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ORIGINAL ARTICLE

THE EFFECT OF IRRIGATION WITH DIFFERENT CONCENTRATIONS OF ALGAZONE ON THE CHEMICAL PROPERTIES OF TWO OKRA CULTIVARS (*ABELMOSCHUS ESCLENTUS* L.) CULTIVATED IN GREENHOUSES

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Abstract: The study was conducted during the 2019-2020 agricultural season in an unheated greenhouse in one of the private farms of Al-Faris Agricultural Company located in Al-Zubair district, southwest of the Basra region, to study the effect of watering with different concentrations of Algazone and the number of watering times on the chemical characteristics of two varieties of the local okra plant. Khunayri and Pateerah the experiment included 54 treatments, which are possible combinations between three concentrations of algae extract (8,4,0) ml / 1 liter with a rate of watering (4, 3, 2) times during the period of the experiment for two varieties of okra plant, which was carried out as a split factor experiment for two times. The plot design was based on Randomized complete block design with three replications. The results showed the excelled of the peter variety with regard to the total chlorophyll leaf content and the percentage of both phosphorous and potassium, as the study showed that the treatment of the number of waterings, especially the watering, was excelled to three and four times for all chemical characteristics, and the treatment of extract concentration exceeded all the studied traits, especially the concentration (8,4), (Ml/1 liter with regard to the leaves content of total chlorophyll and dissolved carbohydrates, the percentage of phosphorous and nitrogen, and the concentration of 8 ml/1 in terms of the percentage of the element nitrogen, as for the binary interference, it was significant for some of the studied. The triple interaction between the experiment factors also showed a significant effect, especially with regard to the percentage of nitrogen and potassium elements.

***Key words*:** Seaweed Extract, Chlorophyll, Carbohydrates, Okra.

Cite this article

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1. Introduction

The Okra (*Abelmoschus esculentus* L.) to the Abkhaz family a major summer crop in Iraq, is believed to be the home of the region comprising Central Africa, Ethiopia, Eritrea, Sudan, Egypt and from there it has moved to the Mediterranean basin, the Arabian Peninsula and India. Okra is a vast, participatory Iraq, where it is planted in all regions of the country for the purpose of obtaining centuries eaten after cooking or using. Its nutritional importance is frozen and contains carbohydrate, protein, fiber, fat, and mineral salts such as calcium, iron, and vitamins such as vitamin A, B_1, B_2 [Okoli *et al.* (2015)]. The medical importance of the primia rings and their use in treating many diseases are rich with many materials with important effects in human health is A, B, C and folic acid B_9 is used to treat anemia and general debility. The production of okra per unit area in Iraq in 2014 amounted to 123583 tons, with a production rate of 7.40 tons.Ha^{-1}, 11.91 tons.Ha^{-1} and 11.62 tons. Ha^{-1}, respectively [FAO (2014)], among other things, this may be due to the deterioration of operations service and non-use of modern techniques in producing this crop and choice the right item for soil and climate conditions. Gangashetty *et al.* (2010)

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showed that the environment and the genetic material of the cultivated okra variety greatly affected the yield and its quality. Okra cultivars in many phenotypic and physiological characteristics and their ability to adapt in the areas in which they grow. Therefore, choosing the appropriate variety in its production area is one of the most important characteristics required for both the breeder and producer.

The use of organic nutrients is gaining great attention at the present time due to the increase in health and nutritional awareness and scientific progress in agricultural scientific research, and the results of scientific studies and research indicate the many benefits that can be obtained by using fertilizers and organic nutrients as alternatives to chemical fertilizers, whether for soil or plants [Kok *et al.* (2010)].

