EFFECT OF PLANTING DATES AND ORGANIC NUTRIENTS ON GROWTH AND YIELD OF LETTUCE (*Lactuca sativa* L.) VARIETY FAJR

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Original Research Article

ABSTRACT

The field experiment was carried out in the winter season 2016-2017 in the project of developing tomato cultivation with modern technologies of the Directorate of Basra Agriculture in Khor Al-Zubayr, it included three factors that are interaction between four dates to plant Fajr lettuce seeds in the field (22/10/2016, 22/11/2016, 22/12/2016 and 22/1/2017) and the organic nutrients which are Algaton in 1.5 and 2 ml L^{-1} concentrations and Agrosign in 2 and 3 ml L^{-1} concentrations as well as the comparison treatment (zero) without addition, using two methods which are spraying on the total vegetative or adding it by watering through the soil, after 30 days from planting seedlings in the field with the date mentioned for each date and by two weeks between treatment and another and for three times.

Randomized Complete Block Design (RCBD) was used to factorial experiment with split plot design with three replications; the mean results were analyzed statistically using Genstat, V. 10.3 (2011) application, and the Least Significant Difference test (L.S.D.) was used to compare the means at a probability level of 0.05. The results showed that the first date (22/10) exceeded in the percentage of total soluble solids, nitrogen and potassium in the leaves, the second date (22/11) in stem diameter, the fresh and dry weights for it and the concentration of chlorophyll in the leaves, the third date (22/12) exceeded in the fresh and dry weights of the roots, and the fourth date (22/1) in the number of wrapped and total leaves and leaf area. The second (22/11) and first (22/10) dates without a significant differences between them exceeded in the number of wrapped leaves (38.92 and 39.83), fresh weight (504.77 and 501.59 g), dry weight (19.34 and 19.22 g) of the leaves, the weight of the marketing head (662.61 and 658.67 g), total marketing production (15.55 and 15.46 ton ha^{-1}), total carbohydrate concentration (132.16 and 131.69 mg g^{-1} dry weight), and the percentage of phosphorus (0.244 and 0.238), while the second date (22/11) and the fourth (22/1) exceeded in stem diameter. The method of adding organic nutrients by spraying the total vegetative was superior in

most of the traits except for the number of unwrapped leaves and the fresh and dry weights of the roots and the stem. The treatment of Agrosign at a concentration of 3ml L^{-1} exceled in most traits except for the superiority of the Agrosign treatments at a concentration of 3ml L^{-1} and Algaton at a concentration of 1.5 ml L^{-1} in plant height, fresh and dry weights, and the percentage of potassium in leaves, also the superiority of Algaton treatment at the 2 and 1.5ml L^{-1} concentrations in the number of total leaves in the plant, while the Agrosign at 3ml L^{-1} concentration and Algaton at of 2ml L^{-1} concentration exceeded in fresh and dry weights and the percentage of potassium in leaves. Most of the bilateral interactions between treatments as well as the triple interaction were significant in the growth indicators and traits under study.

Keywords: Lettuce; planting date; organic nutrients.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a leafy vegetable crop that belongs to the Asteraceae family. It is one of the strategic crops in Iraq and the world and is consumed by the individual in large quantities, and is characterized by its nutritional, medical and economic value. The part of the plant that is eaten is the vegetative, as each 100 grams of lettuce contains 95% water, 1g protein, 3 g carbohydrates, 22 mg calcium, 25 mg phosphorous and 540 IU of vitamin A [1]. The medical importance of lettuce lies in the use of its leaves as a body moisturizer, and its use in the treatment of chronic constipation because it contains cellulose fibers, also it is used as pain reliever and blood purifier; as it is characterized by containing a milky juice (Latex) [2]. The cultivated area of lettuce in Iraq reached 17766 dunum, with a production of 31232 tons and a production rate of 1762 Kg $dunum^{-1}$ [3]. It is believed that its original homeland is in southern Europe, western Asia and north Africa, and it was known to the ancient Egyptians as there are wild species that grow in Egypt and the Mediterranean countries such as *Lactuca serriola* which is known as Egypt oil lettuce, also there is another species called *Lactuca virosa* that has the same use as the first species, and it is a winter annual plant that contains a tap root and a short stem which carries the leaves that form the head and extends to give spikalets and fruits. The majority of foreign varieties that grow in Iraq belong to the varieties of lettuce with elongated heads (Romaine), [1,2].

The selection of optimal planting date is one of the main factors in improving productivity, as the production of lettuce during the spring period is important to the continuation of supplying the market for the longest possible period. In an experiment conducted by Al-Tai and others [4] it was found when planting local lettuce seeds on three dates which are 5/9, 25/9 and 5/10 that delaying the planting date had negatively affected most of the vegetative growth characteristics as the date 5/9 gave the highest yield when compared to the dates 25/9 and 5/10. Delaying the planting date led to a decrease in the vegetative growth indicators represented by plant height, number of leaves, fresh weight, and stem height El-Habar and Al-Saaberi [5] found in an experiment conducted on the lettuce variety Paris Island when studying the effect of two dates of planting seeds in the plantation at the College of Agriculture and Forestry, University of Mosul, Iraq, which are 20/9 and 20/10, the second date plants (20/10) when compared to the first date plants (20/9) were superior in the vegetative growth characteristics represented by the number of leaves, the leaf area and the weight of the marketing head, and Kaleri et al. [6]. In Pakistan found when planting the lettuce variety Butter head on six dates which are 15/9, 1/10 , 15/10, 1/11, 15/11 and 1/12, a significant increase in plant height was obtained from the plants cultivated on 15/11 and 1/12 as it reached 31.65 cm each while the least height observed in the plants cultivated on the first date 15/9 as it reached 20.27 cm, also the results of the study showed the superiority of the plants cultivated on 15/11 in the number of leaves, and the number of marketable leaves as each of them reached 30.80 and 24.58 leaves leaf $plant^{-1}$, followed with an insignificant difference by the plants of the dates 1/11 and 1/12 as they each gave of 33.47, 25.03, 30.04 and 24.65 leaf $plant^{-1}$, respectively, compared to the plants cultivated on 15/9 which gave the lowest number of them reached 15.34 and 8,240 leaf $plant^{-1}$, and the same date (15/11) exceeded in yield as it

reached 20620 kg ha^{-1} followed with an insignificant difference by the plants of 1/12 (20570) kg ha^{-1} then the date 1/11 with a yield of 19870 kg ha^{-1}, and the lowest yield was 6523 kg ha^{-1} which was given by the plants cultivated on 15/9. Furthermore, the results showed the superiority of the date plants 1/10 and 15/10 in the fresh weight of the leaves (434.00 and 431.63) g compared to the least fresh weight of the plants on the date 1/11 which reached 272.31 g.

Many researchers were interested in studying the effects of organic fertilizers on the growth and yield of lettuce, as the organic substance is one of the important and effective factors influencing the readiness of plant nutrients due to its properties that affect the soil content of the nutrients and make it ready for absorption by the plant and there by positively affects the growth and development of the plant [7]. The aqueous extracts of various decomposing organic wastes contain most of the elements that the plant needs and in proportions that depend on the type of element and the nature of the organic substance. Thus, it is possible to supply the plant with a portion of the nutrients it needs by spraying it or adding it during watering the soil in order to feed the plant, accelerate growth, improve production, and also to improve the properties of the soil, as they considered a complementary or an alternative substances to chemical compounds (Sadiq et al., 2002). Many of these nutrients are added to plants, whether in traditional, biological or organic agriculture, including seaweed extract Algaton, which is considered as a primary products for organic substances, also the synthetic substances for seaweed cells consist of many important compounds such as sugars, amino acids and enzymes as well as proteins, vitamins and minerals , as seaweed are nitrogen-fixing organisms rich in potassium and their use date back to the roman era when it was collected from sea projectiles, then they were ground or added without grinding either dry or wet, and they can also be added to the soil as ashes after being burned for improvement [8]. Seaweeds are algae-like plants that are characterized by their high ability to reproduce, including the liquid extract, Agrosign, which contains growth stimulants substances, amino acids and vitamins, so they stimulate the development of roots and drought and improve the quality and the storing ability of the fruits. Many researchers have pointed out to the importance of using these extracts to improve the growth and production of vegetable crops, as explained by Van-staden et al. [9] that the use of marine extracts led to an increase in the yield of the lettuce crops, and Al-Dulaimi [10] concluded that spraying the carnation plants *Dianthus Caryophyllus* with seaweeds extract Algaton at a concentration of 2 ml L^{-1} resulted in improving the characteristics of vegetative and flower growth of the plant compared to the comparison treatment, also Al- Allaf [11] found when spraying lettuce plants with seaweeds extract ALgamix in four concentrations which are 0, 0.5, 2.5 and 3cm^3 L^{-1}, a significant increase in the concentration of chlorophyll in the leaves at 2.5 cm^3 L^{-1} treatment. Al Othaimin [12] indicated that the addition of seaweed extract *Sargassum crassifolia* to the lettuce led to a significant increase in plant height and its dry and soft weights while the Al-Samaraee and Hassan [13] concluded in a study on *Tagetes erecta* L. plant that were sprayed with seaweed extract Algaton at a concentration of 0, 2 and 4 ml L^{-1} twice or three times led to the superiority of the plants treated at concentration 4 ml L^{-1} in plant height, the number of main branches and flowers number and diameter, also the plants that were sprayed three times gave the highest values in the vegetative and flower growth indicators and characteristics under study, and the interaction between the 4 ml L^{-1} concentration treatment and spraying three times showed a significant increase in plant height, number of main branches and number of flowers and their diameter. Kareem and Al-Ajil [14] showed that spraying cauliflower *Brassica oleracea* var. botrytis by seaweed extract Algaton after 15 days of seedling at three concentrations which are 0, 1.5 and 3 ml L^{-1} and re-spray every 15 days resulted in the superiority of the plants sprayed with the extract significantly in the vegetative growth characteristics compared to the comparison treatment, also the superiority of the plants sprayed at a concentration of 1.5 ml L^{-1} in the speed of ripening of the crud, whereas the plants sprayed at a concentration of 2 ml L^{-1} outperformed in weight average attributes and coherence of the crud, meanwhile, Khalil and Al-

Hubeiti [15] explained that spraying lettuce plants with the seaweed extract Alga 300 in three concentrations which are 0, 1.5 and 2.5 ml L^{-1} at a rate of three sprays every two weeks resulted in improving the vegetative growth characteristics compared to the comparison treatment, and Al-Muzaira'a [16] indicated that spraying *Solanum melongena* L. eggplant with seaweed extract Agrosign at three concentrations which are 0, 2 and 4 ml L^{-1} at a rate of four sprays every two weeks to the superiority of the plants sprayed at a concentration of 4 sprays in most of vegetative growth indicators represented by plant height and diameter, leaf area and plant fresh and dry weights and the same treatment excelled in the early flowering and in the number of the total flower $plant^{-1}$ compared to the treatment at a concentration of 2 ml L^{-1} and the comparison treatment.

