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Partial and Full Substitution of Chemical Fertilizer by Organic Fertilizer in Presence of Bio Fertilizer and Seaweed Extract and Its Influences on Productivity and Quality of Head Lettuce Plants

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ABSTRACT

This study was undertaken during the two winter seasons (2014/2015 and 2015/2016) in a private Farm at Kafr Elsohbi Village, Shiben Elqanter, Qalubia Governorate, Egypt, to evaluate the partial and full substitution of mineral nitrogen fertilizer by organic fertilizer in presence of bio fertilizer, foliar spray with different concentrations of seaweed extract (Algreen) and their combinations on vegetative growth parameter, chemical composition, total yield and quality of head for lettuce plants (*Lactuca sativa var. capitata*) cv. Great lakes, grown under sandy loam soil condition during the winter season. Obtained results showed that the tallest plant and the highest number of leaves/plant were recorded by the combination between 100% mineral fertilizer treatment (T1) and seaweed extract at 3ml/l-sprayed plants, whereas the largest head diameter and the heaviest fresh and dry weights/plant and total yield/fed. were achieved by the combination between 200% organic fertilizer (T5) and seaweed extract at 3ml/l, followed by the combined treatment between T1 and seaweed extract at 3ml/l . T1 treatment statistically induced the highest values of leaf N, P, K and total carbohydrates content, followed by the treatment of T5, particularly those received seaweed extract at 3ml/l. additionally, the highest values of leaf total sugars contents were gained by the treatment of 100% organic fertilizer (T4) and 200% organic fertilizer (T5), particularly those received seaweed extract at 3ml/l. Furthermore, the treatments of T4 and T5 statistically decreased leaf nitrate content, especially those sprayed with seaweed extract at 3ml/l when compared with the treatment of T1, particularly those received no seaweed extract which induced the highest values of leaf nitrate content in the two seasons.

Keywords: head lettuce, organic and chemical fertilizers, seaweed extract, productivity, chemical composition and nitrate content.
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INTRODUCTION

Lettuce (*Lactuca sativa* L.) is the most popular salad vegetable crop grown in Egypt, (Midan and Sorial, 2011). Lettuce is considered as an important source of minerals and vitamins as it is consumed as a fresh green salad (Hanafy *et al*.,2000). Also, lettuce leaves are rich source of antioxidants, vitamins A, C and phytochemicals which are anticarcinogenic (Masarirambi *et al*.,2012).The total cultivated area of lettuce in Egypt is about 10813 feddan, which produced about 113179 tons (Ministry of Agriculture and Land Reclamation (EAS), Economic Affairs Sector 2014). Lettuce is a shallow-rooted crop and needs an extensive amount of nitrogen fertilizer to produce high yield. Nitrogen is very important factor for inducing high yield and average head weight of lettuce (Hosseny and Ahmed, 2009). Additionally, nitrogen is the most limiting nutritional factor for crop production in arid and semiarid regions (Sukor, 2013). Nitrate accumulation is one of the most problem facing production of lettuce plant (Hanafy *et al*., 2000). Tests of nitrate accumulation in Egyptian vegetables, including lettuce showed considerable higher records when compared to those found in vegetables grown in several European countries. In this concern, high nitrate accumulation in vegetable crops has been found to be responsible for methemoglobinemia, particularly in babies (Al-Redhaiman, 2002). Also, an increase in N fertilizer led to increase in nitrate content of the crop tissues without significant increment in the yield (Custic, *et al*., 1994). Furthermore, increasing the use of chemical fertilizers lead to the high cost of vegetable production and increases the pollution of agricultural environment as well as affects the soil fertility (Hosseny and Ahmed, 2009). Consumers prefer fresh vegetables among the most popular organic plants products. Thus, the application of organic nitrogen sources as fertilizers for the production of vegetable crops and particularly for the organic production of vegetables are an important demand (Smith and Hadley, 1989). Organic fertilizers can be used to reduce the amount of toxic compounds such as nitrates accumulation by mineral fertilizers in vegetables like head lettuce plant (Masarirambi *et al*., 2012).

Organic agricultural need continuous application of manure fertilizers to increase the nitrogen, phosphorus, potassium, calcium, and magnesium contents in the soil (Watts *et al*., 2010). So, organic fertilizers are added to soils and mineralization process begins, inorganic nitrogen is released and absorbed by the plants (Lobell, 2007).

Bio fertilizers are microbial inoculants which may help in increasing vegetable crops productivity. That is through improve plant growth directly, production of phytohormones, mainly growth promoters and through nitrogen fixation and production of bio-control agents (Ahmed and Kibret, 2014).

Seaweed extract are known as a source of plant growth regulators. As it contains significant amounts of cytokinins, auxins and betaines, which could have promoted cell division, so promote the vegetative growth and productivity in many stages (Jameson, 1993). Also, it increases flower formation and thus total fruit production, while by enhancing chlorophylls concentration could improve CO2 assimilation rate. Furthermore, seaweed has been shown to increase the assimilation rate and to also increase nutrient uptake as well as nitrate reduction and photosynthesis, thus increasing assimilates provided to the plant (Blunden *et al*., 1997).

