J. Plant Production, Mansoura Univ., Vol. 5 (10): 1675- 1689, 2014

EFFECT OF SOME BIO-STIMULANTS AND ANTI-OXIDANTS ON HEAD AND SEED PRODUCTION OF BALADY LETTUCE

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ABSTRACT

Two field experiments were carried out on at Baramon Research Station-Horticulture Research Institute during the winter season 2009/2010 and 2010/2011 lettuce to improve the growth, head and seed yield by enhancing the metabolic processes. Two weeks after transplanting, plants were sprayed (spraying were repeated every two weeks), the treatments were as following: seaweed extract, humic acid complex, NPK (8-8-8), amino acids mixture, Ascorbic acid (VC), Vitamine E+ Selenium and control. The effect of these treatments on vegetative growth, biological constituents, photosynthetic pigments, flowering, head and seed yield were studied. The results can be summarized as following: most treatment surpassed the control in all studied characteristics, as they promoted lettuce performance and yield under the experiment conditions. The best treatment was the seaweed extract; it significantly increased most of vegetative characteristics, biological and chemical parameters which led to the increase of head and seed yield in the two seasons of the experiment. It resulted in 50% increase in head yield and 100% increase in the seed yield. Therefore, it's recommended to spry lettuce plants with seaweed extract (5ml L^{-1}) four times during the season in order to get the highest head and seed yield

Key words: Lettuce- Seaweeds extract- Humic acid- Amino acid- Ascorbic acid- vitamin E +Selenium.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is the most popular and occupies the largest area among salad crops, it is rich in vitamin A, C and minerals like calcium and iron (Aykroyd 1963).

The application of seaweeds extract for different crops is of great importance due to its content of growth promoting substances, i.e., cytokinins, auxin and GAs which stimulate plant growth and yield and enhance plant tolerance to environmental stress (Zhang *et al*., 2003), increase nutrient acquisition (Turan and Kose 2004). Seaweeds (SW) extract have been applied to plants as foliar spray and are widely used in conventional and organic farming. They are commercially marketed as liquid fertilizers and biostimulants due to their regulatory substances (Stirk *et al*., 1999). The wide range of growth responses induced by seaweeds extract implies the presence of more than one group of plant growth-promoting substances/hormones (Crouch and van staden 1993).Importance of crop quality and quantity as well as nutrient uptake [nitrogen (N), phosphorus (P) and potassium (K)] was observed with seaweeds extract application(El-Seifi *et al*., 2013) and (Pramanick *et al*., 2013).(Kumar and Sahoo 2011) demonstrated that seaweeds liquid extract could serve as an alternative boifertilizer as is eco-friendly, cheaper, deliver substantial economic and environmental benefits to farmers.

Foliar application of humic acid (HA) known to be involved in osmo-regulation and anti-oxidation, increase vitamin content of plant, stimulate

plant enzymes, increase membranes permeability and promote nutrients uptake (Mackowiak *et al* ., 2001). Humic substances have a very profound influence on the growth of plant roots, when (HA) and fulvic acids are applied to the soil, since augmentation of root initiation and root growth were observed (Pettit, 2004). The stimulatory effects of humic substances have been directly correlated to enhanced uptake of macronutrients, such as nitrogen, phosphorus and sulfur (Chen and Aviad, 1990b), and micronutrientssuch as, Fe, Zn, Cu and Mn (Chen *et al*., 1999a). Additionally, it increases cation exchange capacity (CEC), and improve root respiration. Application of humic acid significantly increased yield and its components (Ahmed *et al*., 2010) on Snap bean and (Azarpour *et al*., 2012) on Eggplant. The highest value for common millet plant heights, bunch lengths, grain yields, 1000 grain weight, crude protein concentrations and grain number per bunch were obtained from humic foliar fertilizations and the highest hectoliter weight was obtained from humic seeds fertilizations,(Saruhan *et al*., 2011).