Given the importance of the lettuce crop, the idea was to produce it with late planting dates for the purpose of providing it on the market for the longest possible period, as well as using Algaton and Agrosign, which are liquid seaweed extracts either by spraying on the plant to increase the production and improve its quality or by watering to the soil as they work to strengthen the roots and increase their ability to absorb nutrients.

MATERIALS AND WORK METHODS

The field experiment was carried out in the winter season 2016-2017 in the project of developing tomato cultivation with modern technologies of the Directorate of Basra Agriculture in Khor Al-Zubayr, In a mixed sandy soil with a pH of 7.73 and an electrical conductivity of 6.78 decimeters m^{-1} and an organic substance of 0.74%, the maximum and minimum temperatures and the relative humidity of the experiment area during the planting season were recorded using the data of Al-Barjasia Agricultural research station adjacent to the site (Fig. 1).

Fajr variety (Lettuce Romaine), produced by the Dutch company Enza Zaden, production in April 2016 with a germination rate of 96% and 99% purity was used as plant material in this experiment.

The experiment included three factors i. Planting dates (22/10/2016, 22/11/2016, 22/12/2016 and 22/1/2017) ii. Organic nutrients (Algaton fertilizer at 1.5- and 2-ml L^{-1} and Agrosign fertilizer at 2- and 3-ml L^{-1}, water used as control tretment) (Table 1 show the ingerident of the fertilizer) iii. Methods of application (spraying or drantiong on soil with irrigation) as, application of fertilizer was done on seedling at 30 days ago after planting.

Table 1. Includes the components of the organic nutrients and the companies producing them

Fertilizer commercial name	Company of produced	Contents
Algaton	Spanish company Valencia	Total Nitrogen (N) 6% W/W Phosphoric Anhydride (P_2O_5) soluble in water 3% w/w Phosphoric Anhydride (P_2O_5) soluble in water 3% w/w Potassium oxides (K_2O) soluble in water 10% w/w Molybdenum (Mo) soluble in water 0.3% w/w Auxin Cytokinin Gibberelin amino acids sugars and carbohydrates
Agrosign	American company Grow more	organic substance extracted from seaweed 12% organic substance extracted from seaweed 12% group of amino acids 65% natural growth regulators (Auxin, cytokinins and gibberlins) 25 parts in million nitrogen 150% phosphorus 2% potassium 3%

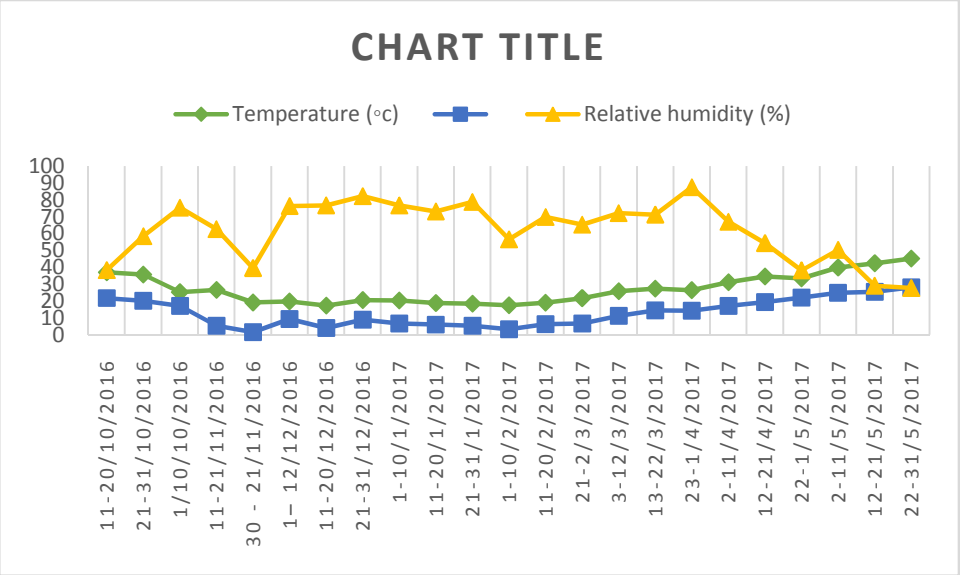

Fig. 1. Maximum and minimum temperatures and relative humidity* during the experiment season

Randomized Completely Block Design (RCBD) was used as split split plot design, planting dates was considered the main plots, application method as Sub - plot and the nutrient concentrations are the sub plots. There are 40 factorial treatments with three replicas with 120 experimental units. Data was statistically analyzed by using the Genstat, V. 10.3 (2011) statistical program, and the test used the least significant difference (L.S.D.) to compare the averages at 0.05 probability level [17].

Field soil was plowed, smoothed, leveled and divided into 12 lines with a length of 25 m and a width of 50 cm and a depth of 15 cm with a distance of one meter between the lines, for three replicas (four lines per one replicate) and cultivation was carried out with a distance of 25 cm between the plants witch 100 plants in the line, each line contains 10 experimental units of a 2.5 m length and 1.5 m width with an area of 3.75 m^2 and ten plants per unit with a plant density of 23467 ha^{-1}.

The service operations were performed in a similar manner to all treatments as usual in the production of this crop, the decomposed organic fertilizer was added by 10m^3 $dunam^{-1}$ during the preparation of the land, irrigation was carried out as needed by the immersion method, the seedlings were transferred after the calibration irrigation to the field with great care while keeping a portion of the Pitmos around the roots during Seedlings to maintain soil moisture, the plants were sprayed with high phosphorous NPK fertilizer at a rate of 10–30–10 at two weeks after the seedlings transferred , and urea fertilizer was added to it by watering with the irrigation water at a rate of one gram L^{-1} one week to another, the weeding process was carried out to get rid of the bushes whenever necessary, harvesting the crop began depending on the appearance of maturity signs which are the large size of the plant and the formation of the head, and the plants were extracted with the roots.

Field data were taken from five plants randomly selected from each experimental unit at the end of the harvest season for each date and the average was calculated for each plant as the following: Plant height (cm), stem length and diameter (cm), the number of unwrapped, wrapped and total leaves of the plant, the leaf area (Dm^2), the fresh and dry weight of the roots, stems and leaves (gm), head weight (gm) and total marketing production (ton ha^{-1}). The qualitative characteristics of the leaves were estimated two weeks after the third addition of nutrients and included, chlorophyll concentration in the leaves

(mg 100 g^{-1} fresh weight) [18], total carbohydrates (mg g^{-1} dry weight [19] percentage of total soluble solids, nitrogen and potassium [20] and phosphorus [21].

RESULTS AND DISCUSSION

Table 2 results show that the highest stem length average was in the second date plants (23.42 cm). As for the method of addition, it is noted that the method of spraying was superior in plant height (29.83 cm) and stem length and diameter (23.09 and 2.68 cm), respectively. The plants treated with organic nutrients showed a significant superiority over the comparison treatment plants, and the effect increased by increasing the concentration and the highest rate of it was in the plants treated with Agrosign at a concentration of 3 ml L^{-1}. as for the interaction of the planting date with the method of addition, it was found that the spraying method for the second date plants exceeded in plant height (32.62 cm)And stem length (26.37 cm) while the interaction of the addition method with the concentration showed that the spray method with Algaton at a concentration of 1.5 ml L^{-1} was superior in plant height reaching 33.80 cm, while the plants that were sprayed with Agrosign at a concentration of 3 ml L^{-1} 1 exceeded in stem length, which reached 28.86 cm. second date Plants, treated with Agrosign at a concentration of 3ml L^{-1}, exceeded in the characteristics mentioned in the same table at the interaction of the planting the date with the concentration. The triple interaction of treatments showed the superiority of the second date plants that were sprayed with Agrosign at a concentration of 3 ml L^{-1} in plant height and stem length as they reached 38.00 and 40.47 cm, respectively.