Therefore, this study was an attempt to evaluate the partial and full supplementation substitution of mineral nitrogen fertilizer by organic fertilizer in presence of bio fertilizer, foliar spray with seaweed extract (Algreen) and their interaction on vegetative growth parameters, chemical composition, total yield and quality of head lettuce (*Lactuca sativa* var. capitata) cv. Great lakes.

MATERIALS AND METHODS

Two field experiments were conducted during the two winter seasons (2014/2015and 2015/2016) in a private farm at Kafr Elsohbi Village, Shiben Elqanter, Qalubia Governorate, to study the partial and full substitution of mineral nitrogen fertilizer by organic fertilizer in presence of bio fertilizer and foliar spray with different concentrations of seaweed extract (Algreen) as well as their combinations on vegetative growth parameter, chemical constituents, total yield and quality of head lettuce (*Lactuca sativa* var. capitata) cv. Great lakes, grown under sandy loam soil during the winter season. Physical and chemical characters of the used soil as average of both seasons are shown in Table 1 Physical analysis was determined according to Jackson (1973), whereas chemical analysis was determined according to Black *et al.*(1982). Lettuce transplants were transplanted at the second week of November in the two growing seasons and harvested after 10 weeks from transplanting.

Table 1: physical and chemical analyses of the utilized soil

Physical analysis		**Chemical analysis**			
		Cations (meq/l)		**Anions (meq/l)**	
Coarse sand	19.6%	Ca^{++}	9.03	CO_3^{--}	Zero
Fine sand	36.3%	Mg^{++}	2.98	HCO_3^-	3.97
Silt	27.6%	Na^+	3.87	Cl^-	5.14
Clay	16.5 %	K^+	1.61	SO_4^{--}	7.88
Texture class: Sandy loam					
Soil pH	7.78		Available N	29.55 mg/kg	
E.C (dS/m)	1.48		Available P	13.41 mg/kg	
Organic matter	1.92%		Available K	152.2 mg/kg	

Head lettuce seedlings were transplanted at 20 cm apart on the two sides of ridge. Each experimental plot included one row 20m length and 70 cm width with an area of 14m^2. A drip irrigation system with nozzles of 20 cm in-between was employed for fertigation process. Horticultural management, irrigation, diseases and pests control programs were conducted when needed as recommended by Egyptian Ministry of Agriculture.

Organic fertilizer treatments: Organic manure i.e., compost at the doses of 3, 4.5, 6 and 12 tons /fed. were applied before planting during soil preparation in the two seasons as an equivalent doses to 50, 75, 100 and 200 % of the recommended dose of nitrogen mineral fertilizer (60 kg N/fed). The chemical properties of the used compost are listed in Table 2.

Table 2: Chemical properties of the used compost

Parameters	**Ec dS.m^{-1} (1:5)**	**pH (1:5)**	**Total C %**	**Total N %**	**Total P %**	**Total K %**	**Ca %**	**Mg %**	**C:N Ratio**
Reading	2.14	6.45	19.27	1.01	0.77	1.31	1.24	0.69	19:1

Chemical fertilizer treatments: The plants received chemical fertilizers at the recommended doses of NPK (60: 32: 24 N: P_2O_5: K_2O Kg/fed.) in the form of (ammonium sulphate 20.6 N%, phosphoric acid 80% P_2O_5 and potassium sulphate 48% K_2O). Chemical fertilizers doses were added throughout drip irrigation system during the growing stage in the two seasons of this study.

Bio fertilizer treatment: A mixture of nitrobein, phosphorein, potassin contained efficient strains of nitrogen fixing bacteria (*Azotobacter chroococcum*) and phosphate dissolving bacteria (PDB) (*Bacillus megaterium var phosphaticum*) as well as silicate dissolving bacteria (SDB) (*Bacillus circulans*) which were produced by the department of Microbiology, Agric. Res. Center, Giza was applied at the rate of 2 l/fed. through drip irrigation four times at one week by interval, starting after two weeks from transplanting in the two seasons.

This experiment contained 20 treatments resulted from the interaction between five fertilization treatments and four seaweed extract foliar spray treatments as follows.

a. Fertilization treatments:

1. T1: Control (100% recommended dose of mineral N)
2. T2: 50 % mineral N + 50 % organic N + bio fertilizer
3. T3: 25 % mineral N + 75 % organic N + bio fertilizer
4. T4: 100 % organic N + bio fertilizers
5. T5: 200 % organic N + bio fertilizers

b. Seaweed extracts foliar spray treatments.

1. Control treatment (spray with tap water).
2. Seaweed extract (Algreen) at 1 ml/l.
3. Seaweed extract (Algreen) at 2 ml/l.
4. Seaweed extract (Algreen) at 3 ml/l.

