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Use of some Bio-stimulants for Improving the Growth, Yield and Bulb Quality of Onion Plants (*Allium cepa* L.) under Sandy Soil Conditions

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ABSTRACT

Increasing onion yield and improving bulb quality are essential aims for growers to fulfill the requirements of the market and the consumers. Two field experiments were carried out during two successive seasons; 2011/2012 and 2012/2013 at the experimental station of National Research Centre, Beheira Governorate (North of Egypt) to find out the influence of some bio-stimulants i.e., yeast extract, seaweed extract (Alga 600), garlic oil, licorice extracts, limonene oil, bee pollen extracts and potassium humate on plant growth, yield, yield components and bulb chemical contents of onion plants "Giza 20" cultivar. One month after planting, foliar applications of bio-stimulants were applied, and repeated 3 times at 15 days intervals throughout the growing season. The design of the experiment was a complete randomized blocks with three replicates. Results indicated that foliar application of yeast extract, seaweeds extract and licorice extract at the same time had the highest stimulation effect on onion plant growth characters i.e. (plant length and number of leaves as well as fresh and dry weight of leaves, nick and pulps), total bulb yield and its components as well as content of the percentage of bulb tissues of nitrogen, protein and dry matter compared to the control and other treatments.

Key words: Onion- bio-stimulants-growth-yield- chemical bulb contents.

Introduction

Onion plants (*Allium cepa* L.) are one of the most important vegetable crops grown in Egypt. Increasing productivity of onion with good quality is an important target by the growers for local market and exportation. However, new reclaimed lands have many problems such as poor fertility which may necessitate the application of special fertilization programs and some foliar application of natural bio-stimulants materials.

Positive influence of bio-stimulant treatment on yield parameters was observed. Overall increase in pigment content of leaves after bio-stimulants application agrees well with better total and commercial yields of treated vegetable cultivars in comparison with their controls. Our results showed that natural bio-stimulants positively influence vegetable plant growth and total yield and quality of plants. In addition, bio-stimulants improved antioxidant activity, vitamin C and higher pigment levels in leaves of vegetables compared to non-treated plants. Thus, the application of bio-stimulants could be considered as a good production strategy for obtaining high yields of nutritionally valuable vegetables with lower impact on the environment Sazetak (2011). In the same respect, bio-stimulants able to promote vegetative growth, mineral nutrient uptake and improve the productivity of many plants (Fayad, 2005; Fathy *et al*, 2008; Hassan *et al* 2008 and Amal *et al* 2010).

Liquid extracts obtained from seaweeds have gained importance as foliar sprays for several crops Thivy, (1961) and Bokil, *et al* (1974) because the extract contains growth promoting hormones (IAA and IBA), cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn, Ni), vitamins and amino acids Challen and Hemingway (1965). Aqueous extract of *Sargassum wightii* when applied as a foliar spray on *Zizyphus mauritiana* showed an increased yield and quality of vegetable crops Rama Rao (1991). Applying seaweed extract increased the response of different growth parameters and yield responses of Watermelon Abdel-Mawgoud *et al* (2010). In the same respect, Shehata *et al* (2011) on Celeriac plants and Fawzy *et al* (2012) on Chinese garlic plants and Dogra and Mandradia (2012) on onion plants found that foliar spraying of seaweed extract obtain the highest values of vegetative growth, yield and its quality.

Garlic oil is a natural product with anti-oxidative, antibiotic, anti-viralic and antifungal activities Curtis *et al* (2004). It has improves the availability of soil nutrients and slows down the growth of plant antagonists Konkov and Kiram (1988). Many investigations found the favorable effect of garlic extract on plant growth and productivity on many plants, i.e., squash Helmy (1992) and Shafshak *et al* (2004) and okra Bhyan *et al* (2007).

Egyptian licorice roots are rich in many essential minerals, flavonoids and natural antioxidants Morsi *et al* (2008). Foliar spraying with licorice extract has a favorable biological effect on fresh and dry weight of plants, flowering, total yield and fruits quality i.e., cucumber Fayad (2005) and Husain and El-Rekaby (2006), sweet pepper El-Jawary (2002) and Jibouri *et al* (2005) and bean Kamal and Ghanem (2012).