Amino acids (AA) are well-known bio-stimulants which has positive effects on plant growth, yield and significantly mitigate the injuries caused by abiotic stresses (Kowalczyk and Zielony 2008). (Hussein *et al*., 1992) stated that, application of amino acids resulted in significant increase of chlorophyll levels while, carotenoids tend to decrease. Foliar application of amino acids enhanced plant growth and fruit yield (El-Shabasi *et al*., 2005) on Garlic (Awad *et al*., 2007) on Potato. (Neeraja *et al*. 2005) and (Cerdan *et al*., 2006) found that amino acids application increased the number of flowers, fruit setting and fruit yield of Tomatoes. (Shehata *et al*., 2011a) indicated that spraying amino acids is effective on growth and yield of Strawberry. (Hadi *et al*., 2011) on chamomile indicated that the highest plant height, flower head diameter, fresh and dry flower yield and significant essential oil content were obtained by using 20 ton vermicompost treatment and all measured traits were seen to besignificantly increased after the spray of amino acids at the budding + flowering stage.

Ascorbic acid (V.C) functions as antioxidant and growth factor. It plays an important role in different processes, including photosynthesis, photoprotection, cell wall growth and cell expansion. Moreover, it enhances plant resistance to environmental stresses by regulating ethylene synthesis, gibberellins, anthocyanins and hydroxyproline content (Nicholas and Wheeler, 2000). Sakr and (Metwally 2009) suggested that antioxidant materials such as HA (1000 mg/l), Salicylic acid (250 mg/l), Ascorbic acid (250 mg /l), putrascine (1 mg/l) and seaweeds extract used as presoaking and foliar spray gave positive effect on growth parameters and yield of pepper plant. It was show that applied antioxidant materials (Ascorbic acid and SWE) were the most effective in increasing growth parameters of pepper plant. It was found that the applied antioxidants completely counteracted the harmful effect of low and moderate salinity levels (2000 and 4000 mg/l) and partially counteracted the harmful effect of salinity stress level (6000 mg/l) on pepper yield. Ascorbic and SWE were most effective in this respect.

Selenium (Se) is an important element for human and animal nutrition, due to its roles on series of biochemical reactions enhancing antioxidant activity (Rayman 2002). Several studies reported the beneficial

effects of Se, because it increases the antioxidant activity in plants, leading to better plant yield (Hartikainen *et al*., 2000), (Lyons *et al*., 2009).A stimulatory effect of foliar application of Selenium on lettuce growth has been reported (Xue *et al*., 2001). (Simojoki 2003) reported that small Se addition increased Se contents in lettuce shoots, up to 1.5 mg kg^{-1} dry matter, consequently enhanced plant growth. Moreover, in potato plant, Se increased carbohydrate accumulation in leaves and tubers.The application of Se at low concentrations is more appropriate for lettuce because it favors shoot biomass growth and Se levels in the shoot biomass. Selenium had two effects on lettuce plant metabolism: at low doses it acted as an antioxidant and enhanced plant growth, whereas at higher levels it reduced yield, (Ramos *et al*., 2010).

α-Tocopherol (V.E) is lipophilic antioxidants synthesized by all plants and some algae and cyanobacteria, it is one of the most important components of cellular defense against oxidative injury and environmental stresses (Fryer 1992 and Hess 1993), V.E and Se showed superior effects on vegetative growth characteristics of plant. Moreover, they increased total chlorophyll, total carbohydrates, total phenols, and N, P, K %. Also, they significantly increased average head fresh and dry weights as well as head diameter, total soluble solids (TSS), vit. C and vit.E concentrations of lettuce plants (Midan and Sorial 2011). (Rios *et al*., 2008) indicated that applying selenium to lettuce increased the antioxidant capacity and biomass accumulation.

It is evident that few studies have gathered the abovementioned biostimulantes and antioxidants in one study as well as studied their influences on the whole plant, growth, productivity and seed yield. The current research aimed to have better insights concerning foliar application of those compounds on lettuce (*Lactuca sativa* L.).