Head lettuce plants were subjected to foliar spray with the aforementioned seaweed extract five times, each at one week by interval, the first one was after three weeks from planting time in both seasons. The chemical composition of the used seaweed extract are shown in Table 3.

Table 3: Chemical composition of the used seaweed extracts (Algreen)

Parameters	**Oliga skrades**	**Manitol**	**Cytokinins**	**Betaine**	**N %**	**P_2O_5**	**Alginic acid**	**Zeatin**	**IAA**	**Boron**	**Mn**	**Mg**
Reading	0.3%	0.001	0.001	0.02	6%	9.6%	4%	0.003%	0.002%	0.5%	0.26%	6%

The design of the experiment was a split plot design with three replicates, as the fertilization treatments were employed in the main plots, where the seaweed extract foliar spray treatments were devoted randomly in the sub plots.

Data recorded:

At the end of the experiments (after ten weeks from transplanting) the following data were taken:

1-Vegetative growth parameters:

Plant height, head diameter, number of leaves/plant, total fresh and dry weights of plant and total fresh yield ton/fed.

2-Chemical composition parameters:

Leaf nitrogen, phosphorus, potassium, total carbohydrates and total sugars (%) were determined according to, Pregl (1945), John (1970), Brown and Lilleland (1946), Herbert *et al*. (1971) and A.O.A.C (1990), respectively. Whereas, nitrate content in head lettuce leaves was determined according to the method described by Cataldo *et al*. (1975).

Statistical Analysis:

The obtained results here in this study of the two seasons were subjected to analysis of variance as factorial experiments in split plot design. Duncan's analysis was used to differentiate between means according to Snedecor and Cochran (1991).

RESULTS AND DISCUSSION

1- Vegetative growth parameters:

Data in Table 4 clear that the tallest plant and the highest number of leaves/plant were scored by 100% mineral fertilizer treatment; control (T1), followed by using 200% organic N fertilizer (T5). The difference between the aforementioned two treatments were not significant except in case of number of leaves/plant in the second season only. Whereas, the largest head diameter was gained by T5-fertilized plants, followed by T1-fertilized plants, with no significant differences between them in the two seasons. Otherwise, the lowest values of plant height, head diameter and leaves number/plants were registered by 100% organic fertilized- plants (T4), followed in ascending order by 25% mineral N+75% organic fertilizer treatment (T3) in the two seasons. The remained treatment i.e., 50% mineral N+50% organic (T2) occupied an intermediate position between the abovementioned treatments in the two seasons. In this respect, Olaniyi, (2008), Hosseny and Ahmed (2009), Masarirambi, *et al*.,(2012), Shams, *et al*.(2013), Cheng *et al*.(2014), Shahein *et al*.,(2014) all working on lettuce reported that all studied vegetative growth parameters were affected by mineral and organic nitrogen fertilizers.

Table 4: Effect of nitrogen fertilizers and foliar spray with seaweed extract and their interactions on vegetative growth parameters of head lettuce during the two seasons of study.