Limonene oil is one of the essential oils families that have an antimicrobial effect without any toxic residue El-Mougy (2009). Limonene oil possesses an antioxidant effect by inhibiting lipid peroxidation Amal *et al* (2010). In addition, Akhauri and Yadova (1999) reported that, natural limonene oil has a remarkable effect on plant growth, not

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only due to the antioxidant ameliorative effect, but also due to the insecticidal protective effect. Moreover, many studies indicated that, foliar spraying with limonene oil increases fresh and dry weight of plant, pod setting and total yield Fathy and Kheder (2005) and Fathy *et al* (2008).

Brewer's yeast is one of the richest source of high quality protein, namely the essential amino acids like lysine, tryptophan etc., contains the essential minerals and trace elements, namely calcium, cobalt, iron etc. and the best sources of the B-complex vitamins such as B_1, B_2, B_6 and B_{12}. The extract is a valuable source of bio-constituents especially, cytokinins Amer (2004), that work as a readily available growth supplement for plants that eventually improve plant production Ghoname *et al* (2009), especially; when sprayed on green bean plants (Fathy and Farid 1996; El-Tohamy and El-Greadly 2007, Kamal and Ghanem 2012, and Marzauk *et,al* 2014) and Tarek *et al* 2014 on garlic plants.

Bee pollen grains contain nutritional compounds like carbohydrates, proteins, amino acids, lipids, vitamins, minerals and traces of micronutrients Serra and Jorda (1997). The extract contains a high amount of polyphenolic substances, flavonoids and cinnamic acid derivatives, which have high ability to neutralize the active oxygen species Silva *et al* (2000) and Almeida *et al* (2005). Moreover, Singh and Sawhney (1992) and Hassan *et al* (2008) reported that, bee pollen grains extract contains auxins, IBA and cytokinin.

Potassium humate can be used as organic potash fertilizers. It supplies high levels of soluble potassium in readily available forms. Combined with humic acid, potassium can be rapidly absorbed and incorporated into plant whether via soil or foliar application methods. Enhancement of plant growth using potassium humate had been reported to be due to increasing nutrients uptake such as N, Ca, P, K, Mg, Fe, Zn and Cu David, *et al* (1994) and Adani *et al* (1998) enhancing photosynthesis, chlorophyll density and plant root respiration which resulted in greater plant growth and yield Chen and Aviad (1990)**.** In North Florida, Castro *et al* (1988) reported a 17% yield increase of large tomato fruits with application of humic acid compared to the control treatment in micro irrigated culture. In the same respect, Padem *et al* (1997) on pepper plants studied that seedling stem diameter, number of leaves; shoot and dry matter were significantly influenced by foliar application of potassium humate. Moreover, Abd El-Al *et al* (2005) on onion plant and Ghoname *et al* (2009) on sweet pepper plant found that, foliar application of potassium humate at different levels had a significant effect on growth characters and total yield and its components as well as chemical characters.

Therefore, the aim of the present study was to evaluate the influence of foliar spraying of some natural bio-stimulants materials as alternatives to the synthetic stimulants, on growth, yield and bulb quality of onion plants.

Materials and Methods

This study was carried out at the experimental station of the National Research Centre, Beheira Governorate (north of Egypt), during the two successive seasons of 2011- 2012 and 2012- 2013 to investigate the effect of foliar application of natural bio-stimulants i. e. seaweed extract, garlic oil, licorice extract, limonene oil, yeast extract, bee pollen grains extract and potassium humate for influence plant growth, total yield and bulb quality of onion plants cv. Giza 20. The experimental trails were conducted in sandy soil using drip irrigation system. Chemical analysis and physical properties of the experimental soil are shown in Table (1).

Table 1: physical and chemical properties of the experimental soil.

Physical properties							
Sand		Clay	Silt	Texture	F.C. %	W.P. %	
90.08		9.26	0.66	Sandy	16.57	5.25	
Chemical analysis							
E.C. M/m	pH	Meq/ L					
		Ca	Mg	Na	K	Hco3	Cl
1.7	8.2	7.02	0.527	0.982	0.31	1.3	0.566

Onion seedlings were transplanted on 19th and 13th of December for 2011/2012 and 2012/2013 seasons respectively. Onion seedlings were transplanted at 25 cm distances on the two sides of each ridge. Pest control and other agriculture practices were applied as commonly recommended for commercial onion production by Ministry of Agriculture.

The experiment included the treatments as follows:

1- Foliar application with tap water (control).
2- Foliar application with seaweed extracts (1 g /l).
3- Foliar application with garlic oil (2ml/l).
4- Foliar application with licorice extracts (25 ml/l).
5- Foliar application with limonene oil (2ml/l).
6- Foliar application with yeast extracts (25 ml/l).
7- Foliar application with bee pollen extracts (5 g/l).
8- Foliar application with potassium humate (0.5 g/l).