MATERIALS AND METHODS

Two field experiments were conducted during two successive seasons of 2009/ 2010 and 2010/2011 at El-Baramoon Research Station, (+7 altitude, 30° 11¯ altitude and 28° 26¯longilude) Mansoura, Dakahlia Governorate, Egypt, to investigate the efficiency of some foliar applied bio-stimulants and antioxidants on vegetative growth characteristics, chemical composition, yield and its components, and seed yield of local lettuce cultivar (*Lactuca sativa* L.) Var.Balady.Prior to the experiment, random soil samples of the experimental site were collected (0 – 50 cm depth) and mixed then a composite representative sample was collected and subjected to physical and chemical analysis. Soil properties are given in Table (1).

Lettuce seeds were planted in foam trays in the nursery by 25th and 27th of November 2009 and 2010 seasons, respectively.

Transplanting was carried out on January 2th and 5th of 2010 and 2011, respectively. Seedlings were transplanted on both sides of ridges with inter spacing of (0.25 × 0.30) m^2 for head production and (0.5 × 0.3)m^2 for seed production whereas two rows were predestined for head production and the rest for seed yield.

Treatments were arranged in a complete randomized design with three replicates. The experimental unit was 11.2 m^2 and contained four rows (4m length×0.7 m width).

Treatments and experimental layout:

The experiment consisted of six treatments as follow;

T1; Sea weeds (SW) extract at concentration of 5ml L^{-1} in the form of Goemar BM 86 (Goemar lab France) (*Ascophyllum nodsium*-brown algae), and contained more than 17 essential amino acid (5738 µm/l), Vitamins (40 mg/kg) phytohormons (200mg/L, Betaines (140 mg/l) and polysaccharids 50% DM, also enriched with N, Mg, S, B and Mo.

T2; Humic acid (HA) and NPK (8-8-8) complex (H.R.I.Reg. product No. 2709) used at concentration of 1.5 ml $L^{-1.}$

T3; Amino acid (AA) combination used at the concentration of 2.5 ml L^{-1}, Spanish compound known as Delfan (10% L-free amino acids) Table (2). The product was obtained from Techno Green Company Group Cairo, Egypt.

T4; Ascorbic acid (V.C) was obtained from El-Gomhoria Company for Chemicals, Egypt and used at concentration of150 mg L^{-1}.

T5; α-Tocopherol + Selenium (V.E +Se) used at concentration of (V.E 100 mg/L +Se 50 mg/L) and was supplied by Sigma Chemical Company, USA.

T6; Control treatment (Tap water).

Table 1: Some physical and chemical properties of the experimental soil profile of cultivated area at 2010 and 2011 seasons.

Soil	2010	2011
Physical analysis		
Fine sand %	18.11	18.14
Coarse sand %	7.71	7.81
Silt %	32.66	32.45
Clay %	41.52	41.60
Texture	Clay-loam	Clay-loam
Chemical analysis		
pH (in 1:5 soil water suspension extract)	8.11	8.1
E.C. (dSm^1) (in 1:5 soil water extract)	1.12	1.13
Organic matter %	1.45	1.45
Available P (ppm)	11.72	11.7
$CaCo_3$	4.55	4.58
Total N %	0.22	0.21
$C1^-$	3.56	3.46
HCo_3^-	3.2	3.27
Co_3^-	0	0
So_4^-	5.16	5.2
Ca^{++}	4.03	4.03
Mg^{++}	1.35	1.35
Na^+	1.21	1.21
K^+	5.33	5.33
Fe^{++}	3.6	3.62
Mn^{++}	1.51	1.5
Zn^{++}	1.35	1.35
Cu^{++}	0.52	0.52

Lettuce plants were sprayed 4 times during the season starting from two weeks after transplanting followed by an application within 15 days interval. Fresh heads were harvested after 88 and 90 days from transplanting in the first and second seasons, respectively. While, seeds were harvested by shaking plants to release mature seeds.