Table 3 results show the presence of a significant effect of the planting date, as the fourth date plants exceeded in the number of unwrapped and total leaves and leaf area, and it is noticed that there is an increase in these mentioned characteristic with the advance of the planting date, while the first and second dates plants exceeded in the number of wrapped as each reached 39.83 and 38.92, respectively, and it is noticed that there is a decrease in this characteristic with the advance of the planting date. The method of adding organic nutrients by spraying led to a significant increase in the number of wrapped leaves (39.05) and leaf area (67.926 Dm^2). The treatment with organic nutrients showed significant differences between plants, as it is evident from the results in the same table that the number of unwrapped leaves increased in the comparison treatment plants as it reached 21.24, while the plants treated with Agrosign at a concentration of 3ml L^{-1} exceeded in the number of wrapped leaves (40.99) and leaf area (69.493 Dm^2), and the plants treated with Algaton at the concentrations of 2 and 1.5 ml L^{-1} exceeded in total leaves number , reaching 57.78 and 57.50 each, respectively. The results showed the superiority of method of addition by spraying of the fourth date plants in leaf area (71.341 Dm^2) when the planting date interacted with the addition method. As for the interaction of the addition method with concentration, it was found that the plants sprayed with Agrosign at a concentration of 3 ml L^{-1} exceeded the number of wrapped leaves (42.38) and leaf area (71.130 Dm^2).Plants sprayed with Algaton at a concentration of 2 ml L^{-1} exceeded in total leaves number (59.18) When the planting date interacted with the concentration, as the delay in planting date led to an increase in the number of unwrapped leaves of the fourth date comparison treatment plants (27.63), an increase in total leaves number in the plants treated with Algaton at a concentration of 1.5 ml L^{-1}reached 63.16, and an increase in leaf area in the plants treated with Agrosign at a concentration of 3 ml L^{-1} reached 74.340 Dm^2. The triple interaction of the same date with the Agrosign at a concentration of 3 ml L^{-1} showed a significant superiority in leaf area, reached 75.507 Dm^2.

Table 4 results show that the highest average of fresh and dry root weights was observed in the third date plants, reaching 8.27 and 2.818 g each, while the second date plants exceeded in the fresh and dry stem weights, reaching 142.57 and 19.28 g, respectively. It is also noted the superiority of the watering method compared to the spray method in the mentioned characteristics. The plants treated with organic nutrients showed a significant superiority over the comparison treated plants, and the effect increased by increasing the concentration and the highest average of it was in the plants treated with Agrosign at a concentration of 3 ml L^{-1}. The plants treated with organic

Table 2. The effect of planting dates, method of addition of organic nutrients, their concentrations and their interactions on plant height, length and stem diameter (cm) for the lettuce variety Fajr

Factors	F_p	df	Treatment	Plant height (cm)	F_p	df	Stem length (cm)	F_p	df	Stem diameter (cm)
Planting dates (D)	0.035	3			<.001	3		0.001	3	
			first (F)	28.04			19.72			2.51
			second (S)	29.57			23.42			2.74
			third (T)	27.97			21.07			2.63
			fourth (U)	29.28			23.07			2.67
LSD				NS			0.49			NS
Application method (M)	<.001	1			<.001	1		<.001	1	
			S	29.83			23.09			2.68
			W	27.59			20.55			2.60
LSD				0.36			0.45			0.04
Concentrations M/L	<.001	4			<.001	4		<.001	4	
			0	23.12			15.75			2.03
			1.5Algaton	30.69			21.10			2.55
			2Algaton	29.63			21.21			2.63
			2Agrosign	28.71			24.24			2.82
			3Agrosign	31.41			26.81			3.16
LSD				0.89			0.69			0.08
D *M	<.001	3			<.001	3		0.004	3	
			F * S	28.42			20.27			2.50
			F * W	27.65			19.18			2.51
			S* S	32.62			26.37			2.84
			S * W	26.51			20.47			2.65
			T * S	28.20			21.90			2.70
			T * W	27.73			20.24			2.57
			U * S	30.09			23.82			2.67
			U * W	28.47			22.31			2.67
LSD				1.24			0.73			NS
M *C lsd	<.001	4			<.001	4		0.924	4	
			0 * S	23.08			15.69			2.06
			0 * W	23.17			15.81			1.99
			1.5Algaton*S	33.80			22.19			2.60
			1.5Algaton*W	27.57			20.00			2.51
			2Algaton * S	30.86			21.60			2.65
			2Algaton * W	28.39			20.82			2.61
			2Agrosign*S	30.00			27.10			2.88
			2Agrosign*W	27.42			21.37			2.76
			3Agrosign*S	31.42			28.86			3.20
			3Agrosign*W	31.40			24.75			3.12

Factors	F_p	df	Treatment	Plant height (cm)	F_p	df	Stem length (cm)	F_p	df	Stem diameter (cm)
LSD				1.17			0.95			NS
lsd D *C	<.001	12			<.001	12		<.001	12	
			F * 0	23.22			14.94			1.91
			F*1.5Algaton	31.33			22.33			2.80
			F* 2Algaton	27.90			19.33			2.43
			F* 2Agrosign	28.05			20.00			2.57
			F* 3Agrosign	29.67			22.00			2.82
			S * 0	23.08			15.64			2.03
			S*1.5Algaton	30.22			20.56			2.43
			S* 2Algaton	30.50			20.81			2.78
			S*2Agrosign	29.47			27.75			2.91
			S*3Agrosign	34.55			32.33			3.56
			T * 0	23.14			15.67			2.08
			T*1.5Algaton	31.03			19.78			2.47
			T* 2Algaton	28.94			20.17			2.66
			T*2Agrosign	26.97			24.33			2.88
			T*3Agrosign	29.75			25.42			3.08
			U * 0	23.05			16.76			2.09
			U*1.5Algaton	30.17			21.72			2.52
			U*2Algaton	31.17			24.53			2.64
			U*2Agrosign	30.33			24.86			2.91
			U*3Agrosign	31.67			27.47			3.19
LSD				1.88			1.29			0.16
D*M* C lsd	<.001	12			<.001	12		0.974	12	
			F * 0* S	22.61			14.00			1.95
			F * 0* W	23.83			15.89			1.86
			F*1.5Algaton *S	36.00			25.67			2.78
			F*1.5Algaton *W	26.67			19.00			2.82
			F*2Algaton *S	28.40			20.67			2.37
			F*2Algaton *W	27.40			18.00			2.48
			F* 2Agrosign *S	27.61			20.00			2.63
			F* 2Agrosign *W	28.50			20.00			2.50
			F*3Agrosign *S	27.50			21.00			2.77
			F*3Agrosign *W	31.83			23.00			2.87
			S * 0 * S	23.33			16.00			2.08
			S * 0 * W	22.83			15.27			1.98
			S*1.5Algaton *S	33.67			20.67			2.55
			S*1.5Algaton *W	26.78			20.45			2.30

Factors	F_p	df	Treatment	Plant height (cm)	F_p	df	Stem length (cm)	F_p	df	Stem diameter (cm)
			S*2Algaton *S	35.00			21.17			2.86
			S*2Algaton *W	26.00			20.45			2.70
			S *2Agrosign *S	33.11			33.33			3.01
			S *2Agrosign *W	25.83			22.17			2.82
			S*3Agrosign *S	38.00			40.67			3.68
			S*3Agrosign *W	31.11			24.00			3.44
			T * 0 * S	23.28			16.00			2.13
			T * 0 * W	23.00			15.33			2.02
			T*1.5Algaton *S	35.22			20.00			2.54
			T*1.5Algaton *W	26.83			19.56			2.40
			T*2Algaton *S	28.72			19.83			2.72
			T*2Algaton *W	29.17			20.50			2.61
			T *2Agrosign *S	25.94			28.33			2.95
			T *2Agrosign *W	28.00			20.33			2.81
			T*3Agrosign *S	27.83			25.33			3.17
			T*3Agrosign *W	31.67			25.50			2.99
			U * 0 * S	23.11			16.78			2.09
			U * 0 * W	23.00			16.74			2.09
			U*1.5Algaton *S	30.33			22.44			2.52
			U*1.5Algaton *W	30.00			21.00			2.52
			U*2Algaton *S	31.33			24.72			2.64
			U*2Algaton *W	31.00			24.33			2.64
			U* 2Agrosign *S	33.33			26.72			2.91
			U *2Agrosign *W	27.33			23.00			2.91
			U*3Agrosign *S	32.33			28.44			3.19
			U*3Agrosign *W	31.00			26.50			3.19
LSD				2.49			1.86			NS

Table 3. The effect of planting dates, method of addition of organic nutrients, their concentrations, and their interactions on the number of unwrapped, wrapped, and total leaves and the leaf area (Dm²) of the lettuce variety Fajr

Factors	F_p	df	Treatment	Number of unwarpped leaves	F_p	df	Number of warpped leaves	F_p	df	Number of total leaves	F_p	df	Leaf area (Dm²)
Planting dates (D)	<.001	3			<.001	3		<.001	3		<.001	3	
			first (F)	13.50			39.83			53.33			63.055
			second (S)	14.83			38.92			53.75			63.135
			third (T)	21.17			37.61			58.78			69.011
			fourth (U)	23.94			36.26			60.20			70.734
LSD				0.87			1.08			1.14			0.005
Application method (M)	0.003	1			<.001	1		0.004	1		<.001	1	