The use of organic fertilizers in the form of seaweed extracts is a recent application to achieve sustainable agriculture as well as stimulate plant growth. Seaweed is a new generation of natural organic fertilizers that contain highly effective nutrients and liquid fertilizer extracted from seaweed is an effective environmentally friendly fertilizer in increasing the growth and yield of many crops and preserving natural resources. Seaweed extracts are an integral part of organic farming because its diverse usefulness in the fields of agriculture including nutrient management and crop growth [Baliah *et al.* (2017)]. More than 31 million tons of them are used annually in the agricultural field in various parts of the world, and they are non-fertilizer materials that stimulate plant growth in low concentrations and contain major and minor nutrients and contain more than one group of growth-promoting substances such as cytokinins, Auxins, vitamins, amino acids, organic and compounds similar to oxins and multiple sugars such as laminaran, fucoidan, and alginate, which have a wide range in their influence on vital activities in the plant [Rioux *et al.* (2007)]. The extracts increase plant resistance to salinity and drought. Numerous studies have been conducted on the effect of seaweed extracts on the growth and productivity of horticultural plants, and the results differed according to the type of seaweed, the method of extraction, the concentration used, the method of addition, its time, the number of times of application, the type of plant and its growth stage. Olaniyi *et al.* (2010) noted that the use of 4 tonsHa^{-1} organic matter for okra plants had a significant effect in increasing the fruit content of nitrogen and chlorophyll compared to the comparison treatment.

In view of the lack of a study on the use of locally produced seaweed extract (Algazon) irrigation and the use of varieties characterized by a high level of production due to the difference in quality between the varieties among them. So this study was prepared to find out its reflection in improving the chemical properties of two varieties of the local okra plant grown in greenhouses in Desert areas in southern Iraq.

2. Materials and Methods

The study was conducted during the 2019 agricultural season in an unheated greenhouse with dimensions of 9x50 m in one of the private farms of the Al-Faris Agricultural Company located in Al-Zubair district, southwest of the Basra region, located at latitude 7°15'15" north and longitude 52° 42' 47" west in Alluvial clay soil was analyzed before planting the greenhouse soil by taking random samples from different places with a depth of 0-30 cm. Table 1 shows some of the physical and chemical characteristics of soil. The land of the greenhouse was plowed twice, perpendicular to a depth of 30 cm, then the soil was smoothed and flattened, and then divided into 6 lines of length 9 m and a width of 0.5 and a distance of 1.2 m between one line and another, with a distance of 1.25 between each side of the house, and the land was fertilized with dissolved organic fertilizer by 0.45 **m 2** for the house, equivalent to 5 m 3 per acre. Then a 5G Radwell pesticide was added at a rate of 3 kg. Dunum, then each line was divided into 9 experimental units with a length of 5 m for each experimental unit, and a distance of 2.5 m was left at the entrance and end of each line. The drip irrigation system was used to irrigate the plants and the planting lines were covered with black plastic. The transactions were distributed randomly to the experimental units, where the experiment was designed according to the Randomized Complete Block Design (RCBD) as a split factor experiment twice as a split plot design where the varieties represent the main factor, the number of watering orders, the secondary factor, and the concentrations of the organic extract, the sub-factor. The seeds of the two local varieties of okra plant, Al-Batira and Al-Khunaisriya, were planted under the supervision of the Director of Basra Agriculture on 1/1/2020, and the soil of the greenhouse was moistened two days before planting by the drip irrigation system. Between each seed and another after germination, the plants were reduced by leaving one plant in each hollow.

Table 1: Some physical and chemical properties of soil and water for the growing season 2019-2020.

Type of analysis	Measuring unit	The value	Source
EC	$ds.m^{-1}$	2.12	Page et al (1982)
pH	–	7.80	
Total nitrogen	$g.kg^{-1}$	20.2	
Ready phosphorous	$g.kg^{-1}$	0.015	
Ready Potassium	g.kg-1	1.15	
Organic matter	%	0.63	
The proportion of clay	%	45.13	Black, 1965
Silt ratio	%	42.6	
Sand ratio	%	12.21	
Soil tissue	–	Silty clay	
Humidity at field capacity	%	30.13	
Irrigation water characteristics			
EC		0.50	Page *et al.* (1982)
pH		8.20	