Table 2: The chemical composition of amino acid (Delfan).

Guaranteed Richness (% w/w)			
Organic matter	18.4	Free amino acids	10
a-aminic nitrogen	2	Total nitrogen	6
Organic nitrogen	4	Total amino acids	34.5
Characteristics			
Aspect	Brown liquid	Specific Gravity	1.12g/ml
PH	5 : 5.5		
Its amino acids content (g amino acids/100 g D.W.)			
Aspartic	2.3	Glutamic	4.2
Glycine	4.6	Histidine	0.3
Threionine	1.2	Serine	2.8
Alanine	2.5	Argnine	2.6
Cystine	0.9	Proline	2.8
Methionine	0.2	Valine	1.1
Hidroxiproline	2.7	Lysine	1.1
Iso-Leucine	1.1	Leucine	2.1
Tyrosine	0.2	Phenyl-alanine	1.8

Variables and data collection

Vegetative growth characteristics:

Growth characters of ten plants were randomly selected.Harvested from each plot after 12 weeks of transplanting. Then following parameters were measured; plant height (cm), leaf area (cm^2), leaves number/plant, leaves fresh and dry weights (g), diameter of head and stem length (cm).

Chemical composition:

*Total chlorophyll content (mg $100g^{-1}$) within fresh leaves following Witham *et al*. (1971)

* Total phenols, as caticol (mg $100g^{-1}$) following Snell and Snell; (1953).

* Total nitrogen content using the micro-kjeldahl as described by Ling (1963).

* Total soluble solids (TSS) using Abbe handy refractometer.

* Vitamin E and C concentrations following A.O.A.C. (1990).

Head and Yield and its Components:

At harvest, heads from the two rows of each plot were used in estimating **lettuce yield and some of its components as follow:**

- Average head fresh weight (g/plant).
- Total head yield (kg/plot).
- Total head yield (ton/fed)
- Head diameter (cm).

Flowering, Seed yield and its components:

- Days to 1st flowering.
- Weight of seed (gm / plant).
- Seed yield (kg/fed).
- Seed index (1000 seed weight /g).
- Germination.%

Table (3): Monthly means of Maximum and Minimum temperatures during 2009/2010 and 2010/2011 fall seasons at experimental region.

Month	2009/2010		2010/2011	
	Maximum (C°)	Minimum (C°)	Maximum (C°)	Minimum (C°)
Nov.	22.5	13.4	26.1	17.4
Dec.	20.0	12.3	20.6	11.1
Jan.	19.6	11.0	18.3	11.2
Feb.	18.7	11.7	19.8	11.4
Mar.	24.5	13.5	24.2	11.5
Apr.	26.0	14.3	24.6	13.3
May	29.8	17.4	30.1	18.8

Data were subjected to analysis of variance (ANOVA). Then, means were compared using Duncan multiple range test (Duncan, 1965).

RESULTS AND DISCUSSION

Vegetative growth characteristics:

Data in Table(4) reveal that (SW), (HA), (AA), (V. C), and (V.E +Se) significantly increased plant length, leaves No./plant, leaves area/plant, stem length, leaves fresh and dry weight/plant and leaves of lettuce plants compared to the control in the two seasons. The most stimulatory and potent effect in diminish order was of (SW) extract followed by AA and V.E+ Se in two seasons. (SW) showed the highest values of all studied traits compared with other treatments followed by (AA) in the two growing seasons. The lowest values obtained from control, These results may be attributed to that(SW) contain high amount of organic and inorganic nutrients, plant growth hormones (gibberellins, auxin and cytokines), amino acids, vitamins, oligosaccharides, algenic acid and betaines which can maintain photosynthetic rats, delay leaf senescence, control cell division and enlargement thereby it greatly improve vegetative growth of plants (Awad *et al*., 2006) and (Shehata *et al*., 2011a). Moreover (AA) improved plant vegetative growth due to its nitrogen content which stimulate cell growth plus acting in osmo-regulation and antioxidation, also induction of phenols and lignin metabolism.