Treatment		First season (2014/2015)			Second season (2015/2016)		
fertilization	Foliar spray	Plant height (cm)	Head diameter (cm)	No. of leaves/ plant	Plant height (cm)	Head diameter (cm)	No. of leaves/ plant
100% mineral N (T1)		19.55a	17.8ab	31.4a	18.30a	16.1ab	30.3a
50%mineral N+50% organic (T2)		18.35b	16.5b	30.1ab	17.25bc	15.5b	28.2b
25%mineral N+75% organic (T3)		16.95c	15.9c	29.5bc	16.45c	14.2c	26.3c
100% organic N (T4)		14.75d	15.12c	28.4c	14.93d	13.3c	25.5c
200% organic N (T5)		19.02ab	18.3a	30.8a	17.70ab	16.6a	29.1b
	Control	15.64d	15.3b	28.7b	15.32d	13.8b	26.1c
	Seaweed extract at 1ml/l	17.16c	16.1b	29.9a	16.16c	14.7b	27.7b
	Seaweed extract at 2ml/l	18.60b	17.4a	30.6a	17.68b	15.7a	28.5ab
	Seaweed extract at 3ml/l	19.50a	18.1a	31.1a	18.57a	16.3a	29.2a
100% mineral N (T1)	Control	17.10e-g	16.3e-h	29.6b-h	16.40d-g	14.6a-h	29.2b-f
	Seaweed extract at 1ml/l	19.20b-d	17.4b-e	31.6a-d	17.90b-e	15.8b-f	30.a-d
	Seaweed extract at 2ml/l	20.60ab	18.6abc	32.1ab	19.10ab	16.8a-d	30.8ab
	Seaweed extract at 3ml/l	21.30a	19.1a	32.4a	19.80a	17.3ab	31.2a
50%mineralN+50% organic (T2)	Control	16.20f-h	14.9ghi	28.8e-h	15.80f-h	14.1e-i	26.1hi
	Seaweed extract at 1ml/l	17.90d-f	15.3f-i	29.9a-h	16.30e-g	15.0d-h	28.3d-g
	Seaweed extract at 2ml/l	19.10b-d	17.6b-e	30.6a-g	18.20a-d	16.1a-e	29.1b-f
	Seaweed extract at 3ml/l	20.20a-c	18.2a-d	31.2a-e	18.70a-c	16.8a-d	29.6a-e
25%mineralN+75% organic (T3)	Control	15.20hi	14.6hi	28.1gh	15.10gh	13.1hi	24.1jk
	Seaweed extract at 1ml/l	16.10f-h	15.1f-i	29.2d-h	15.70f-h	13.8f-i	26.0h-j
	Seaweed extract at 2ml/l	17.90d-f	16.7d-g	30.1a-g	17.10c-f	14.9d-h	27.3f-h
	Seaweed extract at 3ml/l	18.60c-e	17.4b-e	30.6a-g	17.90b-e	15.3b-g	28.1e-g
100% organic N (T4)	Control	12.90j	14.1i	27.4h	13.20i	12.4i	23.9k
	Seaweed extract at 1ml/l	14.20ij	14.9ghi	28.2f-h	14.10hi	13.1hi	25.3i-k
	Seaweed extract at 2ml/l	15.60g-i	15.4f-i	29.0d-h	15.30f-h	13.7g-i	26.1hi
	Seaweed extract at 3ml/l	16.30f-h	16.1e-h	29.3c-h	17.10c-f	14.2e-i	26.9g-i
200% organic N(T5)	Control	16.80e-h	16.9c-f	29.6b-h	16.10e-g	15.2c-g	27.6f-h
	Seaweed extract at 1ml/l	18.40c-e	17.6b-e	30.8a-f	16.80d-g	16.1a-e	28.8c-g
	Seaweed extract at 2ml/l	19.80a-c	19.1ab	31.2a-e	18.70a-c	17.2a-c	29.6a-e
	Seaweed extract at 3ml/l	21.10a	19.6a	31.9a-c	19.20ab	17.9a	30.4a-c

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at5%

As for the effect of seaweed extract "Algreen", data in Table 4 report that all tested seaweed extract concentrations increased the values of plant height, head diameter and leaves number/plant when compared with un-treated control plants in the two seasons. As a matter of fact, the increases in plant height, head diameter and leaves number values were proportionally with the increment of seaweed extract concentrations, hence the tallest plant, the largest head diameter and the highest leaves number/plant were scored by 3ml seaweed extract/l-sprayed plants in the two seasons. Obtained results are in agreement with those reported by Zewail (2014) and Abo Sedera *et al*.(2016) using seaweed extract improved vegetative growth of bean plants.

Considering the interaction effect between fertilization and seaweed extract treatments, data in the same Table reveal that the combination of T1 and T5 with spraying the plants with the highest concentration of seaweed extract (3ml/l) showed to be the most effective ones for inducing the highest values of plant height, head diameter and leaves number/plant in the two seasons of study. In contrast, the lowest values of these parameters were scored by the combination of T4 and T3, particularly those received no seaweed extract sprays in the two seasons.

2-Yield parameters:

Data given in Table 5 show that yield parameters of head lettuce i.e., average fresh and dry weights/plant and total yield/fed. were greatly affected by all utilized fertilization treatments, with superior for T5 treatment, followed in descending order by T1 treatment, without significant differences between them in the two seasons except in case of plant dry weight in the second season which was higher in case of T5. On the opposite side, the lowest values of yield parameters were scored by T4 and T3 treatments in the two seasons. Treatment (T2) 50% mineral-N +50% organic N ranks the second after T5 and T1 with significant differences among them in case of total produced yield and its components during both seasons of study. Obtained results are nearly similar to those reported by Olaniyi (2008), Hosseny and Ahmed (2009), Masarirambi *et al*.,(2012), Shams *et al*.(2013), Cheng *et al*.(2014), Shahein *et al*.(2014).

Table 5: Effect of nitrogen fertilizers and foliar spray with seaweed extract and their interactions on yield parameters of head lettuce during the two seasons of study.

