

EFFECT OF FOLIAR APPLICATION OF MAXI-GROW AND POTASSIUM ON GROWTH, YIELD AND NUTRIENT CONTENT OF LETTUCE (*LACTUCA SATIVA L.*) UNDER PLASTIC HOUSE CONDITION.

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ABSTRACT

The research was carried out in a plastic house at the Malta station research farm in Duhok, Kurdistan region/ Iraq. In the autumn 2019 growing season to study the influence of foliar spraying by seaweed extract (Max grow) with concentrations of (0, 3, 6, and 9 mL.L⁻¹) and potassium (0, 1.5 and 3 g.L⁻¹) on lettuce teresa on vegetative growth, yield and its chemical content in leaves. The application of seaweed extract and potassium was done 10 days after transplanting and repeated 3 times in interval 10 days. Result should that seaweed extract significantly increased (head weight, head diameter, leaf width, dry weight, N,P,K and Yields). Also, potassium gave the highest value and significantly increased head diameter, leaf width, dry weight, Ca concentration. However, the interactions between two factors significantly increased all the parameters where studied compared with control.

KEY WORD: Lettuce, seaweed, potassium

INTRODUCTION

Lettuce (*Lactuca sativa*) is a member of Asteraceae (composite) family rich in vitamin, mineral element, phenol constituent (Kim *et al.*, 2016). The production of lettuce in Iraq 37809 ton, the area of lettuce and chicory in Iraq 41143 ha. In 2021 (Word, data, atlas, topics, agriculture, production).

Seaweeds are a composite mix of hormones, amino acids, proteins, sugars, lipids, vitamins, humic materials, and phenolic mixtures (Crouch and van Staden 1994). The * *biological structures of seaweed and their physical properties had directed to their extensive practice in the nutriment and medicinal productions (Battacharyya *et al.*, 2015) (Battacharyya, D.; Babgohari, M.Z.; Rathor, P.; Prithiviraj, B 2015) Also, seaweed holds carbohydrates, biological combinations, and great quantities of nitrogen, phosphorus, potassium, and extra minerals that recover soil properties and are simply absorbed through the plants. So, those abstracts increase plant development and the antioxidants take through stimulating the respiratory cycle, photosynthesis, and suspending plant aged (Turkamen, 2019). . Di Mola *et al* (2019). Di Mola *et al* 2019. Reported that seaweed improved the growing and produce in lettuce.

The positively effect of seaweed extract presentation is the effect of numerous mechanisms that may work synergistically at diverse meditations, although the method of achievement motionless remnants unidentified (Fornes *et al.*, 2002). But, presentation of seaweed extract improved chlorophyll satisfied (Thirumaran *et al.*, 2009 and Turan and Kose, 2004)

Abdel Mawgoud *et al.*(2010) stated that seaweed extract at absorptions of 1, 2 and 3 g/L is required better to allow for development and yield of watermelon. The advantageous result of seaweed extract presentation is the effect of many workings that may effort synergistically at diverse absorptions,

Chrysargyris *et al.* (2018) showed that foliar spraying of seaweed extract *Ascophyllum nodosum* remarkably enhanced growing and superiority of cut lettuce.

Potassium (K) is a vital nutrient for plant growth. It's confidential as a macronutrient because plants revenue up large amounts of K throughout their life cycle. Potassium is related with the drive of water, nutrients and carbohydrates in plant tissue.

For optimal growth and yield, plants need the macronutrient potassium. It has a significant role in plant physiological and biochemical development (protein synthesis, ion absorption

and transport, photosynthesis, respiration and fighting in plants beside pests and diseases). (Pettigrew, 2008; Bukhsh and colleagues, 2010; Marschner, 2012; and Saud et al., 2013) Potassium is essential for many metabolic processes because it stimulates a large number of enzymes needed for chemical reactions. These involve the production of proteins and carbohydrates necessary for plant growth. Potassium rising the absorption of carbohydrates because of its role in nitrogen element preoccupation by the plant and changed it to proteins (Ibrahim *et al.*, 2000)

Potassium (K) is an important nutrient for improving yield of vegetable crops and its content in vegetables has substantial association with qualities [Bidari and Hebsur 2011].

Earlier studies reveal that plant development and harvest are strongly influence by different quantities of potassium fertilization (Epron et al., 2012.)