Chemical composition:

Data in Table (5) show that, all foliar spray treatments were differed significantly among them and highly superior the control, in total chlorophyll, total phenols, N%, total soluble solid, V.C and V.E in their leaves during the two seasons.The same data clear that, the highest values were recorded with

(SW) extract treatment at both seasons. Similar results were obtained by (Midan and Sorial 2011) and (Shehata *et al*., 2011b). The present significant increments in values of all treatments compared with the control may be explained based on the activator and protective impact of the applied bio-stimulants particularly (SW) extract. In connection with the enhancement of (SW) on photosynthetic pigments, (Richardson *et al*., 2004), found that, (SW) contain significant amounts of cytokinins, auxin and betaines, which enhance chlorophyll concentration in the leaves, improve plant resistance, delay leaf senescence and control cell division (Schwab and Raab, 2004). Also, such induction in chlorophyll content may be due to a decrease in chlorophyll degradation. Our findings coincide with those of (El-Aidy *et al.,* 2002).

The same data showed that, the most effective treatment was (SW) followed by (A.A), (V.C), (H.A) and(V.E+Se), compare to the control treatment,in the two seasons of study. They improve total chlorophyll, total phenols, N%,total soluble solid, V.C and V. E content of lettuce leaves. In fact, maintaining good photosynthetic rate leads to maintenance of vegetative growth of lettuce plants. (SW) has positive effects on photo-synthetic pigments (Chl. a, b, total and cartonoides) due to its roles in maintaining and enhancing photo-synthetic efficiency (Genard *et al*., 1991) ; (Agboma *et al*., 1997a) and (Makela *et al*., 1998). The same results showed that plants which spray with (V.C) and (V.E +Se) gave the highest values of total phenols and V.E respectively in the both seasons.

Head yield and yield components:

As shown in Table(6) that spraying the plants with (SW), (H.A), (A.A), (V.C), (V.E +Se) significantly increased head fresh weight, total head yield, total head yield and head diameter compared with the control.The significant highest values were obtained with (SW) extract treatment at both seasons. The promotional effect of (SW) extract was in agreement with the results obtained by (Awad *et al*., 2006), (Shehata *et al*., 2011b) and (Pramanick *et al*., 2013). The superiority of (SW) extract treatment and the beneficial effect of the others could be due to their similar enhancable effect on growth, chemical composition and flowering of their plants, (Tables 4, 5,7).

Such data indicate that the bio-stimulants foliar spray were significantly increased fresh yield and its components compare to control at both seasons. Additionally, it was considerably show the superiority of (SW) treatment upon the control in head weight (Fig. 1). Since total head yieldof (SW) treatment increased by 52.45% and 52.67% over the control at the first and the second seasons respectively.Once again it was showed that,the highest values were of (SW) extract treatment followed by (AA) and (V.C), respectively in the two seasons. Yield is a result of metabolic reactions in plants; consequently any factor that influences this metabolic activity at any period of plant growth can affect the yield (Ibrahim and Aldesuquy, 2003).

4-5

6-7

Herein the increases in head yield parameters due to (SW) treatment could be attributed with the increase in vegetative growth characteristics (Table 4), Average of head fresh weight and head diameter which have impact on total heads yield and head quality. These results are in harmony with those obtained by (Temple and Bomke 1988), (Crouch and Van-Staden 1994), (Awad *et al*., 2006) and (Rathore *et al*., 2009).

Flowering, Seed yield and its components:

As shown in Table (7), that spraying the plants with (SW), (H.A), (A.A), (V.C), (V.E +Se) significantly decreased the number of days required for 25% flowering of their plants. Induces flowering earliness. All were better than the control.The best earliness existed with (SW) followed by (AA) than other treatments at two seasons.