Treatment		First season (2014/2015)			Second season (2015/2016)		
fertilization	Foliar spray	Average fresh weight/ plant(g)	Plant dry weight (g)	Total yield (ton/fed)	Average fresh weight/ plant(g)	Plant dry Weight (g)	Total yield (ton/fed)
100% mineral N (T1)		624a	76.60a	37.49a	555a	69.72b	33.33a
50%mineral N+50% organic (T2)		541b	65.12b	32.49b	491b	62.82c	29.51b
25%mineral N+75% organic (T3)		421c	51.19c	25.29c	400c	52.10d	24.0c
100% organic N (T4)		344d	41.37d	20.66d	322d	41.17e	19.34d
200% organic N (T5)		629a	77.27a	37.78a	561a	73.06a	33.66a
	Control	490d	54.58d	29.45d	439d	52.82d	26.34d
	Seaweed extract at 1ml/l	506c	60.72c	30.36c	459c	57.02c	27.58c
	Seaweed extract at 2ml/l	520b	64.14b	31.25b	477b	62.56b	28.64b
	Seaweed extract at 3ml/l	531a	69.78a	31.90a	488a	66.68a	29.30a
100% mineral N (T1)	Control	604e	69.42e	36.24e	524d	60.26e	31.44d
	Seaweed extract at 1ml/l	623cd	74.76d	37.38cd	551c	66.12c	33.06c
	Seaweed extract at 2ml/l	631bc	78.87c	37.86bc	568a-c	71.42b	34.08abc
	Seaweed extract at 3ml/l	641ab	83.33b	38.46ab	579a	81.06a	34.74a
50%mineralN+50% organic (T2)	Control	514i	56.64h	30.84i	462g	55.44f	27.72g
	Seaweed extract at 1ml/l	523h	63.84g	31.92h	483f	60.37e	28.98f
	Seaweed extract at 2ml/l	551g	66.12fg	33.06g	504e	65.52cd	30.24e
	Seaweed extract at 3ml/l	569f	73.97d	34.14f	518de	69.93bc	31.08de
25%mineralN+75% organic (T3)	Control	408k	44.88kl	24.48k	367i	51.12fg	22.56i
	Seaweed extract at 1ml/l	413k	49.56j	24.78k	392i	47.06gh	23.52i
	Seaweed extract at 2ml/l	428j	53.50i	25.68j	411h	55.48f	24.66h
	Seaweed extract at 3ml/l	437j	56.81h	26.22j	421h	54.73f	25.26h
100% organic N (T4)	Control	317n	34.87n	19.02n	302l	36.24j	18.92l
	Seaweed extract at 1ml/l	338m	40.56m	20.28m	316kl	39.50ij	18.96kl
	Seaweed extract at 2ml/l	358l	42.72lm	21.48l	331jk	43.03hi	19.86jk
	Seaweed extract at 3ml/l	364l	47.32jk	21.84l	340j	45.90h	20.40j
200% organic N(T5)	Control	611de	67.21ef	36.66de	531d	61.06de	31.86d
	Seaweed extract at 1ml/l	624cd	74.88d	37.44cd	556bc	72.07b	33.36bc
	Seaweed extract at 2ml/l	636a-c	79.50c	38.16abc	573ab	77.35a	34.38ab
	Seaweed extract at 3ml/l	647a	87.48a	38.84a	584a	81.76a	35.04a

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at5%

Regarding the effect of seaweed extract "Algreen" data in the same Table indicate that all sprayed concentrations of seaweed extract statistically increased the fresh and dry weights of plant as well as total yield/fed. over the control plants in the two seasons. In this connection, using 3ml seaweed extract/l resulted in the heaviest fresh and dry weights/plant and the highest yield/fed., followed in descending order by

2ml/l seaweed extract-sprayed plants in the two seasons. In this regard, Zewail (2014) and Abo Sedera *et al*.(2016) came to similar conclusion.

Respecting to the interaction effect between fertilizations and seaweed extract, data in Table 5 declare that the heaviest fresh weight/plant (647 and 584 g) and dry weight / plant (87.48 and 81.76 g) and total yield/fed., (38.84 and 35.04 ton/fed.) were achieved by the combined treatment between T5 and seaweed extract at 3ml / l, followed by the combined treatment between T1 and seaweed extract at 3ml/l as it gave 641 and 579 g for fresh weight, 83.33 and 81.06 g for dry weight as well as 38.46 and 34.74 tons for total yield /fed. in the first and second seasons, respectively.

3- Leaf chemical composition:

Data illustrated in Tables 6 and 7 show that the greatest leaf N, P, K and total carbohydrates contents were detected by T1 and T5 treatments in the two seasons. On the contrary, the lowest values of these parameters were gained by T4 and T3 treatments in the two seasons. Besides, the highest leaf total sugars content was scored by T4 treatment, followed by T5 treatment in the two seasons. Furthermore, the lowest leaf nitrate content was recorded by T4 treatment, followed by T5 treatment in the two seasons. Also, T3 and T2 scored high decreases in leaf nitrate content as compared with T1 which induced the greatest leaf nitrate content in the two seasons. Similar results were reported by Olaniyi, (2008), Hosseny and Ahmed (2009), Masarirambi, *et al*.,(2012), Shams, *et al*.(2013), Cheng *et al*.(2014), Shahein *et al*.,(2014) on lettuce.