Lettuce requisites substantial amount of potassium to harvest great, high superiority leaves and heads. Because the majority of nutrients occupied up by the plant are removed with the biomass at harvest, it is vital to necessarily replace potassium levels for upcoming yields. Di Mola et al (2019). Dudaš S.; Šola, et al (2016) The central goal of this research was to raise the yield and quality of lettuce through studying the result of diverse potassium fertilization rates and foliar application by seaweed extract) and their collaboration.

MATERIALS AND METHODS

This experiment was conducted during autumn seasons of 2019 in Research station Malta Duhok Government, Kurdistan Region / Iraq, toward studying the effect of foliar spraying with max grow and potassium on growth and yield of Lettuce var. Teresa were the seeds sown in trays in 17/9/2019. Typical agricultural practices for Lettuce nurseries were agreed out. Seedlings were transplanted in

plastic house on the 15/10/2019. Drip irrigation system was used in plastic house.

A completely randomized block design (RCBD) was used in this experiment. Each experimental unit consisted of plants with three replication was used by 3 replication. The factors undertaken in this study Four levels of seaweed (0, 3, 6 and 9 ml.l⁻¹) and Three levels of potassium (0, 1.5 and 3 g.l⁻¹) (the experiment contain of 12 treatments (4*3=12)).

The first foliar spray was after 10 days from transplanting, second and third foliar spraying in interval of 10 days from each other.

For data collection ten plants were randomly selected from each experimental unit. Data were analysed by using S A S program (AL-Rawi and Khalaf Alah, 2000) Plant high, number of leaves, head weight, head diameter, leaf width, dry weight, N, P, K, Ca and Yield

EXPERIMENTAL MEASUREMENT

Plant high cm, Number of leaves, Head weight g, Leaves width, Total yield (ton/ha)

Nitrogen % , Phosphorus %, Potassium % , Calcium (%) In dry weight.

All mineral analysis were carried out at the College of Agricultural engineering Sciences University of Duhok laboratory.

RESULT

Plant height (cm)

Data presented in table (1) revealed that result illustrated no significant difference of seaweed extract. For data collection ten plants were randomly selected from each experimental unit. Best result obtained in rate of 9 ml.L⁻¹ was 38.416 cm. The effect of spraying with potassium remarked significant variance at rate of 3 g.l⁻¹ was 38.33 cm. The interaction between seaweed extract and potassium observed significant effects, best result obtained in level of 6 ml.l⁻¹ (40.500 cm) compared by (35.040 cm) with interaction between 3 ml.l⁻¹ seaweed extract and 1.5 g.L⁻¹ potassium

Table (1):- Effect of foliar application by seaweed, potassium and their interaction on on plant height (cm) of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L ⁻¹	1.5 g.L ⁻¹	3 g.L ⁻¹	
0ml.L ⁻¹	37.517 a-c	37.877 a-c	37.053 bc	37.482 a
3ml.L ⁻¹	36.720 bc	35.040 c	39.123 ab	36.961 a
6ml.L ⁻¹	40.500 a	35.040 c	37.333 a-c	37.624 a
9ml.L ⁻¹	38.500 ab	38.123 a-c	38.623 ab	38.416 a
Potassium effect	38.309 a	36.520 b	A	

Table (2):- showed that there were no significant variance of using seaweed extract and potassium on number of leaves.plant⁻¹.

Table (2):- Effect of foliar application by seaweed , potassium and their interaction on number of leaves.plant⁻¹ of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	29.202 ab	28.997 ab	28.890 ab	29.029 a
3ml.L-1	29.220 ab	29.130 ab	29.607 ab	29.319 a
6ml.L-1	28.261 b	28.430 ab	29.240 ab	28.644 a
9ml.L-1	28.797 ab	30.230 ab	30.707 a	29.911 a
Potassium effect	28.870 a	29.197 a	A	

Regarding the interaction between seaweed extract and potassium, a substantial difference was remarked, at level of 9ml.L⁻¹ seaweed and 3g.L⁻¹ potassium (30.707) compared with level of 6 ml.L⁻¹ seaweed and zero potassium which was (28.261).

Head weight (kg)

Table (3) indicated that the seaweed extract significant affected lettuce weight, at 9 ml.L⁻¹ seaweed extract gave the highest value (1.292 kg), compared with control 1.023kg.

