3.875	0.4461	0.1501	0.0915	0.0865	0.1830
Y_0	123.06	105.37	217.71	196.61	2.180	1.570	10.523	9.257
Y_1	127.91	109.00	224.28	200.13	2.393	1.766	10.750	9.613
Y2	133.26	114.33	227.68	204.64	2.573	1.861	10.970	9.837
L.S.D 0.05	4.628	1.854	3.875	0.4461	0.1501	0.0915	0.0865	0.1830
K_0Y_0	111.37	95.23	201.40	188.60	1.740	1.250	9.650	8.590
K_0Y_1	116.43	97.50	209.63	190.53	2.130	1.357	9.870	9.140
K_0Y_2	120.53	100.53	215.47	193.63	2.290	1.480	10.220	9.410
K_1Y_0	123.30	104.37	220.40	195.77	2.200	1.580	10.450	9.300
K_1Y_1	127.53	108.77	225.73	197.63	2.270	1.690	10.690	9.450
K_1Y_2	129.57	112.83	228.70	200.47	2.480	1.780	10.890	9.660
K_2Y_0	134.50	116.50	231.33	205.47	2.600	1.880	11.470	9.880
K_2Y_1	139.77	120.73	237.47	212.23	2.780	2.250	11.690	10.250
K_2Y_2	149.67	129.63	238.87	219.83	2.950	2.323	11.800	10.440
L.S.D 0.05	8.016	3.212	6.712	0.7726	0.2601	0.1585	0.1499	0.3170
P(T< 0.05)	109.6	106.6	223.2	200.5	2.382	1.732	10.75	9.57

This increase may be due to the algae extract role in increasing the plant content of carbohydrates and nitrogen (27). The rise in the percentage of carbohydrates, mainly glucose, helps to increase the production of Glucosinolates since glucose contributes to the biosynthesis of Glucosinolates molecule as a form of Uridine Glucose Diphosphate (52). The plants treated with yeast extract at the concentration of 4mg-1 achieved the highest increase in the leaves' content of Glucosinolate, total Glucosinolates, phenolics, and total flavonoids (10.97 ppm, 2.573 µmol/g, 227.6 g/mg, 133.26g/mg). The increase is because the extract of the dry bread yeast is a natural source of cytokinins responsible for stimulating cell division and elongation as well as synthesizing protein and nucleic acids and chlorophyll construction (10, 23), resulting in increasing the photosynthesis effectiveness and products and thus increasing the production of the Metabolism Secondary Compounds accompanying the production of primary compounds (9). The treatments of the interaction between the algae extract and the yeast extract produced the highest percentages if the increase in the leaves' content of Glucosinolate (fig 2) , total Glucosinolates, phenolics, and total flavonoids (11.800 ppm, 2.950 µmol/g, 238.87 g/mg, 149.67 g/mg). The same table shows that the second mow was significantly (47, 51). Those results are in line with the results of (13) superior to the first mow in all the traits above, which may be due to the mowing being one of the environmental stresses that increases the photosynthetic secondary products as a means of plant defense against stress the plant subjected to, or it is because the flowering stage that plants pass through in which plants need to increase the secondary compounds rate (26). These results are agreed with (42)

Conclusions

Based on the experiment, it could be concluded that spraying the watercress plants (local variety) with algae extract and yeast extract, individually and interacted, significantly affects the traits of growth and biochemical content in the leaves, leading to an increase in the productivity of leaves per unit area