Factors	F_p	df	Treatment	Number of unwarpped leaves	F_p	df	Number of warpped leaves	F_p	df	Number of total leaves	F_p	df	Leaf area (Dm^2)
			S	17.90			39.05			56.95			67.926
			W	18.82			37.27			56.09			65.041
LSD				NS			0.48			NS			0.004
Concentrations M/L	<.001	4			<.001	4		<.001	4		<.001	4	
			0	21.24			34.22			55.46			62.031
			1.5Algaton	19.81			37.69			57.50			65.961
			2Algaton	18.50			39.28			57.78			68.119
			2Agrosign	17.08			38.61			55.69			66.814
			3Agrosign	15.18			40.99			56.16			69.493
LSD				0.51			0.53			0.71			0.005
D *M	0.614	3			0.189	3		0.380	3		<.001	3	
			F * S	13.01			41.07			54.08			65.313
			F * W	13.99			38.59			52.58			60.797
			S* S	14.36			39.83			54.19			64.269
			S * W	15.31			38.01			53.32			62.000
			T * S	20.52			38.51			59.03			70.782
			T * W	21.82			36.72			58.53			67.240
			U * S	23.71			36.78			60.49			71.341
			U * W	24.17			35.75			59.92			70.126
LSD				NS			NS			NS			0.007
M *C lsd	0.007	4			<.001	4		<.001	4		<.001	4	
			0 * S	20.51			34.61			55.12			63.384
			0 * W	21.96			33.83			55.79			60.667
			1.5Algaton*S	19.72			37.96			57.68			67.095
			1.5Algaton*W	19.90			37.42			57.32			64.828
			2Algaton * S	18.17			41.01			59.18			70.216
			2Algaton * W	18.83			37.55			56.38			66.023
			2Agrosign*S	16.85			39.28			56.13			67.807
			2Agrosign*W	17.31			37.94			55.25			65.821
			3Agrosign*S	14.24			42.38			56.62			71.130
			3Agrosign*W	16.11			39.60			55.71			67.855
LSD				NS			0.79			0.99			0.007
lsd D *C	<.001	12			0.009	12		<.001	12		<.001	12	
			F * 0	15.83			35.50			51.33			57.614
			F*1.5Algaton	14.03			38.83			52.85			62.112
			F* 2Algaton	13.99			41.13			55.12			65.540
			F* 2Agrosign	12.89			39.84			52.73			63.077
			F* 3Agrosign	10.76			43.86			54.62			66.932
			S * 0	17.38			34.87			52.24			58.665
			S*1.5Algaton	16.37			38.19			54.56			63.687
			S* 2Algaton	14.64			39.72			54.35			65.386
			S*2Agrosign	14.39			39.87			54.25			62.858

Factors	F_p	df	Treatment	Number of unwarpped leaves	F_p	df	Number of warpped leaves	F_p	df	Number of total leaves	F_p	df	Leaf area (Dm^2)
			S*3Agrosign	11.39			41.98			53.36			65.076
			T * 0	24.11			33.92			58.03			65.102
			T*1.5Algaton	22.09			37.34			59.43			69.066
			T* 2Algaton	20.86			38.86			59.72			69.564
			T*2Agrosign	19.39			38.06			57.44			69.702
			T*3Agrosign	19.39			39.89			59.28			71.623
			U * 0	27.63			32.58			60.21			66.743
			U*1.5Algaton	26.75			36.41			63.16			68.980
			U*2Algaton	24.50			37.42			61.92			71.988
			U*2Agrosign	21.65			36.69			58.34			71.618
			U*3Agrosign	19.17			38.22			57.39			74.340
LSD				1.17			NS			1.60			0.011
D*M* C lsd	0.002	12			0.128	12		0.002	12		<.001	12	
			F * 0* S	15.11			35.74			50.85			59.414
			F * 0* W	16.55			35.26			51.81			55.813
			F*1.5Algaton *S	13.46			38.98			52.44			63.593
			F*1.5Algaton *W	14.59			38.67			53.26			60.632
			F*2Algaton *S	13.50			43.93			57.43			68.894
			F*2Algaton *W	14.48			38.33			52.81			62.185
			F* 2Agrosign *S	12.11			40.71			52.82			64.611
			F* 2Agrosign *W	13.66			38.97			52.63			61.543
			F*3Agrosign *S	10.86			46.00			56.86			70.053
			F*3Agrosign *W	10.67			41.72			52.39			63.811
			S * 0 * S	16.68			35.04			51.72			59.775
			S * 0 * W	18.07			34.70			52.77			57.554
			S*1.5Algaton *S	15.82			38.52			54.34			64.623
			S*1.5Algaton *W	16.93			37.85			54.78			62.752
			S*2Algaton *S	14.94			41.43			56.37			66.945
			S*2Algaton *W	14.33			38.00			52.33			63.828
			S *2Agrosign *S	13.67			39.18			54.22			64.224
			S *2Agrosign *W	15.11			38.87			54.29			61.493
			S*3Agrosign *S	10.67			40.33			54.29			65.779
			S*3Agrosign *W	12.11			41.22			52.44			64.373
			T * 0 * S	23.33			34.46			57.79			66.621
			T * 0 * W	24.89			33.39			58.27			63.583
			T*1.5Algaton *S	22.37			37.52			59.88			70.486
			T*1.5Algaton *W	21.81			37.17			58.97			67.647
			T*2Algaton *S	20.11			40.47			60.59			72.063
			T*2Algaton *W	21.60			37.25			58.86			67.064
			T *2Agrosign *S	19.33			38.87			58.21			71.559
			T *2Agrosign *W	19.44			37.24			56.68			67.845
			T*3Agrosign *S	17.44			41.22			58.67			73.182

Factors	F_p	df	Treatment	Number of unwarpped leaves	F_p	df	Number of warpped leaves	F_p	df	Number of total leaves	F_p	df	Leaf area (Dm^2)
			T*3Agrosign *W	21.33			38.55			59.89			70.063
			U * 0 * S	26.93			33.21			60.13			67.727
			U * 0 * W	28.33			31.96			60.29			65.759
			U*1.5Algaton *S	27.22			36.81			64.04			69.677
			U*1.5Algaton *W	26.28			36.00			62.28			68.282
			U*2Algaton *S	24.12			38.21			62.33			72.962
			U*2Algaton *W	24.89			36.63			61.52			71.014
			U* 2Agrosign *S	22.29			37.00			59.29			70.833
			U *2Agrosign *W	21.00			36.39			57.39			72.402
			U*3Agrosign *S	18.00			39.00			56.67			75.507
			U*3Agrosign *W	20.33			37.78			58.11			73.173
LSD				NS			NS			NS			0.015

Table 4. The effect of planting dates, method of adding organic nutrients, their concentrations and their interactions on the fresh and dry weights of roots and stem(gm) of the lettuce variety Fajr

Factors	F_p	df	Treatment	Fresh weight of the roots (g)	F_p	df	Dry weight of the roots (g)	F_p	df	Fresh weight of the stem (g)	F_p	df	Dry weight of the stem (g)
Planting dates (D)	<.001	3			<.001	3		<.001	3		<.001	3	
			first (F)	6.66			2.756			122.81			17.18
			second (S)	6.97			2.409			142.57			19.28
			third (T)	8.27			2.818			103.55			14.59
			fourth (U)	7.07			2.321			96.47			12.79
LSD				0.01			0.007			2.07			0.76
Application method (M)	<.001	1			<.001	1		<.001	1		<.001	1	
			S	7.13			2.555			111.52			14.86
			W	7.34			2.596			121.17			17.06
LSD				0.01			0.004			1.03			0.40
Concentrations M/L	<.001	4			<.001	4		<.001	4		<.001	4	
			0	6.18			2.009			95.88			12.34
			1.5Algaton	6.77			2.240			116.19			15.80
			2Algaton	7.30			2.509			118.19			15.68
			2Agrosign	7.59			2.830			122.15			16.53
			3Agrosign	8.36			3.292			129.33			19.45
LSD				0.01			0.005			1.57			0.60
D *M	<.001	3			<.001	3		<.001	3		<.001	3	
			F * S	6.52			2.783			127.27			17.64
			F * W	6.79			2.729			118.34			16.71
			S* S	6.71			2.553			120.35			16.85
			S * W	7.21			2.265			164.80			21.72
			T * S	8.72			2.910			98.61			13.34

Factors	F_p	df	Treatment	Fresh weight of the roots (g)	F_p	df	Dry weight of the roots (g)	F_p	df	Fresh weight of the stem (g)	F_p	df	Dry weight of the stem (g)
			T * W	7.82			2.726			108.48			15.84
			U * S	6.59			1.977			99.87			11.59
			U * W	7.55			2.665			93.07			13.98
LSD				0.01			0.008			2.31			0.85
M *C lsd	<.001	4			<.001	4		<.001	4		<.001	4	
			0 * S	5.88			1.944			99.01			12.35
			0 * W	6.49			2.074			92.74			12.33
			1.5Algaton*S	6.74			2.229			110.44			14.81
			1.5Algaton*W	6.80			2.251			121.95			16.79
			2Algaton * S	7.13			2.423			111.88			14.44
			2Algaton * W	7.46			2.594			124.50			16.92
			2Agrosign*S	7.47			2.845			115.26			15.03
			2Agrosign*W	7.70			2.816			129.03			18.03
			3Agrosign*S	8.46			3.336			121.03			17.65
			3Agrosign*W	8.27			3.248			137.63			21.24
LSD				0.01			0.007			2.18			0.83
lsd D *C	<.001	12			<.001	12		<.001	12		<.001	12	
			F * 0	5.73			2.232			104.91			14.00
			F*1.5Algaton	6.28			2.398			135.44			18.57
			F* 2Algaton	6.57			2.660			119.15			16.04
			F* 2Agrosign	7.06			3.050			124.47			17.10
			F* 3Agrosign	7.66			3.438			130.06			20.18
			S * 0	6.21			1.821			105.72			13.06
			S*1.5Algaton	6.88			2.148			149.02			19.68
			S* 2Algaton	6.95			2.471			147.39			20.04
			S*2Agrosign	7.17			2.615			152.90			20.81
			S*3Agrosign	7.59			2.991			157.83			22.81
			T * 0	7.30			2.205			87.89			11.37
			T*1.5Algaton	7.68			2.386			90.98			12.59
			T* 2Algaton	8.45			2.607			105.70			13.01
			T*2Agrosign	8.51			3.142			112.72			15.66
			T*3Agrosign	9.40			3.749			120.43			20.31
			U * 0	5.48			1.777			85.00			10.93
			U*1.5Algaton	6.23			2.027			89.33			12.36
			U*2Algaton	7.21			2.296			100.50			13.62
			U*2Agrosign	7.61			2.515			98.50			12.54
			U*3Agrosign	8.81			2.990			109.00			14.49
LSD				0.02			0.011			3.30			1.24
D*M* C lsd	<.001	12			<.001	12		<.001	12		<.001	12	
			F * 0* S	5.11			2.237			110.82			15.04
			F * 0* W	6.35			2.227			99.00			12.96
			F*1.5Algaton *S	6.34			2.563			146.67			20.24