Table (3) :-Effect of foliar application by seaweed , potassium and their interaction on head weight (kg) of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	1.023 d	1.049 cd	1.039 cd	1.037 c
3ml.L-1	1.183 b-d	1.228 b	1.154 b-d	1.188 b
6ml.L-1	1.128 b-d	1.223 b	1.189 bc	1.180 b
9ml.L-1	1.199 bc	1.272 ab	1.405 a	1.292 a
Potassium effect	1.133 a	1.193 a	A	

For the effect of potassium there were no significant effect on the head weight, supra lettuce heads weight, in rate of 3g.L⁻¹ was superior 1.197 kg compared with control 1.133kg not treated with potassium.

Concerning the interaction between application of seaweed extract and potassium was significant, the best interaction was between 9ml.L⁻¹ seaweed extract and 3g.L⁻¹ potassium which gave the highest value (1.405 kg) compared with control 1.023 kg.

Head diameter (cm):

Table (4) observed that seaweed significantly affected on the supra head , 9ml.L⁻¹ Seaweed

extract which was 21.428 cm compared by 0ml.L⁻¹ treatment 17.752 cm. Using the potassium application significantly increased head diameter, the maximum value (20.078 cm) was observed with 3 g.L⁻¹ potassium compared with no potassium 18.498 cm.

The interaction between foliar application with seaweed and potassium on head weight, the best interact noticed between 9ml.L⁻¹ and rate 3g.L⁻¹ was 22.613 cm. compared with 17.557 cm at level of 6ml.L⁻¹ without treatment of potassium

Table (4):- Effect of foliar application by seaweed extract, potassium and their interaction on head diameter(cm) of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	17.753 cd	17.803 cd	17.160 d	17.572 d
3ml.L-1	17.843 cd	18.447 c	19.980 b	18.757 c
6ml.L-1	17.557 cd	20.360 b	20.560 b	19.492 b
9ml.L-1	20.837 b	20.833 b	22.613 a	21.428 a
Potassium effect	18.498 c	19.361 b	20.078 a	

Leaf width (cm):

Data presented in table (5) Showed that the 3 ml.l⁻¹ seaweed extract significantly increased leaf width (11.101 cm) compared with other levels. Regarding the effect of potassium, the maximum value (10.868 cm) was noticed at 3 g.l-1 potassium, while the minimum value (9.988 cm) at 0 g.l-1 potassium. compared with control 9.988 cm.

Concerning the interaction between seaweed extract and potassium, the highest value (11.173 cm) was obtained from interaction between 3ml.l⁻¹ seaweed extract and 0 g.l⁻¹ potassium, while the lowest value (9.513 cm) was obtained with the interaction between 0 ml.l⁻¹ seaweed and 0 g.l⁻¹ potassium compared with control untreated 9.513 cm.

Table (5):- Effect of foliar application by seaweed , potassium and their interaction on leaf width (cm) of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	9.513 c	11.073 a	11.140 a	10.576 ab
3ml.L-1	11.173 a	10.963 ab	11.167 a	11.101 a
6ml.L-1	9.777 bc	10.445933 a-c	10.467 a-c	10.229 b
9ml.L-1	9.490 c	10.483 a-c	10.697 a-c	10.223 b
Potassium effect	9.988 b	10.741 a	10.868 a	

Dry weight (g):

Data presented in table (6) Observed that the 9 ml.l⁻¹ of seaweed extract significantly

enhanced dry weight (19.539 g). Regarding the result of potassium, 3 g.l⁻¹ potassium gave the maximum dry weight (17.881 g).

Table (6):-Effect of foliar application by Seaweed, potassium and their interaction on dry weight (g) of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	15.491 d	16.667 cd	15.770 cd	15.976 b
3ml.L-1	16.987 cd	14.893 d	16.383 cd	16.088 b
6ml.L-1	16.090 cd	16.060 cd	18.033 bc	16.728 b
9ml.L-1	18.013 bc	19.267 b	21.337 a	19.539 a
Potassium effect	16.645 b	16.722 b	17.881 a	

Concerning the interaction between foliar application with seaweed and potassium, The interaction between 9 ml.l-1 seaweed extract and 3 g.l-1 potassium was the best interaction which gave (21.337 g)

Nitrogen %

Data in table (7) Showed that foliar spraying of 9 ml.l-1 seaweed significantly increased nitrogen percentage (1.967%) compared with another levels.