As for the effect of seaweed extract "Algreen " data in Tables 6 and 7 show that leaf N, P, K, total carbohydrates and total sugars contents were increased progressively with the increasing of seaweed extract concentration in the two seasons. So, the highest concentration of seaweed extract (3ml/l) is being the most effective one for inducing the highest values of these parameters, followed by the medium concentrate (2ml/l) in the two seasons. On the reverse, it was observed that there was a negative correlation between the values of leaf nitrate content and the concentration of seaweed extract. As the concentration of seaweed extract increased the values of leaf nitrate content were decreased until it reached to a maximum drop at the highest used concentration in the two seasons. In detail, 3ml seaweed extract/l–sprayed plants scored the lowest leaf nitrate content, followed in ascending order by 2ml seaweed extract /l- sprayed plants in the two seasons. In this respect, Zewail (2014) and Abo Sedera *et al*.(2016) reported that seaweed extract increased chemical constituents of bean plant foliage.

Table 6: Effect of nitrogen fertilizers and foliar spray with seaweed extract and their interaction on macronutrients content of head lettuce during the two season of study.

Treatment		First season (2014/2015)			Second season (2015/2016)		
Fertilization	**Foliar spray**	**N%**	**P%**	**K%**	**N%**	**P%**	**K%**
100% mineral N (T1)		1.74a	0.278a	1.36a	1.81a	0.273a	1.47a
50%mineralN+50% organic (T2)		1.65bc	0.257abc	1.27b	1.68c	0.248b	1.34b
25%mineralN+75% organic(T3)		1.58c	0.247bc	1.19c	1.55d	0.235bc	1.27c
100% organic N(T4)		1.45d	0.235c	1.13c	1.50d	0.223c	1.19d
200% organic N(T5)		1.68ab	0.270ab	1.33ab	1.74b	0.256ab	1.41a
	Control	1.50b	0.242b	1.16c	1.53d	0.231b	1.23d
	Seaweed extract at 1ml/l	1.57b	0.252ab	1.23b	1.61c	0.242ab	1.30c
	Seaweed extract at 2ml/l	1.67a	0.264ab	1.29a	1.71b	0.255a	1.37b
	Seaweed extract at 3ml/l	1.74a	0.270a	1.35a	1.76a	0.261a	1.44a
100% mineral N(T1)	Control	1.62c-f	0.264a-d	1.24d-h	1.65f-i	0.261abc	1.35cde
	Seaweed extract at 1ml/l	1.70a-e	0.273abc	1.32b-e	1.76c-f	0.269ab	1.43bc
	Seaweed extract at 2ml/l	1.81ab	0.286ab	1.41abc	1.89ab	0.281a	1.51ab
	Seaweed extract at 3ml/l	1.86a	0.291a	1.48a	1.94a	0.284a	1.59a
50%mineralN+50% organic (T2)	Control	1.51fg	0.241bcd	1.19fgh	1.58h-j	0.231bcd	1.24e-h
	Seaweed extract at 1ml/l	1.59c-f	0.253a-d	1.24d-h	1.64g-i	0.243a-d	1.31def
	Seaweed extract at 2ml/l	1.71a-d	0.264a-d	1.31b-f	1.72d-g	0.257abc	1.38cd
	Seaweed extract at 3ml/l	1.80ab	0.271abc	1.36a-d	1.78b-e	0.263abc	1.43bc
25%mineralN+75% organic (T3)	Control	1.48f-h	0.232cd	1.12hi	1.45kl	0.219cd	1.19ghi
	Seaweed extract at 1ml/l	1.54e-g	0.241bcd	1.16hi	1.51jk	0.230bcd	1.23fgh
	Seaweed extract at 2ml/l	1.62c-f	0.254a-d	1.21e-h	1.61g-j	0.243a-d	1.31def
	Seaweed extract at 3ml/l	1.68b-e	0.262a-d	1.29c-g	1.64g-i	0.251a-d	1.37cd
100% organic N(T4)	Control	1.34h	0.212d	1.04i	1.39l	0.206d	1.11i
	Seaweed extract at 1ml/l	1.42gh	0.232cd	1.12hi	1.64kl	0.218cd	1.16hi
	Seaweed extract at 2ml/l	1.51fg	0.241bcd	1.17gh	1.54i-k	0.231bcd	1.22f-i
	Seaweed extract at 3ml/l	1.56d-g	0.246a-d	1.21e-h	1.61g-j	0.239a-d	1.29d-g
200% organic N(T5)	Control	1.58c-g	0.256a-d	1.21e-h	1.61g-j	0.241a-d	1.29d-g
	Seaweed extract at 1ml/l	1.62c-f	0.264a-d	1.31b-f	1.69e-h	0.250a-d	1.38cd
	Seaweed extract at 2ml/l	1.73a-c	0.278abc	1.38abc	1.81b-d	0.264abd	1.46bc
	Seaweed extract at 3ml/l	1.81ab	0.283ab	1.42ab	1.87a-c	0.271ab	1.52ab

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at5%

Table 7: Effect of nitrogen fertilizers and foliar spray with seaweed extract and their interaction on chemical constituents of head lettuce during the two season of study.