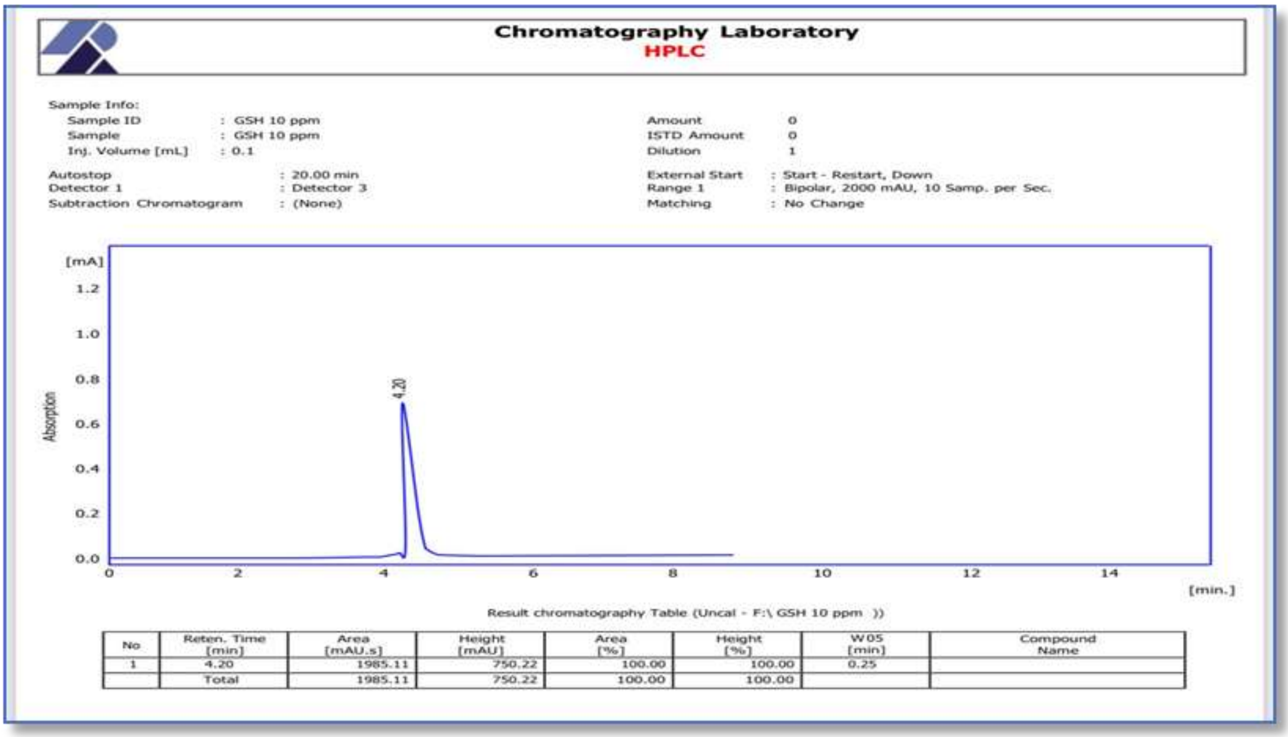

Fig 1. Standard curve of a compound Glucosinolates

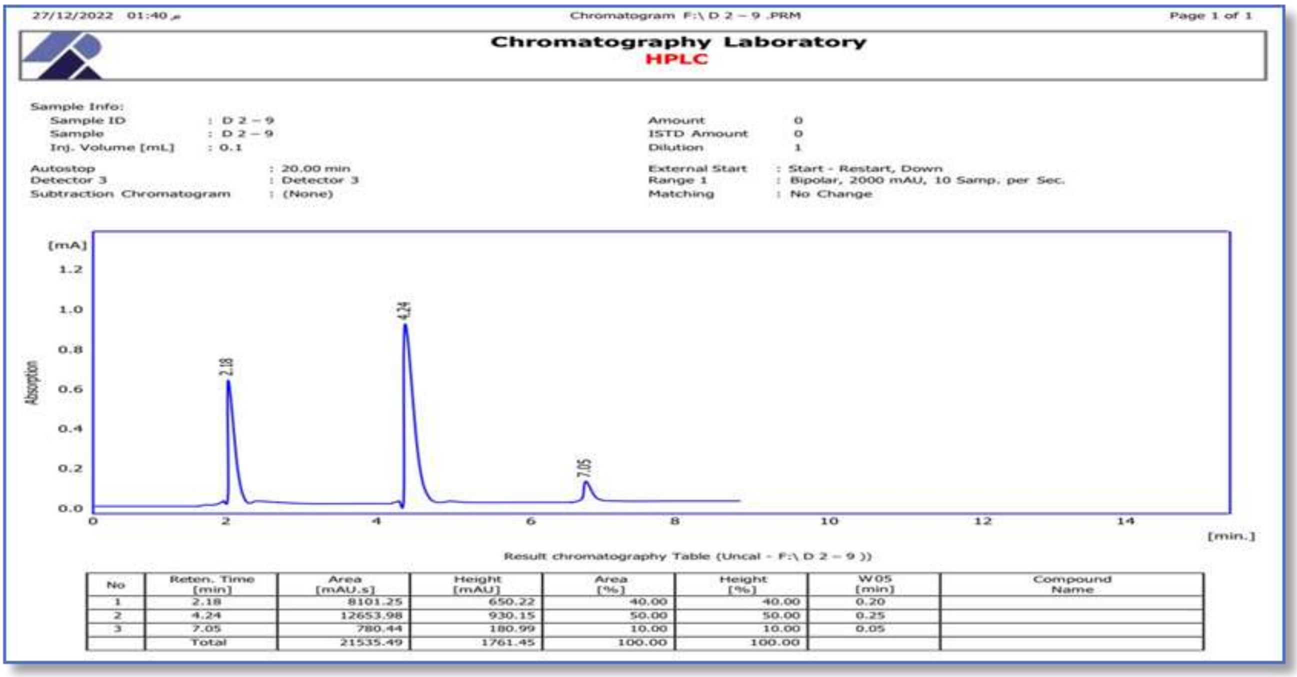

Fig 2. best form of interaction treatment is (algae extract + yeast extract and harvest date).

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