The same data show that weight of seeds/plant (g), Seed yield (kg/fed), and Germination% were considerably increased as effected by most treatments compared with the control, the highest values were of SW followed by(AA), (V.C) and (V.E +Se) treatments with significant differences among them in the two seasons (Fig 2). Additionally it was obvious that treatments of (AA), (V.C) and (V.E + Se) had no significant difference among them in most cases.

Lastly, the ability of the harvested seeds to germinate was also induced significantly with the most of the applied treatments. For instance, germination rate reached to (60.3 and 60.9%) with (SW) in the two seasons respectively comparing with (50.1 and 50.3%) of control treatment.

Finally it could be concluded that (SW) was the most effective treatment,it increased head yield by (52.45 and52.67 %) and the most favorite for seed yield increased it by(102.62 and115.50 %) in two seasons respectively relative to the control.

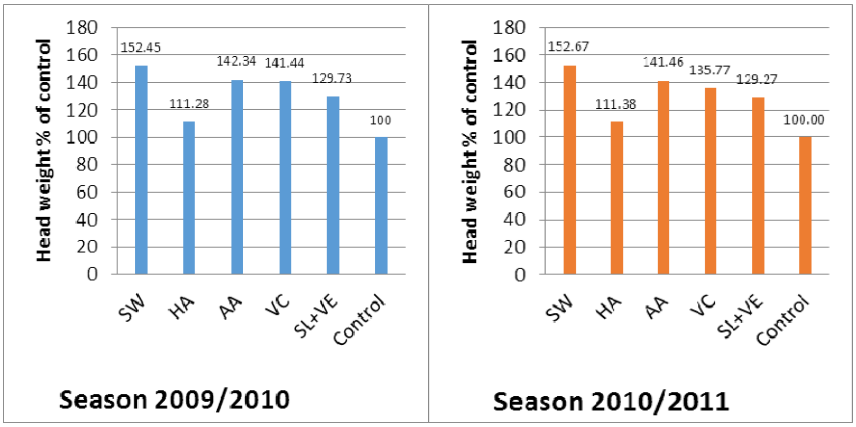

Fig 1: Head weight of different treatments % of control treatment .

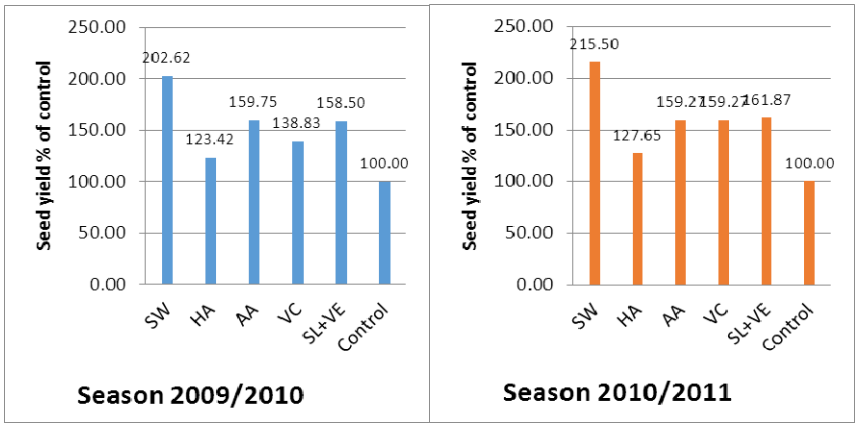

Fig 2: Seed yield of different treatments % of control treatment .