All agricultural operations used in the production of this crop were carried out in greenhouses. Then start spraying the plants with the first spray of Algazone twenty days after planting. Table 2 shows the components of the seaweed extract of Algazone. The plants were sprayed with the second spray 15 days after the first spray, the third spray 15 days after the second spray and the fourth spray 15 days after the third spray. The structure of the plastic house was covered with transparent white plastic for the winter agricultural season on 1/1/2020 and raised on 1/4/2020, after which the house was covered with a green canopy (Saran). The start of harvesting the crop 3/15/2020 and the reaping ended on 1/7/2020. The results were analyzed using analysis of variance and the least significant difference test (L.S.D) was chosen to compare the averages with equal probability (0.05) [Al-Rawi and Khalaf Allah (1980)].

The analysis took place in the Central Laboratory, College of Agriculture, University of Basra, Iraq.

2.1 Experimental measurements

Leaf content of total chlorophyll (mg100 g^{-1} fresh $weight^{-1}$) are

1. The total chlorophyll stain was estimated in the leaves according to the method of Zeahringer *et al.* (1974).
2. Leaf content of total dissolved carbohydrates (mg 100g^{-1} dry weight).

It was estimated by the modified phenol-sulfuric acid method previously described [Dubois *et al.* (1956)].

3. Nitrogen concentration in leaves (%): 0.2g of the dry leaves were taken and digested according to Cresser and parsons (1979). The amount of nitrogen in the digested samples using a microkjeldhal device as described by Page *et al.* (1982) was estimated.
4. Phosphorus concentration in leaves (%): The phosphorus was estimated using ammonium molybdate and ammonium vanadate, the color intensity of the solution was measured by a spectrometer at a wavelength of 470 nm according to the method of Murphy and Riley (1962).
5. Potassium concentration in leaves(%): The potassium was measured in the digested paper samples using a flame photometer, according to Page *et al.* (1982).

3. Results and Discussion

3.1 Effect of seaweed extract, number of watering times, variety, and the interaction between them on leaf content of total chlorophyll (mg 100 g^{-1} soft weight)

Table 2: The content of the seaweed extract Algzon.

The ingredients	The value
Natural compounds	30%
*K*20	43
Natural growth stimulants (Auxins, gibberellins, cytokinins)	20%
Natural growth stimulants (Auxins, gibberellins, cytokinins)	5%
Amino acids	2%

Table 3: Effect of seaweed extract, number of watering times, variety, and the interaction between them on leaf content of total chlorophyll (mg 100 g $^{-1}$ soft weight).

Seaweed Extract (C)	The number of Watering (N)	Varieties (V)		C*N
		Peter	Khnasiri	
0 ml/L	2	36.59	39.28	37.93
	3	35.78	39.21	37.50
	4	38.93	42.69	40.81
4 ml/L	2	42.69	46.98	44.83
	3	44.92	48.73	46.82
	4	46.90	53.52	50.21
8 ml/L	2	59.73	61.38	60.55
	3	60.62	64.17	62.39
	4	61.37	67.25	64.31
L.S.D(0.05)		n.s.		n.s
Item impact rat		47.50	51.47	
L.S.D.(0.05)		1.84		
				Extract Concentration Rate
C*v	0 ml/L	37.10	40.39	38.75
	4 ml/L	44.83	49.74	47.29
	8 ml/L	60.57	64.27	62.42
L.S.D (0.05)		n.s.		1.24

Table 4: Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total dissolved carbohydrates (mg 100 g $^{-1}$ dry weight).

Seaweed Extract (C)	The number of Watering (N)	Varieties (V)		C*N
		Peter	Khnasiri	
0 ml/L	2	193.8	221.6	207.7
	3	231.2	249.0	240.0
	4	244.0	258.9	251.5
4 ml/L	2	279.8	279.4	279.6
	3	300.0	314.6	307.3
	4	313.7	319.4	316.5
8 ml/L	2	340.3	362.9	351.6
	3	367.1	373.9	370.5
	4	472.8	476.1	474.4
L.S.D(0.05)				13.17
Item impact rat		304.7	317.3	
L.S.D.(0.05)		n.s.		
				Extract Concentration Rate
C*V	ml/L0	223.0	243.2	233.1
	ml/L4	297.8	304.5	301.2
	ml/L8	393.4	404.3	398.9
L.S.D (0.05)				8.88
				The number of watering (N)
N*V	2	207.7	240.1	279.8
	3	279.6	307.3	306.0
	4	351.6	370.5	347.5
L.S.D (0.05)		n.s		6.60

Table 3 shows the existence of a significant effect of the variety on the leaf content of total chlorophyll, as the variety was significantly excelled to the kenis, with an increase of 36.8%.