Treatment		First season (2014/2015)			Second season (2015/2016)		
Fertilization	**Foliar spray**	**Total carbohydrates %**	**Total sugars%**	**Nitrate (mg/kg)**	**Total carbohydrates %**	**Total sugars%**	**Nitrate (mg/kg)**
100% mineral N (T1)		11.76b	2.09d	523a	12.75a	2.13d	560a
50%mineral N+50% organic (T2)		10.49c	2.14c	237b	11.37b	2.20cd	246b
25%mineral N+75% organic (T3)		9.89d	2.19c	176c	9.82c	2.27bc	182c
100% organic N (T4)		9.49e	2.36a	127e	9.64c	2.46a	135a
200% organic N (T5)		12.07a	2.28b	137d	13.00a	2.32b	149d
	Control	10.08d	2.13d	284a	10.29b	2.19c	271a
	Seaweed extract at 1ml/l	10.71c	2.18c	243ab	10.50b	2.25bc	257b
	Seaweed extract at 2ml/l	11.05b	2.24b	237bc	11.95a	2.31ab	249c
	Seaweed extract at 3ml/l	11.20a	2.30a	233c	12.53a	2.37a	242d
100% mineral N (T1)	Control	11.16d	2.01j	536a	11.40c-g	2.06j	586a
	Seaweed extract at 1ml/l	11.64c	2.06ij	529ab	12.69a-d	2.12ij	564b
	Seaweed extract at 2ml/l	12.04ab	2.13ghi	518bc	13.28abc	2.16hij	551bc
	Seaweed extract at 3ml/l	12.18a	2.17fgh	512c	13.64ab	2.19g-j	542c
50%mineralN+50% organic (T2)	Control	9.84gh	2.09hij	246d	10.12e-h	2.13ij	262d
	Seaweed extract at 1ml/l	10.16ef	2.12ghi	241de	10.80d-g	2.19g-j	250de
	Seaweed extract at 2ml/l	10.93d	2.16f-i	234de	11.94b-e	2.22f-i	241ef
	Seaweed extract at 3ml/l	11.05d	2.21efg	229e	12.60a-d	2.28d-h	234f
25%mineralN+75% organic (T3)	Control	9.26i	2.12ghi	184f	9.47gh	2.19g-j	196g
	Seaweed extract at 1ml/l	10.02fgh	2.16f-i	178f	7.26i	2.24e-i	181h
	Seaweed extract at 2ml/l	10.28ef	2.21efg	174f	10.92d-g	2.32c-g	178hi
	Seaweed extract at 3ml/l	10.39e	2.29cde	171f	11.64c-f	2.36b-f	173hi
100% organic N (T4)	Control	8.30j	2.26def	134g-i	8.64hi	2.37b-e	146kl
	Seaweed extract at 1ml/l	9.71h	2.32bcd	130g-i	9.49gh	2.41bcd	138l-n
	Seaweed extract at 2ml/l	9.84gh	2.41ab	126hi	9.78fgh	2.50ab	131mn
	Seaweed extract at 3ml/l	10.14efg	2.48a	121i	10.86d-g	2.59a	126n
200% organic N (T5)	Control	11.83bc	2.18fgh	142g	12.01a-e	2.21ghi	165ij
	Seaweed extract at 1ml/l	12.03ab	2.24def	139gh	12.26a-d	2.29c-h	152jk
	Seaweed extract at 2ml/l	12.16a	2.32bcd	136g-i	13.81ab	2.36b-f	144k-m
	Seaweed extract at 3ml/l	12.24a	2.38abc	132g-i	13.92a	2.43bc	138l-n

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at5%

Referring to the interaction effect between fertilization treatments and seaweed extract concentration data in Tables (6 and 7) reveal that the combination of fertilization treatment (T1) combined with spraying plants with seaweed extract at 3ml/l statistically induced the highest values of leaf N, P, K and total carbohydrates content as it scored 1.86 and 1.94, 0.291 and 0.284, 1.48 and 1.59 and 12.18 and 13.64% for leaf N, P, K and total carbohydrates, followed by the combination of T5, particularly those received seaweed extract at 3ml/l as it scored 1.81 and 1.87, 0.283 and 0.272, 1.42 and 1.52 and 12.24 and 13.92 % for N,P,K, total carbohydrates in the first and second seasons, respectively. Whereas, the lowest values of leaf N, P, K and total carbohydrates contents were scored by the combination of T4, especially those of un-treated control plants in the two seasons. Additionally, the highest values of leaf total sugars content were gained by the combination of T4, particularly those received seaweed extract at 3ml/l as it recorded 2.48 and 2.59%, in the same time the aforementioned treatment scored the lowest leaf nitrate content as it registered 130 and 138 mg/kg in the first and second seasons, respectively. Furthermore, the combination of T5, T3 and T2 with those sprayed with seaweed extract at 3ml/l statistically decreased leaf nitrate content when compared with the combination of T1, particularly those received no seaweed extract which induced the highest values of leaf nitrate content in the two seasons.