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تأثير الرش ببعض المنشطات الحيوية و مضادات الأكسدة على انتاج الرؤوس و البذرة فى الخس البلدى

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اجريت تجرباتان حقليتان خلال الموسم الشتوى ٢٠٠٩/٢٠١٠ و ٢٠١٠/٢٠١١ بمحطة البرامون البحثية التابعة لمعهد بحوث البساتين على نبات الخس البلدى بهدف تحسين النمو و انتاج الرؤوس و البذور من خلال تحسين العمليات الأيضية الداخلية و ذلك برش النباتات فى عمر اسبوعين بعد الشتل (مع تكرار الرش كل ١٥ يوم) وكانت المعاملات كالأتى:مستخلص الطحالب البحرية ومعقد حمض الهيوميك و النيتروجين و الفسفور و البوتاسيوم (٨ – ٨ - ٨) و خليط الأحماض الأمينية و حمض الأسكوربيك (فيتامين ج) و (فيتامين هـ + سيلنيوم) بالاضافة الى الكنترول و دراسة تأثير ذلك على صفات النمو الخضرى و المكونات الحيوية و صبغات البناء الضوئى و التزهير و صفات محصول الرؤوس والبذور لنباتات الخس.

وعموما يمكن تلخيص النتائج كما يلى:

تفوقت معظم المعاملات على المقارنة فى كل الصفات المدروسة حيت أدت الى تحسين أداء نبات الخس ومحصوله تحت ظروف التجربة و من أفضل المعاملات (مستخلص الطحالب البحرية) حيث أدت الى زيادة واضحة فى معظم القياسات الخضرية و كذلك المكونات الكيماوية و الحيوية و إنعكس أثر هذا على زيادة محصول الرؤوس و البذور فى موسمى التجربة و التى ادت الى زيادة محصول الرؤوس بمقدار 50% ومحصول البذور بمقدار ١٠٠% مقارنة بالكنترول خلال موسمين التجربةعلى التوالى.

و فى ضوء هذه النتائج يمكن ان نوصى برش نباتات الخس بمستخلص الأعشاب البحرية ٥ مل/لتر أربع مرات خلال الموسم حيث أعطت أعلى محصول للرؤوس و البذور.

Table(4):Effect of bio-stimulants and antioxidants on lettuce growth during 2009/2010 – 2010/2011.

Parameters / Treatment	Plant length (cm)		No.leaves/plant		leaf area cm^2/plant		Stem length(cm)		Leaves fresh weight (g/plant)		Leaves dry weight (g/plant)	
	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Seaweeds extract (SW)	50.1 a	52.1 a	52.3 a	54.2 a	2696.1 a	2702.1 a	12.3 a	11.4 a	400.1 a	525.2 a	35.15 a	36.35 a
Humic acid (H.A)	43.2 e	45.3 e	42.3 e	44.2 e	1297.7 e	1090.7 e	8.1d	7.5d	300.1 c	425.1 c	29.35 c	30.55 c
Amino acid (A.A)	48.1 b	50.3 b	50.4 b	52.3 b	1945.2 b	1934.6 b	10.3 b	7.6b	375.2 b	500.3 b	34.35 a	35.55 a
Ascorbic acid (V.C)	45.2 d	47.3 d	47.3 d	49.4 d	1515.9 d	1512.1 d	9.2 c	8.1c	325.4 b	450.3 b	20.75 b	31.95 b
Selenium + V.E	47.4 c	49.4 c	49.3 c	52.4 c	1899.6 c	1903.8 c	10.3 b	9.5b	350.0 b	475.2 b	33.50 a	34.70 a
Control(Tap water)	38.4 f	40.3 f	37.5 f	39.4 f	1150.5 f	962.4 f	7.1e	6.6e	266.2 d	357.3 d	25.46 d	26.09 d

Means followed by the same letters within column in the same season are not statically different by (mean) test at 5% probability

Table (5):Effect of biostimulants and antioxidants on lettuce chemical composition during 2009/2010 and 2010/2011 seasons.