Factors	F_p	df	Treatment	Fresh weight of the roots (g)	F_p	df	Dry weight of the roots (g)	F_p	df	Fresh weight of the stem (g)	F_p	df	Dry weight of the stem (g)
			F*1.5Algaton *W	6.23			2.232			124.22			16.89
			F*2Algaton *S	6.55			2.796			123.31			16.14
			F*2Algaton *W	6.58			2.525			115.00			15.95
			F* 2Agrosign *S	7.00			3.055			127.13			18.15
			F* 2Agrosign *W	7.12			3.045			121.80			16.06
			F*3Agrosign *S	7.63			3.262			128.44			18.65
			F*3Agrosign *W	7.70			3.614			131.67			21.72
			S * 0 * S	6.02			2.223			111.80			13.24
			S * 0 * W	6.41			1.420			99.65			12.89
			S*1.5Algaton *S	6.51			2.252			118.81			17.06
			S*1.5Algaton *W	7.26			2.044			179.23			22.31
			S*2Algaton *S	6.52			2.484			116.01			16.29
			S*2Algaton *W	7.39			2.458			178.78			23.79
			S *2Agrosign *S	6.99			2.738			123.46			17.31
			S *2Agrosign *W	7.35			2.491			182.34			24.31
			S*3Agrosign *S	7.51			3.068			131.67			20.33
			S*3Agrosign *W	7.66			2.914			184.00			25.29
			T * 0 * S	7.67			2.081			89.44			10.65
			T * 0 * W	6.94			2.329			86.33			12.09
			T*1.5Algaton *S	8.22			2.388			92.96			11.59
			T*1.5Algaton *W	7.13			2.384			89.00			13.60
			T*2Algaton *S	8.83			2.472			98.21			12.40
			T*2Algaton *W	8.06			2.742			113.20			13.61
			T *2Agrosign *S	8.84			3.554			103.45			13.59
			T *2Agrosign *W	8.19			2.730			122.00			17.73
			T*3Agrosign *S	10.05			4.052			109.00			18.46
			T*3Agrosign *W	8.76			3.445			131.86			22.15
			U * 0 * S	4.71			1.235			84.00			10.46
			U * 0 * W	6.24			2.319			86.00			11.40
			U*1.5Algaton *S	5.88			1.712			83.33			10.36
			U*1.5Algaton *W	6.57			2.343			95.33			14.35
			U*2Algaton *S	6.62			1.941			110.00			12.91
			U*2Algaton *W	7.81			2.651			91.00			14.32
			U* 2Agrosign *S	7.07			2.033			107.00			11.06
			U *2Agrosign *W	8.15			2.996			90.00			14.02
			U*3Agrosign *S	8.65			2.962			115.00			13.16
			U*3Agrosign *W	8.97			3.018			103.00			15.83
LSD				0.02			0.015			4.49			1.70

Table 5. The effect of planting dates, method of adding organic nutrients, their concentrations and their interactions on the fresh and dry weights of the leaves (g), the marketing head weight (g) and the total marketing yield (ton ha^{-1}) for the lettuce variety Fajr

Factors	F_p	df	Treatment	Fresh weight of the leaves (g)	F_p	df	Dry weight of the leaves (g)	F_p	df	Weight of the marketing head (g)	F_p	df	Total marketing production (ton ha^{-1})
Planting dates (D)	<.001	3			<.001	3		<.001	3		<.001	3	
			first (F)	501.59			19.22			658.67			15.46
			second (S)	504.77			19.34			662.61			15.55
			third (T)	443.58			17.01			567.62			13.32
			fourth (U)	411.20			15.73			529.37			12.42
LSD				18.85			0.73			4.55			0.11
Application method (M)	<.001	1			<.001	1		<.001	1		<.001	1	
			S	473.49			18.27			612.81			14.38
			W	457.08			17.38			596.32			13.99
LSD				6.94			0.26			3.21			0.08
Concentrations M/L	<.001	4			<.001	4		<.001	4		<.001	4	
			0	404.04			15.47			518.30			12.16
			1.5Algaton	478.85			18.36			620.38			14.56
			2Algaton	489.74			18.77			627.26			14.72
			2Agrosign	457.49			17.52			606.43			14.23
			3Agrosign	496.30			19.01			650.46			15.26
LSD				9.92			0.38			3.98			0.09
D *M	0.095	3			0.052	3		<.001	3		<.001	3	
			F * S	513.07			19.81			676.61			15.88
			F * W	490.12			18.63			640.72			15.04
			S* S	517.20			19.96			657.75			15.44
			S * W	492.33			18.71			667.47			15.66
			T * S	451.54			17.44			574.75			13.49
			T * W	435.60			16.59			560.48			13.15
			U * S	412.13			15.87			542.13			12.72
			U * W	410.27			15.60			516.60			12.12
LSD				NS			NS			5.81			0.14
M *C lsd	<.001	4			<.001	4		<.001	4		<.001	4	
			0 * S	404.25			15.58			523.43			12.28
			0 * W	403.83			15.35			513.16			12.04
			1.5Algaton*S	478.45			18.50			625.31			14.67
			1.5Algaton*W	479.25			18.22			615.45			14.44
			2Algaton * S	509.15			19.62			646.69			15.18
			2Algaton * W	470.33			17.91			607.83			14.26
			2Agrosign*S	463.42			17.87			612.76			14.38
			2Agrosign*W	451.56			17.16			600.10			14.08
			3Agrosign*S	512.17			19.76			655.86			15.39
			3Agrosign*W	480.42			18.26			645.05			15.14

Factors	F_p	df	Treatment	Fresh weight of the leaves (g)	F_p	df	Dry weight of the leaves (g)	F_p	df	Weight of the marketing head (g)	F_p	df	Total marketing production (ton ha^{-1})
LSD				13.90			0.53			5.76			0.14
lsd D *C	<.001	12			<.001	12		<.001	12		<.001	12	
			F * 0	408.00			15.63			528.07			12.39
			F*1.5Algaton	503.50			19.28			676.94			15.89
			F* 2Algaton	561.17			21.50			701.82			16.47
			F* 2Agrosign	494.13			18.94			680.09			15.96
			F* 3Agrosign	541.17			20.74			706.39			16.58
			S * 0	427.67			16.38			549.05			12.88
			S*1.5Algaton	530.17			20.31			693.69			16.28
			S* 2Algaton	527.50			20.21			695.39			16.32
			S*2Agrosign	530.00			20.30			695.40			16.32
			S*3Agrosign	508.50			19.49			679.50			15.95
			T * 0	420.83			16.13			526.89			12.36
			T*1.5Algaton	439.40			16.86			554.87			13.02
			T* 2Algaton	458.00			17.60			578.49			13.58
			T*2Agrosign	426.84			16.36			554.56			13.01
			T*3Agrosign	472.84			18.11			623.27			14.63
			U * 0	359.67			13.73			469.17			11.01
			U*1.5Algaton	442.33			16.98			556.00			13.05
			U*2Algaton	412.34			15.76			533.33			12.52
			U*2Agrosign	379.00			14.48			495.67			11.63
			U*3Agrosign	462.67			17.70			592.67			13.91
LSD				24.09			0.92			8.05			0.19
D*M* C lsd	<.001	12			<.001	12		<.001	12		<.001	12	
			F * 0* S	401.00			15.48			528.49			12.40
			F * 0* W	415.00			15.78			527.66			12.38
			F*1.5Algaton *S	491.67			18.98			691.33			16.22
			F*1.5Algaton *W	515.33			19.59			662.55			15.55
			F*2Algaton *S	592.33			22.86			738.64			17.33
			F*2Algaton *W	530.00			20.15			665.00			15.61
			F* 2Agrosign *S	503.33			19.44			692.47			16.25
			F* 2Agrosign *W	484.92			18.43			667.72			15.67
			F*3Agrosign *S	577.00			22.27			732.11			17.18
			F*3Agrosign *W	505.33			19.21			680.67			15.97
			S * 0 * S	429.00			16.55			556.13			13.05
			S * 0 * W	426.33			16.21			541.98			12.72
			S*1.5Algaton *S	527.00			20.34			664.81			15.60
			S*1.5Algaton *W	533.33			20.27			722.56			16.96
			S*2Algaton *S	542.67			20.95			685.01			16.08
			S*2Algaton *W	512.33			19.48			705.78			16.56
			S *2Agrosign *S	536.67			20.71			685.13			16.08
			S *2Agrosign *W	523.33			19.89			705.67			16.56