The same table also shows that the number of waterings with Algzon extract had a significant effect in this aspect, as the total chlorophyll content in the leaves of the plants that were sprayed increased four times, and an increase of 39.8% compared to the plants that were watered twice or three. It is also evident from the table that the irrigation with Algzon extract had a significant effect in this characteristic, especially at levels 4 and 8 ml/liter, with an increase of (04.22%) and (08.61%) compared to the comparison treatment, respectively

The table also shows that all the binary interference were not significant for this characteristic.

As for the triple interference that shows the factors of the experience, it was not significant in this characteristic.

3.2 Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total dissolved carbohydrates (mg 100 g^{-1} dry weight)

It is evident from Table 4 that the variety has no significant effect on the leaf content of total dissolved carbohydrates.The same table also shows that the number of watering with Algzon extract had a significant effect on this characteristic, as the plants that were watered outperformed three and four times, with an increase of (44.9%) and (56.13%) compared to the plants that were sprayed twice. It is also clear from the same table that the irrigation with Algzon extract had a significant effect on this pigment, especially at levels 4 and 8 ml/liter, with an increase of (21.29%) and (13.17%) compared to the comparison treatment. It is also clear from the table that the bi-interaction between the concentration of the extract and the number of watering times showed a significant effect in this characteristic, if the plants that were irrigated with algae extract were given at a level of 8 ml/liter at a rate of 4 times the highest values, reaching 474.4 mg (100 gm^{-1}). As for the triple interaction between the experiment factors, it was not significant.

3.3 Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total nitrogen (%)

It is evident from Table 5 that the cultivar has no significant effect on the leaves' total nitrogen content. The table also shows that the number of watering's with Algzon extract had a significant effect on this characteristic, as the plants that were watered with the extract outperformed at a rate of 4 times and an increase of 8.49% compared to the plants that were watered two or three times.

The same table also shows that the irrigation with Algzon extract had a significant effect on this trait, as it outperformed the plants that were watered at a level of 4, 8 ml/liter with an increase of 38.5% and 54.73% compared to the comparison treatment.

The table also shows that the bi- interaction shows the concentration of the extract and the number of watering times was also significant, as the plants that were watered with the extract outperformed with the level of 8 ml/liter at a rate of 4 times, as this treatment gave the highest percentage of nitrogen in the leaves, reaching (4.65%)

The bi-interaction between the cultivar and the concentration also showed a significant effect, as the plants of the cultivar which were irrigated with the extract at the level of 8 ml/liter gave the highest percentage of nitrogen in the leaves, reaching (4.61%).

The bi-interaction between the variety and the number of watering times was also significant, as the plants of the variety, which were watered four times, gave the highest percentage of nitrogen in the leaves, reaching (4.24%). As for the triple interaction between the experimental factors, it was significant. As the plants of the ragweed variety, which were irrigated with algae extract at a level of 8 ml/1 liter, outperformed 4 times, it gave the highest value of the nitrogen percentage, reaching (4.66%).

3.4 Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total phosphorous (%)

Table 6 shows the existence of a significant effect of the variety on the total phosphorus content of leaves, as the Khenisari variety excelled the variety with a rate of increase of 20.59%. The same table also shows that the number of waterings with the extract has a significant effect on this traits, as the plants that were watered outperformed at a rate of three or four times with an

Table 5: Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total nitrogen (%).