The obtained results of this study of head lettuce plants may be due to the role of the combined effect between chemical and organic fertilizer in presence of bio fertilizer and supplemented with seaweed extract foliar spray; where the use of bio-fertilizer it may have not only the ability to fix nitrogen but also to release certain phytohormones such as auxins, gibberellins and cytokinins that may enhance head lettuce growth through the uptake of macro and micro-nutrients and that reflected on improving the process of photosynthesis (Hegde *et al*.,1999). Furthermore, when organic fertilizers like compost applied, it led to decrease soil pH which is reflected on increasing the uptake of nutrients for plant, in some cases organic fertilizer may play as slow release fertilizer. On the way of sustainable agriculture with minimum effects, using organic fertilizer i.e., compost as natural soil amendments is recommended to substitute the chemical fertilizers. That improve the physical and chemical properties of sandy soils and

improve their water holding capacity. Besides, it increase the fertility of the soil, and increase root growth, produce active biological conditions and increasing activities of micro-organisms, especially those involved in mineralization (Suresh *et al*.,2004). Furthermore, the role of NPK fertilization on improving vegetative growth parameters, enhancing growth, yield component as well as increasing the chemical composition of lettuce plants could be determined by recognizing their function in the very large number of enzymatic reactions that depend on NPK fertilization. NPK fertilization reflected directly on enhancing total carbohydrates, total sugars and total free amino acids contents as well as leaves NPK contents that indirectly the cause for improving the augmenting of all other vegetative growth characters, yield and chemical composition of head lettuce plants (Cooke,1982). In addition, to the role of seaweed extract as it contain much amounts of cytokinins and auxins which induce cell division, thus increase the growth and productivity of head lettuce plant (Jameson, 1993).

Conclusively, it is preferable from the obtained results that fertilizing head lettuce plants with the treatment of 200 % of the recommended nitrogen in the form of organic fertilizer or the combined treatment between half dose of chemical nitrogen fertilizer + 3 ton compost/fed. (50% of recommended dose of N) + bio fertilizer enriched with spraying the plants five times with seaweed extract at 3 ml/l for improving growth and plant productivity. Thus, this investigation greatly admit using such treatments to induce good and high exportation criteria because of its safety role on human health.

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الاستبدال االجزئى والكلى للتسميد الكيماوى باستخدام التسميد العضوى فى وجود التسميد الحيوى ومستخلص الطحالب البحرية وتاثير ذلك على الانتاجيه وجودة نباتات خس الرؤوس

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*** قسم البساتين- كلية الزراعة – جامعة بنها**

****قسم النبات الزرعى– كلية الزراعة - جامعة بنها**

اجريت تجربتان حلقليتان خلال الموسمين الشتويين (٢٠١٣/٢٠١٤ - ٢٠١٤/٢٠١٥) فى مزرعه خاصه بقريه كفر الصهبى – شبين القناطر- بمحافظه القليوبية وذلك لتقييم الاستبدال االجزئى والكلى للتسميد النيتروجينى المعدنى باستخدام التسميد العضوى فى وجود التسميد الحيوى والرش ببعض التركيزات من مستخلص الطحالب البحريه (الالجرين) والتفاعل بينهما على قراءات النمو الخضرى والمحتوى الكيماوى والمحصول وجودة الخس الرؤوس صنف جريت ليكس والنامى تحت ظروف تربه رمليه طمييه خلال موسم الشتاء وقد اوضحت النتائج المتحصل عليها ان اطول النباتات تم الحصول عليها بالمعامله المختلطه ١٠٠% تسميد الكيماوى (T1) والرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر بينما تم الحصول على اكبر قطر للراس بواسطه تسميد النباتات ٢٠٠% تسميد عضوى (T5) والرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر. وتم الحصول على اكبر وزن طازج وجاف باستخدام المعامله المختلطه بين التسميد عضوى (T5) والرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر يليها فى ذلك استخدام المعامله المختلطه (T1) والرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر. واعطت المعاملة (T1) اكبر محتوى للاوراق من النتروجين والفوسفور والبوتاسيوم والكربوهيدرات الكليه يليها فى ذلك استخدم المعامله T5 وخاصه عند رش النباتات بمستخلص الطحالب البحرية بتركيز ٣مل/لتر بالاضافه الى ذلك وجد ان اعلى محتوى من الاوراق من السكريات الكليه قد تم الحصول عليه باستخدام المعامله بالتسميد العضوى ١٠٠%(T_4) و المعامله T5 وخاصه عند الرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر .علاوه على ذلك وجد ان المعامله T4 , T5 قد اعطت اقل محتوى للاوراق من النترات وخاصه عند الرش بمستخلص الطحالب البحرية بتركيز ٣مل/لتر وذلك عند المقارنه بالمعامله T1 وخاصة التى لم تعامل بمستخلص الطحالب البحرية حيث اعطت هذه المعامله اعلى محتوى من النترات فى كلا الموسمين .