About the effect of potassium, no significant variance among rate of potassium a supra Nitrogen content only in level of 3g.L⁻¹ was 1.850% compared with untreated 1.758 % Nitrogen.

Concerning the interaction between seaweed and potassium, Interaction between 9 ml.l-1 seaweed extract and 1.5 g.l-1 potassium gave the highest value (2.133%), while the lowest value (1.567%) was between 6 ml.l-1 seaweed and 0 g.l-1 potassium.

Table (7):- Effect of foliar application by seaweed , potassium and their interactions on N %

of lettuce plants

Seaweed	Potassium			Seaweed Effect
	0 g.L ⁻¹	1.5 g.L ⁻¹	3 g.L ⁻¹	
0ml.L ⁻¹	1.633 c	1.967 ab	1.867 a-c	1.822 ab
3ml.L ⁻¹	1.833 a-c	1.767 bc	1.733 bc	1.778 b
6ml.L ⁻¹	1.567 c	1.633 c	2.033 ab	1.744 b
9ml.L ⁻¹	2.000 ab	2.133 a	1.767 bc	1.967 a
Potassium effect	1.758 a	1.875 a	1.850 a	

Phosphorus %

Data presented in table (8) showed that seaweed extract significant affected at 3ml.L⁻¹ which was 0.455% compared with another level

Regarding the effect of foliar application of had not significant effect on phosphorus percentage.

About the interaction between seaweed extract and potassium On phosphorus percentage, observed that 3ml.L⁻¹ seaweed extract and 1.5 g.L⁻¹ potassium gave the highest significant value 0.484%, compared with 6ml.L⁻¹ seaweed and 3g.L⁻¹ potassium was 0.149%

Table (8):- Effect of foliar application by seaweed , potassium and their interaction on P % Of lettuce plant

Seaweed	Potassium			Seaweed Effect
	0 g.L ⁻¹	1.5 g.L ⁻¹	3 g.L ⁻¹	
0ml.L ⁻¹	0.247 ab	0.245 ab	0.369 ab	0.287 b
3ml.L ⁻¹	0.429 ab	0.484 a	0.453 ab	0.455 a
6ml.L ⁻¹	0.415 ab	0.235 ab	0.149 b	0.266 b
9ml.L ⁻¹	0.313 ab	0.242 ab	0.255 ab	0.270 b
Potassium effect	0.351 a	0.302 a	0.240 A	

Potassium % Data in table (9) Noticed that foliar spraying with 9 ml.L⁻¹ seaweed extract significantly improved potassium percentage

(1.367%) compared with other levels. For the effect of potassium, using potassium had no significant effect on potassium percentage.

Table (9):- Effect of foliar application by seaweed ,potassium and their interaction on K% of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L ⁻¹	1.5 g.L ⁻¹	3 g.L ⁻¹	
0ml.L ⁻¹	0.879 e	1.079 c-e	1.110 c-e	1.023 c
3ml.L ⁻¹	1.295 bc	1.018 de	1.187 b-d	1.167 b
6ml.L ⁻¹	1.311 bc	1.434 ab	1.126 cd	1.290 ab
9ml.L ⁻¹	1.249 b-d	1.264 b-d	1.588 a	1.367 a
Potassium effect	1.183 a	1.199 a	1.240 A	

Concerning the combination between seaweed and potassium, resulted 9ml.L⁻¹ seaweed extract and of 3g.L⁻¹ potassium gave the highest significant value 1.588% comparison with untreated with both factors studied 0.879 %

Calcium %

Table (10) found that foliar spraying with seaweed extract had not significant effect on calcium percentage.

Regarding the content of calcium in lettuce leaves, they are influenced by potassium foliar

application, producing a significant variance in rate of 1.5g.L⁻¹ stayed 2.009-% compared with untreated 1.657%.

The interaction between seaweed extract and potassium Had significant effect, interaction between 6ml.L⁻¹ Seaweed extract and 3g.L⁻¹ Potassium gave the highest significant value (2.277%), Compared with 9ml.L⁻¹ seaweed extract and untreated by potassium which gave (1.534%).