Factors	F_p	df	Treatment	Fresh weight of the leaves (g)	F_p	df	Dry weight of the leaves (g)	F_p	df	Weight of the marketing head (g)	F_p	df	Total marketing production (ton ha^{-1})
			S*3Agrosign *S	550.67			21.25			697.67			16.37
			S*3Agrosign *W	466.33			17.73			661.33			15.52
			T * 0 * S	436.33			16.84			545.44			12.80
			T * 0 * W	405.33			15.42			508.33			11.93
			T*1.5Algaton *S	443.79			17.19			572.08			13.43
			T*1.5Algaton *W	435.00			16.54			537.67			12.62
			T*2Algaton *S	467.91			18.04			585.78			13.75
			T*2Algaton *W	448.0			17.15			571.20			13.40
			T *2Agrosign *S	442.67			17.09			567.78			13.32
			T *2Agrosign *W	411.00			15.62			541.33			12.70
			T*3Agrosign *S	467.00			18.02			602.67			14.14
			T*3Agrosign *W	478.67			18.20			643.86			15.11
			U * 0 * S	350.67			13.45			463.67			10.88
			U * 0 * W	368.67			14.01			474.67			11.14
			U*1.5Algaton *S	451.33			17.50			573.00			13.45
			U*1.5Algaton *W	433.33			16.46			539.00			12.65
			U*2Algaton *S	433.67			16.64			577.33			13.55
			U*2Algaton *W	391.00			14.88			489.33			11.48
			U* 2Agrosign *S	371.00			14.25			505.67			11.87
			U *2Agrosign *W	387.00			14.71			485.67			11.40
			U*3Agrosign *S	454.00			17.49			591.00			13.87
			U*3Agrosign *W	471.33			17.92			594.33			13.95
LSD				30.75			1.17			11.40			0.27

Table 6. Effect of planting dates, method of adding organic nutrients, their concentrations and their interactions on total chlorophyll concentration (mg 100g⁻¹ fresh weight), the percentage of total soluble solids and total carbohydrates (mg g⁻¹ dry weight) in leaves of the lettuce variety Fajr

Factors	F_p	df	Treatment	Chlorophyll in leaves (mg 100 g^{-1} fresh weight)	F_p	df	Total soluble solids in leaves (%)	F_p	df	Total carbohydrates in leaves (mg g^{-1} dry weight)
Planting dates (D)	<.001	3			<.001	3		<.001	3	
			first (F)	9.34			5.96			131.69
			second (S)	9.69			5.86			132.16
			third (T)	7.69			5.59			115.82
			fourth (U)	7.39			5.26			110.30
LSD				0.12			0.02			0.73
Application method (M)	<.001	1			<.001	1		<.001	1	
			S	8.89			6.00			124.52
			W	8.16			5.34			120.46
LSD				0.10			0.01			0.72
Concentrations M/L	<.001	4			<.001	4		<.001	4	
			0	6.99			4.61			110.37
			1.5Algaton	8.44			5.58			124.74
			2Algaton	8.87			5.83			126.20
			2Agrosign	8.85			6.12			123.06
			3Agrosign	9.49			6.22			128.09
LSD				0.19			0.02			0.92
D *M	<.001	3			<.001	3		<.001	3	
			F * S	9.97			6.43			137.62
			F * W	8.71			5.49			125.76
			S* S	10.11			6.02			133.43
			S * W	9.28			5.71			130.89
			T * S	8.00			5.96			116.10
			T * W	7.37			5.22			115.53
			U * S	7.49			5.57			110.95
			U * W	7.29			4.95			109.66
LSD				0.16			0.02			1.15
M *C lsd	<.001	4			<.001	4		<.001	4	
			0 * S	7.48			5.05			111.92
			0 * W	6.50			4.16			108.82
			1.5Algaton*S	8.49			5.93			125.62
			1.5Algaton*W	8.39			5.24			123.87
			2Algaton * S	9.53			6.04			129.78
			2Algaton * W	8.20			5.61			122.62
			2Agrosign*S	9.17			6.41			124.17
			2Agrosign*W	8.53			5.82			121.95

Factors	F_p	df	Treatment	Chlorophyll in leaves (mg 100 g^{-1} fresh weight)	F_p	df	Total soluble solids in leaves (%)	F_p	df	Total carbohydrates in leaves (mg g^{-1} dry weight)
			3Agrosign*S	9.79			6.56			131.13
			3Agrosign*W	9.19			5.87			125.05
LSD				0.25			0.02			1.33
lsd D *C	<.001	12			<.001	12		<.001	12	
			F * 0	7.92			4.52			113.58
			F*1.5Algaton	9.29			5.71			133.17
			F* 2Algaton	9.64			6.37			138.46
			F* 2Agrosign	9.91			6.84			133.83
			F* 3Agrosign	9.92			6.37			139.41
			S * 0	7.62			4.95			118.00
			S*1.5Algaton	9.75			5.54			136.62
			S* 2Algaton	10.18			6.01			135.98
			S*2Agrosign	10.35			6.31			136.60
			S*3Agrosign	10.57			6.50			133.59
			T * 0	6.31			4.72			108.20
			T*1.5Algaton	7.02			5.75			114.52
			T* 2Algaton	8.02			5.54			120.60
			T*2Agrosign	8.16			5.94			114.27
			T*3Agrosign	8.92			6.01			121.49
			U * 0	6.11			4.24			101.69
			U*1.5Algaton	7.70			5.34			114.66
			U*2Algaton	7.62			5.39			109.74
			U*2Agrosign	6.97			5.38			107.55
			U*3Agrosign	8.53			5.99			117.89
LSD				0.35			0.03			1.76
D*M* C lsd	<.001	12			<.001	12		<.001	12	
			F * 0* S	7.98			5.37			113.73
			F * 0* W	7.86			3.67			113.42
			F*1.5Algaton *S	9.74			6.07			138.79
			F*1.5Algaton *W	8.84			5.35			127.55
			F*2Algaton *S	10.43			6.72			148.97
			F*2Algaton *W	8.86			6.03			127.96
			F* 2Agrosign *S	10.93			7.51			139.03
			F* 2Agrosign *W	8.90			6.16			128.63
			F*3Agrosign *S	10.76			6.51			147.56
			F*3Agrosign *W	9.09			6.23			131.26
			S * 0 * S	8.67			5.23			119.68
			S * 0 * W	6.57			4.68			116.32
			S*1.5Algaton *S	9.57			5.49			133.08
			S*1.5Algaton *W	9.92			5.59			140.16
			S*2Algaton *S	10.73			6.11			137.42
			S*2Algaton *W	9.63			5.91			134.53

Factors	F_p	df	Treatment	Chlorophyll in leaves (mg 100 g^{-1} fresh weight)	F_p	df	Total soluble solids in leaves (%)	F_p	df	Total carbohydrates in leaves (mg g^{-1} dry weight)
			S *2Agrosign *S	10.69			6.27			136.80
			S *2Agrosign *W	10.01			6.36			136.40
			S*3Agrosign *S	10.87			6.99			140.15
			S*3Agrosign *W	10.27			6.01			127.02
			T * 0 * S	7.14			5.02			113.03
			T * 0 * W	5.48			4.41			103.36
			T*1.5Algaton *S	7.38			6.35			117.28
			T*1.5Algaton *W	6.66			5.14			111.75
			T*2Algaton *S	8.47			5.72			118.55
			T*2Algaton *W	7.57			5.36			122.65
			T *2Agrosign *S	8.00			6.23			112.03
			T *2Agrosign *W	8.32			5.65			116.50
			T*3Agrosign *S	9.03			6.50			119.63
			T*3Agrosign *W	8.81			5.52			123.36
			U * 0 * S	6.14			4.58			101.23
			U * 0 * W	6.09			3.90			102.16
			U*1.5Algaton *S	7.25			5.80			113.32
			U*1.5Algaton *W	8.14			4.88			116.00
			U*2Algaton *S	8.50			5.61			114.16
			U*2Algaton *W	6.74			5.17			105.31
			U* 2Agrosign *S	7.05			5.64			108.83
			U *2Agrosign *W	6.90			5.11			106.26
			U*3Agrosign *S	8.50			6.25			117.19
			U*3Agrosign *W	8.57			5.73			118.58
LSD				0.49			0.04			2.56

Table 7. Effect of planting dates, method of addition of organic nutrients, their concentrations and their interactionson the percentage of nitrogen, phosphorus and potassium on leaves of the lettuce variety Fajr

Factors	F_p	df	Treatment	Nitrogen in leaves (%)	F_p	df	Phosphorus in leaves (%)	F_p	df	Potassium in leaves (%)
Planting dates (D)	<.001	3			<.001	3		<.001	3	
			first (F)	3.66			0.238			3.80
			second (S)	3.30			0.244			3.32
			third (T)	2.94			0.219			2.89
			fourth (U)	2.97			0.227			1.75
LSD				0.09			0.007			0.48
Application method (M)	<.001	1			<.001	1		0.002	1	
			S	3.38			0.243			3.13
			W	3.06			0.220			2.75