A commercial seaweed extract product "Alga 600" (Techno green company) mixed of three seaweed viz., *Ascophyllum nodosum, Laminaria* spp and *Sargassum sp*. Seaweed extract also contains N (1%), K (18.5%), Ca (0.17%), Mg (0.42%), Fe (0.06%), S (2.2%), alganic acids (10-12%) and plant hormones (600 ppm). Natural garlic oil was

produced by Anhui Ruisen Biological Technology Co., Ltd., China. Licorice extract was prepared from the powdered roots of commercial licorice by mixing with boiled tap water (1kg licorice : 2 liter water) and left at room temperature for 24 hours then mixed in a blender and filtered to obtain a brown concentrated liquid extract. Minerals and antioxidant content of Egyptian licorice root are tabulated in Table (2): minerals and antioxidants content of Egyptian licorice roots (mg/ 100g dry weight) according to Morsi *et al* (2008**).**

Table 2: Minerals and antioxidants content of Egyptian licorice roots (mg/ 100g dry weight) according to Morsi *et al* (2008**).**

Minerals content		Antioxidants content	
Mg	473.5	Total phenol	405.0
Fe	25.27	Total flavonoids	114.9
Ca	984.0	Tannins	47.54
K	480.2	Saponins	27.99
Mn	1.25	Carotenoids	11.78

Commercial natural limonene oil was obtained from El-Gomhoria Company for chemicals. Yeast extract was prepared from brewer's yeast (*saccharomyces cerevisiae*), dissolved in water followed by adding sugar at a ratio of 1: 1 and kept 24 hours in a warm place for reproduction according to the methods of Morsi *et al* (2008). Chemical analysis of activated yeast is shown in Table (3): chemical analysis of activated yeast (mg/ 100g dry weight).

Table 3: chemical analysis of activated yeast (mg/ 100g dry weight).

Minerals		Amino acids		Vitamins	
Total N	7.23	Arginine	1.99	Thiamin	2.71
P_2O_5	51.68	Histidine	2.63	Riboflavin	4.96
K_2O	34.39	Isoleiucine	2.31	Nicotinic acid	39.88
MgO	5.76	Leucine	3.09	Pantothenic acid	19.56
CaO	3.05	Lysine	2.95	Biotin	0.09
SiO_2	1.55	Methionine	0.72	Pyridoxine	2.90
SO_2	0.49	Phrnylalanine	2.01	Folic acid	4.36
NaCl	0.30	Theronine	2.09	Cobalamin	153ug
Fe	0.92	Tryptophan	0.45	Enzymes	
Ba	157.6	Valine	2.19	Oxidase	0.350
Co	67.8	Glutamic acid	2.00	Peroxidase	0.290
Pd	438.6	Serine	1.59	Catalase	0.063
Mn	81.3	Aspartic acid	1.33		
Sn	223.9	Praline	1.53	Carbohydrates	23.20
Zn	335.6	Tyrosine	1.49		

Bee pollen extract was prepared from bee pollen grains obtained from the Egyptian Agriculture Research Center as described by Carpes *et al* (2007) with some modifications by mixing bee pollen in a blender with water (1:2, w/v) at temperature of 70*C for 30 min with constant agitation, the extract was further filtered to obtain a concentrated liquid extract. The control treatment was sprayed with tap water.

The tested bio-stimulants were applied as a foliar spray thrice by 15 day intervals, beginning from 30 days after transplanting. The experimental design was a complete randomized blocks with 3 replications for each treatment. The plot area was 15 m^2 (one row of 15 m length and 1m width).

The following data recorded:

1-Plant growth characters:

After 120 days from transplanting samples of onion plants were taken and number of leaves/ plant, plant length (cm), fresh and dry weight of leaves, neck and bulb (g/plant) were recorded.

2-Bulb yield and its physical properties:

At harvest time (180 days old) the total weights of bulbs resulting from each experiments plot were recorded and the yield of number and weight of bulbs /m^2 as well as total yield ton/fed. were calculated. Samples of 10 bulbs from each experimental plot were taken and average weight (g), length and diameter of bulb and nick (cm) were recorded.

3-Chemical bulb quality:

At harvest time, onion bulb samples from each experimental plot were taken for elemental analysis where N element % in the dry matter of bulb tissue were determined according to the methods described by Pregl (1945), In addition, protein percentages in bulbs were calculated by multiplying nitrogen content by 6.25. Reading of TSS was taken using hand refract meter calibrated as percent sucrose. The dry matter of bulb tissue was determined according the method described by Dubois *et al*. (1956).