Table (10):- Effect of foliar application by seaweed ,potassium and their interaction on Ca%

of lettuce plant.				
Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	1.593 ab	2.097 ab	1.566 ab	1.752 a
3ml.L-1	1.843 ab	1.870 ab	1.681 ab	1.798 a
6ml.L-1	1.656 ab	2.096 ab	2.277 a	2.010 a
9ml.L-1	1.534 b	1.976 ab	2.123 ab	1.878 a
Potassium effect	1.657 b	2.009 a	1.912 ab	

Yield ton.ha⁻¹

Table (11) illustrated That foliar spraying of 9 ml.l-1 seaweed extract significantly improved yield (52.967 ton.ha⁻¹) compared with another levels.. Regarding the effect of potassium , application of potassium had not significant effect on yield.

The double interaction between seaweed extract and potassium , the best interaction was found between 9 ml.l⁻¹ seaweed extract and 3 g.l-1 potassium which gave (57.605 ton.ha⁻¹) compared with control (41.957 ton.ha⁻¹)

Table (11):- Effect of foliar application by seaweed Potassium and their interaction on yield ton.ha⁻¹ of lettuce plant.

Seaweed	Potassium			Seaweed Effect
	0 g.L-1	1.5 g.L-1	3 g.L-1	
0ml.L-1	41.957 d	43.023 cd	42.613 cd	42.531 c
3ml.L-1	48.489 b-d	50.362 b	47.300 b-d	48.717 b
6ml.L-1	46.234 b-d	50.157 b	48.735 bc	48.375 b
9ml.L-1	49.159 bc	52.138 ab	57.605 a	52.967 a
Potassium effect	46.460 a	48.920 a	49.063 a	

DISCUSSION

The results of this study showed that seaweed and potassium and their interaction positively affected on the plan lettuce, Rana et al (2007) reported the same result that application of seaweed extract resulted in higher plant height, weight and yield (table 3-5 - 12). Colla et al 2017. reported that foliar application of SWE increased the fresh and dry weight Number of leaves and head diameter (table 2 – 4) of lettuce obtained by combined seaweed and potassium which led to absorption of essential element in lettuce, the use of seaweed improved plant growth may be due to the availability of significant amounts of growth hormones, amino acids, and macro-and microelements. Moradi, S.; Pasari, B.; Talebi 2019, head weight Moradi, S.; Pasari, B.; Talebi2015.Following the present results, Moradi, S.; Pasari, B.; Talebi 2019, head weight Moradi, S.; Pasari, B.; Talebi2015 Dudaš et al 2016 in lettuce. Application of commercial extract of *E. maxima* on lettuce growth under optimal condition improved yield and the

concentration of Ca, K and Mg in the leaves (Crouch et al.1990). Content of lettuce leaves in N P K (table 7,8,9) was superior in high dose of seaweed extract and potassium Turan and Köse, 2004, Mancuso et al., 2006 also observed increased uptake of N, P, K and Mg in grapevines and cucumber with application of seaweed extract. The presence of marine bioactive substances in seaweed extract improves stomata uptake efficiency in treated plants compared to non-treated plants (Mancuso et al., 2006).

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یوخته

ئەف ئەكولېنە يا ھاتېە ئەنجام دان دخانىيەت پلاستيكي ئە لسەنتەري ئەكولينا ل مالتايى/دھوك/ھەريما كوردستانى-عيراق لپايزا سالا 2019 بو زانينا كارتىكونا رەشاندا (Seaweed extract) بسى خەستيا (6,3,0) مل/لتر ھەروھسا پوتاسيوم بخەستيا (3,1.5,0) غم/لتر لسەر خەسى توخمى تيريزا (Teresa) و گەشا كەسكاتىي و بەرھەم و ھەبونا ھندەك توخما دناف بەلگادا و ھەردوو كارتىكەر ھاتىنە رەشاندا پىشتى 10 روژا جارەكى دەرئەنجام دياردەكن گيراوى دەرپايى بشپوھكى پشووهرى) سەنگا سەرەكى ، تيرا سەرەكى ، فرەھيا بەلگى ، كىشا ھەشك ، (N,P,K)ئو بەرھەم زىدەكرن

ھەروھسا پوتاسيوم ژى بويە ئەگەري زىدەكرنا) تيرا سەرەكى ، فرەھيا بەلگى ، ئىشا ھەشك ، ئو خەستيا (Ca)بشپوھكى پشووهرى . جارەكادى تىكەلكرنا ھەردوو كارتىكەرا بويە ئەگەري زىدەكرنا ھەمى تىشتىت ھاتىنە ھەرگرتن ب حياوازي دگەل وان پىت نەھاتىنە رەشاندا