Seaweed Extract (C)	The number of Watering (N)	Varieties (V)		C*N
		Peter	Khnasiri	
0 ml/L	2	2.28	2.29	2.28
	3	2.32	2.86	2.59
	4	3.55	4.45	4.00
4 ml/L	2	3.63	3.62	3.63
	3	4.63	3.66	4.14
	4	4.50	4.58	4.54
8 ml/L	2	4.45	4.54	4.49
	3	4.50	4.65	4.58
	4	4.65	4.66	4.65
L.S.D(0.05)		0.25		0.16
Item impact rat		3.84	3.92	
L.S.D.(0.05)		n.s.		
				Extract Concentration Rate
C*V	0 ml/L	2.72	3.20	2.96
	4 ml/L	4.25	3.96	4.10
	8 ml/L	4.54	4.61	4.58
L.S.D (0.05)				0.09
				The number of watering (N)
N*V	2	3.74	3.81	3.77
	3	3.82	3.72	3.77
	4	3.95	4.24	4.09
L.S.D (0.05)		0.19		

increase of (6.60%) and (33.33%) compared to the plants that were watered twice and in succession, as it is clear from the table that watering Algzon seaweed extract had a significant effect on this characteristic, as it excelled the plants that were watered at levels of 4 and 8 ml/1 liter, with an increase of 54.17% and 112.5% compared to the comparison treatment and the higher, respectively.

The table also shows that the bi-interaction between the concentration of the extract and the number of watering times was significant, as it gave the plants that were watered with the extract at a level of 8 ml/1 liter, which were irrigated with the extract with a disadvantage of 8 ml/1 liter, which was irrigated at a rate of 4 times, as this treatment gave the highest percentage of phosphorus which reached (0. 63)%.

The other bi-interaction also showed non-significant interaction, as for the triple interaction between the experiment factors, it was not significant

3.5 Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total potassium (%)

Table 7 shows that the variety has a significant effect on the total potassium content of the leaves, as the Khenisari variety excelled the variety with an increase rate of (51.81%). The same table also shows that the average number of waterings with Algzon extract was significant in this characteristic, as it excelled plants that were watered at a rate of three times, with an increase of (11.66%) and (27.35%) on decay. The table also shows that watering with marine algae extract had a significant effect in this characteristic, as the plants that were watered with the extract excelled (4) and (8) ml/L water, with an increase of (11.76%) and (58.82%) compared to the comparison treatment

The table also shows that the bi-interaction shows the concentration of the extract and the number of watering times was significant, as the plants that were watered with the extract at the level of 8 ml/ liter, which were watered at a rate of 4 times, gave the highest values of the percentage of potassium in the leaves,

Table 6: Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total phosphorous (%).

Seaweed Extract (C)	The number of Watering (N)	Varieties (V)		C*N
		Peter	Khnasiri	
0 ml/L	2	0.19	0.22	0.21
	3	0.20	0.27	0.24
	4	0.22	0.33	0.27
4 ml/L	2	0.32	0.36	0.34
	3	0.33	0.38	0.35
	4	0.39	0.46	0.42
8 ml/L	2	0.41	0.47	0.44
	3	0.43	0.49	0.46
	4	0.58	0.68	0.63
L.S.D(0.05)		n.s.		0.03
Item impact rat		0.34	0.41	
L.S.D.(0.05)		0.03		
				Extract Concentration Rate
C*V	0 ml/L	0.20	0.27	0.24
	4 ml/L	0.34	0.40	0.37
	8 ml/L	0.47	0.54	0.51
L.S.D (0.05)				0.01
				The number of watering (N)
N*V	2	0.30	0.35	0.33
	3	0.32	0.38	0.35
	4	0.40	0.49	0.44
L.S.D (0.05)		n.s.		0.02

which reached 3.54%.

Also, the bi-interaction between the variety and the concentration of the extract was significant, as the plants of the variety, which were watered with a level of 8 ml/L water, gave the highest content of the percentage of potassium in the leaves, which reached (3.34%).