Factors	F_p	df	Treatment	Nitrogen in leaves (%)	F_p	df	Phosphorus in leaves (%)	F_p	df	Potassium in leaves (%)
LSD				0.08			0.004			Ns
Concentrations M/L	<.001	4			<.001	4		<.001	4	
			0	2.33			0.200			2.53
			1.5Algaton	3.12			0.225			3.01
			2Algaton	3.49			0.234			3.12
			2Agrosign	3.35			0.240			2.90
			3Agrosign	3.80			0.260			3.15
LSD				0.09			0.006			0.07
D *M	0.004	3			<.001	3		0.206	3	
			F * S	3.76			0.256			4.04
			F * W	3.56			0.220			3.56
			S* S	3.61			0.244			3.35
			S * W	2.99			0.243			3.29
			T * S	3.02			0.248			3.10
			T * W	2.87			0.190			2.68
			U * S	3.11			0.225			2.05
			U * W	2.82			0.229			1.46
LSD				NS			0.008			Ns
M *C lsd	0.008	4			<.001	4		<.001	4	
			0 * S	2.46			0.219			2.67
			0 * W	2.19			0.181			2.39
			1.5Algaton*S	3.31			0.241			3.14
			1.5Algaton*W	2.93			0.209			2.87
			2Algaton * S	3.66			0.230			3.39
			2Algaton * W	3.32			0.238			2.85
			2Agrosign*S	3.57			0.257			3.07
			2Agrosign*W	3.12			0.224			2.72
			3Agrosign*S	3.87			0.269			3.40
			3Agrosign*W	3.74			0.250			2.90
LSD				NS			0.008			0.20
lsd D *C	<.001	12			<.001	12		<.001	12	
			F * 0	2.87			0.212			3.05
			F*1.5Algaton	3.59			0.233			3.80
			F* 2Algaton	3.90			0.242			4.27
			F* 2Agrosign	3.87			0.248			3.73
			F* 3Agrosign	4.06			0.257			4.15
			S * 0	2.47			0.202			2.81
			S*1.5Algaton	3.24			0.244			3.49
			S* 2Algaton	3.49			0.239			3.47
			S*2Agrosign	3.45			0.244			3.48
			S*3Agrosign	3.85			0.289			3.35
			T * 0	2.02			0.190			2.73

Factors	F_p	df	Treatment	Nitrogen in leaves (%)	F_p	df	Phosphorus in leaves (%)	F_p	df	Potassium in leaves (%)
			T*1.5Algaton	2.77			0.212			2.86
			T* 2Algaton	3.20			0.221			3.00
			T*2Agrosign	3.24			0.231			2.78
			T*3Agrosign	3.48			0.240			3.08
			U * 0	1.94			0.197			1.51
			U*1.5Algaton	2.89			0.212			1.89
			U*2Algaton	3.36			0.233			1.76
			U*2Agrosign	2.82			0.240			1.59
			U*3Agrosign	3.83			0.254			2.01
LSD				0.17			0.012			0.49
D*M* C lsd	<.001	12			<.001	12		<.001	12	
			F * 0* S	3.19			0.226			3.17
			F * 0* W	2.56			0.197			2.92
			F*1.5Algaton *S	3.73			0.248			3.85
			F*1.5Algaton *W	3.46			0.217			3.75
			F*2Algaton *S	3.95			0.263			4.69
			F*2Algaton *W	3.84			0.221			3.86
			F* 2Agrosign *S	3.80			0.263			3.94
			F* 2Agrosign *W	3.94			0.229			3.52
			F*3Agrosign *S	4.12			0.278			4.54
			F*3Agrosign *W	4.00			0.235			3.76
			S * 0 * S	2.55			0.224			2.77
			S * 0 * W	2.39			0.179			2.85
			S*1.5Algaton *S	3.82			0.265			3.41
			S*1.5Algaton *W	2.66			0.222			3.57
			S*2Algaton *S	3.92			0.182			3.51
			S*2Algaton *W	3.06			0.296			3.43
			S *2Agrosign *S	3.77			0.264			3.47
			S *2Agrosign *W	3.13			0.224			3.50
			S*3Agrosign *S	3.99			0.282			3.59
			S*3Agrosign *W	3.71			0.294			3.12
			T * 0 * S	2.22			0.219			2.98
			T * 0 * W	1.82			0.161			2.49
			T*1.5Algaton *S	2.94			0.234			3.05
			T*1.5Algaton *W	2.60			0.190			2.67
			T*2Algaton *S	3.05			0.246			3.23
			T*2Algaton *W	3.36			0.196			2.76
			T *2Agrosign *S	3.39			0.266			3.03
			T *2Agrosign *W	3.10			0.196			2.53
			T*3Agrosign *S	3.49			0.274			3.19
			T*3Agrosign *W	3.47			0.206			2.96
			U * 0 * S	1.89			0.206			1.73

Factors	F_p	df	Treatment	Nitrogen in leaves (%)	F_p	df	Phosphorus in leaves (%)	F_p	df	Potassium in leaves (%)
			U * 0 * W	2.00			0.187			1.29
			U*1.5Algaton *S	2.77			0.216			2.26
			U*1.5Algaton *W	3.00			0.207			1.51
			U*2Algaton *S	3.71			0.227			2.15
			U*2Algaton *W	3.01			0.238			1.37
			U* 2Agrosign *S	3.32			0.235			1.84
			U *2Agrosign *W	2.33			0.246			1.35
			U*3Agrosign *S	3.88			0.242			2.26
			U*3Agrosign *W	3.78			0.266			1.76
LSD				0.25			0.017			0.53

nutrients showed a significant superiority over the comparison treated plants, the effect increased by increasing the concentration and the highest average of it was in the plants treated with Agrosign at a concentration of 3 ml L^{-1}, as for the planting date interaction with the addition method, it was found that the spraying method of the third date plants exceeded in both the fresh and dry weight of the roots (8.72 and 2.910 g) while the watering method for the second date plants exceeded in the fresh and dry weights of the stems (164.80 and 21.72 g). the interaction of the method of addition with the concentration resulted in the superiority of the spraying method with Agrosign at a concentration of 3 ml L^{-1} in the fresh and dry weights of the roots, reaching 8.46 and 3.336 g, while the plants that were watered with the nutrient at the same concentration exceeded in the fresh and dry weights of the stems reaching 137.63 and 21.24 g. Third date plants treated with Agrosign at a concentration of 3ml L^{-1}exceeded in both the fresh and dry weight of the roots (9.40 and 3.749 g), and the second date plants treated with Agrosign at a concentration of 2 ml L^{-1} exceeded in the fresh and dry weight of the stems (157.83 and 22.81 g) when the planting date interacted with the concentration. The triple interaction of treatments showed the superiority of the third date plants that were sprayed with Agrosign at a concentration of 3ml L^{-1} in the fresh and dry weight of the roots, reaching 10.05 and 4.052 g each, while the second date plants that were watered with the nutrient at the same concentration exceeded in the fresh and dry weights of the stems reaching 184.00 and 25.29 g. respectively.

Table 5 results show the effect of the treatments and their interactions on the fresh and dry weights of leaves, the marketing head weight and the total marketing production, as the plants of the second and first dates respectively exceeded, with a non-significant difference between them, as well as the method of spraying with organic nutrients and the plants treated with Agrosign at a concentration of 3ml L^{-1} with that treatment with Algaton At a concentration of 2 ml L^{-1} significantly in the mentioned characteristics.

The results showed the superiority of the spraying method for the first date plants in the weight of the marketing head (676.61 g) and the total marketing production (15.88 ton ha^{-1}) when the planting date interacted with the method of addition. As for the interaction of the addition method with concentration, the plants that were sprayed with Agrosign at a concentration of 3 ml L^{-1} were superior in the mentioned characteristics. the interaction of the planting date with the concentration resulted in the superiority of the first date plants treated with Agrosign at a concentration of 2 ml L^{-1} in both fresh and dry weight of the leaves , reaching 561.17 and 21.50 g, while the plants of the same date - treated with Agrosign at a concentration of 3 ml L^{-1} exceeded in the marketing head weight (706.39 g) and the total marketing production(16.58 ton ha^{-1}). The triple interaction of the same date with the Algaton spray method at a concentration of 2 ml L^{-1} showed a significant superiority in the mentioned characteristics.

Table 6 results show that the highest average of total chlorophyll in the leaves was observed in the second date plants, as it reached 9.69 mg100 g^{-1}fresh weight, while the first date plants exceeded in the percentage of total soluble solids, reaching 5.96%, and plants of both dates the second and first respectively, with a non-significant difference between them exceeded in the total carbohydrates, as they reached 132.16 and 131.69 mg g^{-1} dry weight each. The spray method was superior in the mentioned characteristics when compared to the watering method. The plants treated with organic nutrients showed a significant superiority over the comparison treatment plants, and the highest average for them was in the plants treated with Agrosign at a concentration of 3 ml L^{-1} for the same characteristics. the interaction of the planting date with the method of addition showed that the method of spraying for second date plants exceeded in the total chlorophyll concentration in leaves (10.11 mg 100 g^{-1} fresh weight) while the first date plants of the same method exceeded in the percentage of total soluble solids (6.43%) and total carbohydrates (137.62 mg g^{-1} dry weight). When the addition method interacted with the concentration, the Agrosign spray method with a concentration of 3 ml L^{-1} liter was superior in the mentioned characteristics. The second date plants treated with Agrosign at a concentration of 3 ml

L^{-1} exceeded in the total chlorophyll rate in the leaves (10.57 mg 100 g^{-1} fresh weight) and the first date plants treated with Agrosign at a concentration of 2 ml L^{-1} exceeded in the percentage of soluble solids and total carbohydrates (6.84% and 133.83 mg g^{-1} dry weight) when the planting date interacted with the concentration. The triple interaction of treatments showed that the second date plants sprayed with Agrosign at a concentration of 3 ml L^{-1} exceeded in the total chlorophyll (10.87 mg 100 g^{-1}fresh weight), while the first date plants that were sprayed with Agrosign at a concentration of 2 ml L^{-1} exceeded in the percentage of total dissolved solids (7.51%), and the plants of the same date that were sprayed with Algaton at a concentration of 2 ml L^{-1} exceeded the in total carbohydrates in the leaves, reaching 148.97 mg g^{-1}dry weight.