All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

Results and Discussion

Plant growth characters

Data presented in Table (4) show that, the effect of spraying bio stimulants on vegetative growth characters of onion plants during 2012 and 2013 seasons. It was evidently clear that most of the applied foliar treatments greatly improved all studied growth characters of onion plants with various significant degrees compared with those of control in both seasons. However, foliar spraying of yeast extract, seaweeds extract and licorice extract at the same time had the highest stimulation effect on onion plant growth characters i.e. (plant length and number of leaves as well as fresh and dry weight of leaves, nick and pulps). These results are the same fending in both seasons. The positive effect of foliar application of yeast extract have been repeatedly reported on many vegetable crops, for instance, it significantly increased vegetative growth parameters of potato (Gomaa *et al* 2005). Furthermore, the improvement of onion plant growth in response to foliar application of yeast extract may be attributed to its contents of proteins, amino acids, different nutrients and higher percentage of vitamin B which may play an important role in improving growth and controlling the incidence of fungal diseases (Nitalikar *et al* 2010). These findings are in agreement with the results of Abou EL-Yazied and Mady (2012), Kamal and Ghanem (2012), Tarek *et al* (2014) and Marzauk *et al* (2014) who found that the application of yeast extract increased plant growth characters on vegetable crops. Moreover, the superiority of onion plants by spraying seaweed extract these may be attributed the extract contains growth promoting hormones (IAA and IBA), cytokinins, trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni) as well as vitamins and amino acids (Zodape *et al.* 2011). Such enhancement in growth parameters could be attributed to either improvement in soil condition resulting in greater root growth thereby enhancing the utilization of soil nutrients or the changes in the biotic and abiotic environment of plants which alters the host-parasitic relationship. Applying seaweed extract increased the response of different growth parameters responses of Watermelon Abdel-Mawgoud *et al* (2010). In the same respect, Shehata *et al* (2011) on Celeriac plants**,** Fawzy *et al* (2012) on Chinese garlic plants and Hernández *et al* (2013) on tomato found that foliar spraying of seaweed extract obtain the highest values of vegetative growth. Further, seaweed extracts are considered an organic farm input as they are environmentally benign and safe for the health of animals and humans. However, foliar application of licorice extract had the highest stimulation effect on plant growth characters. The stimulation effect on growth behavior could be explained based on their beneficial physiological effects, since licorice had a high concentration of naturally chemical compounds in the extract like; phenolic compounds (Table 2), which is essential for plant physiology due to its contribution for morphological plant form and structure, also, they are involved in plant growth and reproduction process (Cook and Samman 1996). On the other hand, licorice flavonoids are currently the strongest natural antioxidants known with 100 times stronger than that of vitamin E (Ju 1989). In addition, licorice extract reported to have antimicrobial activities against a wide range of pathogens by the action of the phytoalexins (Nitalikar *et al* 2010).

Table 4: Effect of foliar application of natural bio-stimulants on growth characters of onion plants during 2012 and 2013 seasons.

Treatments	2012 season								2013 season							
	Plant length (cm)	No. of leaves	Fresh weight (g)			Dry weight (g)			Plant length (cm)	No. of leaves	Fresh weight (g)			Dry weight (g)		
			leaves	neck	bulb	leaves	neck	bulb			leaves	neck	bulb	leaves	neck	bulb
1	48.46	7.71	28.41	34.63	79.00	9.40	7.10	21.86	48.80	7.67	29.40	34.26	78.67	9.71	7.06	21.42
2	68.80**	9.25*	30.27*	35.58*	82.97*	11.29*	8.31*	24.38*	57.11*	9.22*	29.99*	35.74*	82.63*	11.29*	8.27*	23.95*
3	63.34*	8.66	29.93	35.43	82.75	11.19	8.15	23.92	53.62	8.74	29.64	35.70	82.19	11.22	8.11	23.20
4	66.67*	9.04	30.10	35.53	82.86	10.97	8.18	23.80	54.62	9.01	29.00	34.97	81.67	11.09	8.15	23.04
5	67.25*	9.19*	28.78	34.84	83.17	11.13	8.19	23.40	51.70	8.35	29.13	35.13	82.62	11.03	8.21	23.00
6	68.86**	9.59**	30.45*	35.56*	83.19**	11.26*	8.31*	23.92*	57.18*	9.55*	30.26*	35.65*	83.12*	11.33*	8.32*	23.54*
7	57.00*	8.57	29.65	35.40	82.18	10.89	8.21	23.67	56.92	9.14	29.73	35.49	82.37	11.26	8.23	23.25
8	68.54*	8.44	28.29	34.18	80.96	10.22	8.01	22.05	53.52	8.30	27.96	34.48	80.42	10.44	8.01	22.19
LSD at 5 %	1.12	0.50	1.07	0.53	0.65	0.43	0.19	0.79	2.22	0.48	0.82	0.53	0.76	0.38	0.12	0.52