Parameter / Treatment	Total chlorophyll (mg/100 g fr.wet)		Total phenols (mg catiol/100g fr.wet)		Total nitrogen content		Total soluble solids (TSS)		Vitamin C (mg/100g fr.wet)		VitaminE (mg/100g fr.wet)	
	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Seaweeds extract (SW)	8.536 a	8.386 a	39 a	37 a	3.15 a	2.95 a	5.81 a	6.21 a	18 b	16 b	0.68 c	0.58 c
Humic acid (H.A)	5.736 bc	5.542 bc	31 d	29 d	2.70 b	2.65 b	5.35 b	5.51 b	16 c	15 c	0.50 d	0.41 d
Amino acid (A.A)	7.277 a	7.127 a	35 b	33 b	2.31 b	2.20 b	5.31 b	5.61 b	18 b	16 b	0.51 d	0.41 d
Ascorbic acid (V.C)	5.981 b	6.762 b	31 d	29 d	2.66 b	2.41 b	5.71 b	6.01 a	20 a	18 a	0.75 b	0.65 b
Selenium +V.E	6.912 b	5.831 b	33 c	31 c	2.10 b	2.00 b	5.28 b	5.58 b	15 c	15 c	0.81 a	0.71 a
Control (tap water)	5.339 c	5.189 c	29 e	27 e	1.80 c	1.75 c	3.85 c	3.95 c	12 d	14 d	0.48 e	0.38 e

Means followed by the same letters within column in the same season are not statically different by (mean) test at 5% probability

Table (6):Effect of biostimulants and antioxidants on fresh yield of lettuce during 2009/2010 – 2010/2011 seasons.

Parameters / Treatments	Average of head fresh weight (g/plant)		Total head yield kg/plot		Total head yield ton/fed		Head diameter (cm)	
	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Sea weeds extract (SW)	370.1 a	410.2 a	23.7 a	26.3 a	16.922 a	18.778 a	38.2 a	45.8 a
Humic acid (H.A)	270.1 c	300.1 c	17.3 c	19.2 c	12.352 c	13.700 c	32.2 c	36.6 c
Amino acid (A.A)	345.2 b	380.3 b	22.1 b	24.3 b	15.800 b	17.400 b	35.3 b	40.8 b
Ascorbic acid (V.C)	344.4 b	365.3 b	22.0 b	23.4 b	15.700 b	16.700 b	32.8 c	36.7 c
Selenium +V.E	320.0 b	350.0 b	20.1 b	22.4 b	14.400 b	15.900 b	33.3 c	37.2 c
Control (tap water)	245.2 d	272.3 d	15.7 d	17.3 d	11.100 d	12.300 d	30.2 d	32.8 d

Means followed by the same letters within column in the same season are not statically different by (mean) test at 5% probability

Table (7):Effect of bio-stimulants and antioxidants on flowering and seed yield of lettuce during 2009/2010 and 2010/2011 seasons.

Parameters / Treatments	Days to 1^{s} flowering		wt. of seeds/plant(g)		Seed yield (g/ plot)		Seed yield (kg/fed)		1000 seed wt.(g)		Germination (%)	
	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Sea weeds extract (SW)	78.0c	78.2c	15.6a	15.5a	499.2 a	496 a	356.4a	374.1a	1.15a	1.12a	60.3a	60.9a
Humic acid (H.A)	86.3a	86.1a	9.5c	9.7c	304 c	310.4 c	217.1c	221.6c	1.09a	1.09a	52.4c	52.5c
Amino acid (A.A)	81.1b	81.5b	12.3b	12.1b	393.6 b	387.2 b	281.0b	276.5b	1.11a	1.11a	56.2b	56.1b
Ascorbic acid (V.C)	81.0b	81.3b	12.0b	12.1b	384 b	387.2 b	244.2b	276.5b	1.10a	1.10a	56.0b	56.1b
Selenium +V.E	81.2b	81.1b	12.2b	12.3b	390.4 b	393.6 b	278.8b	281.0b	1.09a	1.09a	56.4b	56.3b
Control (tap water)	86.6a	86.3a	7.7d	7.6d	246.4 d	243.2 d	175.9d	173.6d	1.05a	1.05a	50.1d	50.3d

Means followed by the same letters within column in the same season are not statically different by (mean) test at 5% probability