Table 7 shows that there is a decrease in the percentage of nitrogen and potassium in the leaves with the advance of the planting date, as the first date plants exceeded in that, and the percentage for each was 3.66 and 3.80%. The second and first date plants respectively, with an insignificant difference between them exceeded in the percentage of phosphorus, as it reached 0.244 and 0.238% for each. The method of adding organic nutrients by spraying significantly increased the nitrogen and phosphorus percentage in leaves when compared to the watering method. It was observed that the plants treated with nutrients were superior in the percentage of the elements mentioned in the table to the comparison treatment plants, and the Agrosign treated plants at a concentration of 3ml L^{-1} were the most superior in that. The interaction of first date plants with the method of spraying with organic nutrients exceeded in the percentage of phosphorus, reaching 0.256%. When the method of addition interacted with the concentration, the plants that were sprayed with Agrosign at a concentration of 3ml L^{-1} exceeded in the phosphorus and potassium percentage, reaching 0.269 and 3.40% for each. First date plants that were sprayed with Agrosign at a concentration of 3 ml L^{-1} exceeded in the percentage of nitrogen (4.06%), second date plants at the same concentration in the percentage of phosphorus (0.289%), and first date plants that were sprayed with Algaton at a concentration of 2ml L^{-1}in the percentage of potassium (4.27%), when the planting date interacted with the concentration. The triple interaction between the first date plants sprayed with Agrosign at a concentration of 3ml L^{-1} showed a significant superiority in the percentage of nitrogen in the leaves (4.12%), while the second date plants that were watered with Algaton at a concentration of 2 ml L^{-1} exceeded in the percentage of phosphorus in the leaves, reaching 0.296%. also, the first date plants sprayed with Algaton at a concentration of 2 ml L^{-1} were significantly superior in the percentage of potassium in the leaves, reaching 4.69%.

The results indicate the superiority of the first (22/10) and second (22/11) dates in most of growth and vegetative growth indicators under study, perhaps due to the favorable climatic conditions represented by temperature and light period to form a good vegetative growth and increase in the nutrients manufactured by photosynthesis which reflected an increase in the total carbohydrate (Table 6), and this increased the marketing head weight (Table 5) due to the increase in the number of wrapped leaves (Table 3), and in result reflected an increase in the total marketing production (Table 5).

This is consistent with what Matloob et al. [1] mentioned that the success of lettuce cultivation depends on the average of temperature during growth. (Table 3) also show an increase in the number of unwrapped leaves as the planting date was delayed because of the increase in temperature and daylight length of which led to the emergence of bitter taste in the fourth date yield (22/1), this is consistent with what Sharma et al. [22] found that it is possible to grow lettuce for the period from October to January, as it was possible to obtain a good crop compared to the late dates that led to a lower yield, except in the case of a heat-resistant variety, when planting lettuce variety Green Wave in Bangladesh.

It is clear from the results that improving the growth and productivity of lettuce plants sprayed with a high concentrations of organic nutrients may be due to the seaweed extracts content of plant stimuli and hormones necessary for growth that lead to an increase in the plant growth strength and absorption of essential nutrients such

as nitrogen, phosphorus and potassium and the reflection of this in increasing production and improving its quality [23], also spraying it on the total vegetative may help stimulate the growth and development of plants and increase the efficiency of photosynthesis and its reflection on the vegetative growth characteristics and yield ([24] on the mango), furthermore the presence of cytokines helps the transition of nutrients and directing them towards the vegetative system, induces the physiological processes and increases the chlorophyll and photosynthesis which reflects on the vegetative growth. Also, the presence of hormones in the extract reduces the stress that the plant is exposed to and increases the ability of the root to absorb nutrients, thereby increases the vegetative growth indicators ([25] on onions). The method of adding seaweed extracts to the soil by watering may lead to an increase in nutrients absorption which is reflected on the vegetative growth, consistent with Valarini et al. [6] who indicated that the organic substance helps in improving the physical and chemical properties of the soil and increases the weight and strength of the root system that affects the vegetative growth and productivity.

CONCLUSIONS

It is concluded from the experience that the most appropriate date for planting Fajr lettuce seeds in the desert lands of southern Iraq is on the dates 22/10 and 22/11, and the organic nutrient Agrosign can be added by spraying with a concentration of 3 ml L^{-1} to obtain the highest head weight, with high productivity and good quality.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Matloob AN, Ezzedine SM, Karim SA. Vegetables production, part one. Dar Al Kutb Prin. Publ. Univ. Mosul: 1989;680.
2. Al-Dijawi A. The technology of cultivating and producing vegetables. Agricultural Library. Egypt. 1996;444.
3. CSO. Central Statistical Organization. Bagdad. Iraq; 2019.
4. Al-Tai, Abd Jabbar I, Al-Assaf MA, Abdullah MA. The effect of planting dates and nitrogen fertilizers on the growth and yield of lettuce (the local variety). The Second Technical Scientific Conference / Technical Institutes Foundation; 1990.
5. El-Habar MTA, Al-Saaberi MRS. Effect of some Agricultural treatments on growth and yield of lettuce *Lactuca sativa* L. Mesopotamia J. of Agric. 2008;36(1):56–66.
6. Kaleri AH, Kaleri AA, Kaleri GA, Wahocho NA, Kaleri SH, Kaleri MK, Kaleri AA, Kaleri SH, Rajput SY. Effect of sowing dates on the growth and yield of lettuce (*Latuca sativa* L.) International Journal of Information Research and Review. 2016;03(07):2617–2619.
7. Tisdale SL, Nelson WL, Beaton JD, Havlin JL. Soil fertility and fertilizer. 5th Ed. The Macmillan pub. Co. New York. NY. USA; 1997.
8. Alwan ARA, Al-Hamim FHI. Aquatic plants and algae. Part One. Ministry of Higher Education and Scientific Research. University of Basra – Iraq. 1991;472.
9. Van–Staden, Crouch J, Bechett RP. UN/ FRD research unit for plant growth and development of botany. University of Natal. Piertermaritzburg. South Africa; 1999.
10. Al-Dulaimi HE. The effect of some nutrients, growth media and breeding method on carnation flowers production. M.Sc. Thesis. College of Agriculture. University of Kufa – Iraq; 2005.
11. Al-Allaf MSA. The effect of mulching and spraying with licorice extract and jamex on the growth and yield of lettuce *Lactuca sativa* L. M.Sc. Thesis. College of Agriculture and Forestry. University of Al Mosul. Iraq; 2009.
12. Al-Othaimin, Abdul-Aziz HS. Physiological studies of growth rates and cellular savings productivity of *Lactuca sativa* L. using a food source from algae extract *Sargassum crassifolia*. M.Sc. Thesis, College of Applied Sciences, Umm Al-Qura University. Saudi Arabia; 2010.

13. Al-Samaraee SMS, Hassan Abb Razzak O. The effect of spraying of the extract of sea algae on vegetative growth, flowering in *Tagetes erectal* L. Journal of Thi-Qar University for Agricultural Researches. 2012;1(1):201–210.
14. Kareem ZHK, Al-Ajil S, Abd Hadi S. The effect of spraying marine algae extract and the foral induction treatments on the growth and production of cauliflower *Brassica oleracea* var. botrytis. Kufa Journal for Agricultural Science. 2012;4(1):165–178.
15. Khalil, Abd Moneim S, Al-Hubeiti Abd Jabbar I. Response of lettuce plant (*Paris island* cos cv.) to humic acid and seaweed extract alga – 300 spray. Euphrates Journal of Agriculture Science. 2013;5(4):256–265.
16. Al-Muzaira'a HSJ. Effect of flliar spraying agrosin marine seaweed extract and plant growth (NAA) on growth yield hybrids of eggplant *Solanum melogena* L. M. Sc. Thesis. College of Agriculture. University of Basra – Iraq; 2013.
17. Al Rawi KM, Khalaf Allah AM. Designing and analyzing agricultural experiments. Dar Al Kutub Institution for Printing and Publishing. University of Mosul. Iraq. 1980;488.
18. Abbas MF, Abbas MC. Storage of fruits and vegetables. Dar Al Hikma Printing. University of Basra – Iraq. 1992;142.
19. Dubois MK, Crilles KA, Hamiltor JK, Rebers DA, Smith F. Colorimetric method for determination of sugars and related substances. Anal Chem. 1956;28:350-35.
20. Page AL, Miller RH, Keeney DR. 2nd. Ed Madison Son, Wisconsin, USA. 1982;1159.
21. Murphy T, Riley JR. A modified single solution method for the determination of phosphate in natural water. Anal. Chem. Acta. 1962;27:31–36.
22. Sharma PCD, Rahman MM, Mollah MAH, Islam MS. Influence of method and date of planting on the production of lettuce. Bangladesh J. Agril. Res. 2009;34(1):75-80.
23. Dawood ZA, Alalaf AH, Alalam ATS. Effect of foliar spray of seaweed extract algareen and urea on vegetative growth of *Pistacia khinjuk* stocks transplant. Mesopotamia Journal of Agriculture. 2013; 41(1):59–68.
24. Abd El-Motty Z, Shahim FM, El-Shiekh H, Abd El-Migeed MM. Effect of alge extract and yeast application on growth nutritional status, yield and fruit quality of Keitte mango trees. Agriculture of Biological Journal American. 2010;1(3):421–429.
25. Hidangmayum A, Sharma R. Effect of different concentration of commercial seaweed liquid extract of (*Ascophyllum nodosum*) as a plant bio stimulant on growth yield and biochemical of onion (*Allium cepa* L.). Journal of pharma-cognosy and photochemistry. 2017;6(4): 658–663.
26. Valarini PJ, Curaqueno G, Seguel A, Manzano K, Rubio R, Cornejo P, Borie F. Effect of compost application on some properties of a volcanic soil from central south chili. Chilean Journal of agricultural Research. 2009;69(3):416-425.

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