As for the bi-interaction between the variety and the number of watering times, it was not significant, as for the triple interaction between the experimental factors, it was a significant interaction, as the plants of the variety gave rosacea, which was irrigated with algae extract at a level of 8 ml/liter at a rate of four times higher than the percentage of potassium in the leaves, reaching 3.56%

It is evident from the results of Tables 5, 6, 7 that the varietal supremacy of the variety with a frequency in leaf content of the percentage (*N*, *P*, *K*) that these differences between the varieties are due to the genetic difference between them and their role in controlling the nature of growth and the content of nutrients. Addition of the different enzymatic components of both types related to protein metabolism and thus their internal components, which are among their content of elements. As shown in Tables 3, 4, 5, 6, 7, the watering with seaweed extract had a significant effect on the leaf content of total chlorophyll and carbohydrates and the percentage of elements *N*, *P*, *K*

The positive role of seaweed extract in increasing the total chlorophyll content in the leaves is due to the fact that the extract contains auxins and cytokinins that encourage physiological activities and thus increase total chlorophyll. Also, increase in the leaf's total chlorophyll content (Table 3) increases the efficiency of the carbon representation process, which leads to the increase of nutrients in the plant and their accumulation, including carbohydrates [Frimpong *et al.* (2017)], and this is consistent with what is found by Al-Kaabi (2020).

Also, an increase in the total chlorophyll content of leaves (Table 4) leads to an increase in nitrogen levels, which in turn increases nitrogen accumulation in the plant. Nitrogen works to increase the speed of absorption and the transfer of the rest of the elements

Table 7: Effect of seaweed extract, number of watering times, variety, and the interaction between them in leaf content of total potassium (%).

Seaweed Extract (C)	The number of Watering (N)	Varieties (V)		C*N
		Peter	Khnasiri	
0 ml/L	2	1.35	1.37	1.36
	3	1.37	2.51	1.94
	4	2.46	3.21	2.84
4 ml/L	2	3.27	3.32	3.30
	3	1.38	1.38	1.38
	4	1.79	2.52	2.15
8 ml/L	2	2.58	3.07	2.82
	3	3.33	3.40	3.37
	4	3.52	3.56	3.54
L.S.D(0.05)		0.30		0.21
Item impact rat		2.34	2.71	
L.S.D.(0.05)		0.23		
				Extract Concentration Rate
C*V	0 ml/L	1.73	2.36	2.04
	4 ml/L	2.15	2.41	2.28
	8 ml/L	3.14	3.34	3.24
L.S.D (0.05)		0.19		0.12
				The number of watering (N)
N*V	2	2.40	2.59	2.49
	3	2.03	2.43	2.23
	4	2.59	3.10	2.84
L.S.D (0.05)		n.s.		0.14

by entering the composition of the chlorophyll pigment and then increasing the process of carbonate representation and building proteins and this process is important in stimulating plant growth and reaching a good nutritional state and thus increasing the efficiency of the plant in the absorption and accumulation of elements in the leaves, including phosphorus and potassium [Olaniyi *et al.* (2010)]. Also, the organic matter present in the extract prevents the precipitation of phosphorus and adsorption on the exchange sites, which increases the liberation of phosphorous on the surfaces of colloids and absorption by the roots and increases the concentration in the leaves [Abdel Razzak and EL-Sharkawy (2013)] and these results are in agreement with what Al-Akayishi (2017) found on okra plant.

4. Conclusions

1. The study showed the significant excelled of the Khenisari variety over some of the chemical properties of the leaves.
2. Irrigation with algae extract showed significant effect on all chemical properties of leaves, especially at level 4 and 8 ml/liter.
3. Significant excelled of the average number of waterings with the extract, as the plants that were watered outperformed three and four times in all the chemical properties of the leaves.

Recommendations

1. Khenisiyah variety is recommended for cover planting in the southern region.
2. It is recommended to use algae extract at a concentration of 4 and 8 ml/liter.
3. We recommend watering with algae extract at a rate of three or four times.
4. Conducting more studies on other varieties and comparing them to obtain the best suitable varieties for the southern region

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