(1)- Foliar application with tap water (control). (2)- Foliar application with seaweed extracts (1 g /l).(3)- Foliar application with garlic oil (2ml/l). (4)- Foliar application with licorice extracts (25 ml/l).(5)- Foliar application with limonene oil (2ml/l).(6)- Foliar application with yeast extracts (25 ml/l).(7)- Foliar application with bee pollen extracts (5 g/l). 8- Foliar application with potassium humate (0.5 g/l).

Total bulb yield and its components

Data showing the effect of foliar application of bio stimulants materials on total yield and its components of onion plants are presented in (Table 5). However, total onion bulb yield as ton\fed. recorded its heaviest values (11.73 and 11.77 ton\fed.) for 1st and 2nd seasons respectively with foliar application of seaweed extract. In descending order yeast extract recorded (11.72 and 11.75 ton\fed.). In the same respect, licorice extract recorded (11.64 and 11.69 ton\fed.) compared control treatment recorded (10.01 and 11.18 ton\fed.) for 1st and 2nd seasons respectively. The response of average bulb weight as g\bulb and bulb dimension (length and diameter) as well as total bulb yield per m^2 followed the same pattern of change like that mentioned above. The statistical analysis of the obtained data showed that the differences within different treatments of bio stimulants materials were great enough to reach the 5% levels. The obtained results in both two seasons were similar. It could be concluded that the heaviest bulbs yield and its best values of some physical properties which resulted may be attributed to the best vigor of plant growth characters which obtained by foliar

application of (seaweed, yeast and licorice extracts) Table (4). And also seaweed extracts improve nutrient uptake by roots (Crouch *et al* 1990). In the same respect, seaweed extract has been shown to enhance plant defense against pest and diseases (Allen *et al* 2001). However, yield increases in seaweed treated plants are thought to be associated with the hormonal substances present in the extracts especially cytokinins. The reduction in disease severity could be due the fact that higher plants have reservoirs of bio gradable secondary metabolites (Fawcett and Spencer 1997) that are reported to inhibit various phytopathogenic fungi (Pandey and Pant 1997). On the other hand, the enhancing effect of yeast and licorice extracts on total yield and its components of onion plant could be such treatments improved N, P and K % as well as total chlorophyll content and increased natural axons specially cytokinins, IAA and GA^3 contents.

Table 5: Effect of foliar application of natural bio-stimulants on total yield of onion plants during 2012 and 2013 seasons.

Treatments	2012					2013				
	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Total bulb yield (m^2) kg	Total yield (ton../ fed)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Total bulb yield (m^2) kg	Total yield (ton../fed)
1	5.29	6.51	152.33	2.73	10.01	5.18	6.79	158.70	2.80	11.18
2	6.93***	7.98**	192.72**	3.32**	11.73**	7.02**	8.03**	193.99**	3.39**	11.77**
3	6.71*	7.55*	173.34*	3.15*	11.51*	6.48*	7.63*	177.94*	3.18*	11.52*
4	6.78**	7.63*	177.94**	3.24**	11.64*	6.73**	7.82**	178.20*	3.27**	11.69**
5	6.45*	7.47*	175.21*	3.15*	11.52*	6.67*	7.74*	175.42*	3.17*	11.52*
6	6.88***	7.64**	186.16**	3.26**	11.72**	6.94**	7.84**	184.77**	3.29**	11.75**
7	6.62*	7.57*	164.31*	3.16*	11.56*	6.67*	7.59*	171.35*	3.18*	11.65*
8	6.56*	7.55*	169.61*	3.16*	11.63*	6.64*	7.68*	174.51*	3.20*	11.64*
LSD at 5 %	0.29	0.37	10.87	0.23	0.17	0.29	0.22	9.63	0.21	0.22

(1)- Foliar application with tap water (control). (2)- Foliar application with seaweed extracts (1 g /l).(3)- Foliar application with garlic oil (2ml/l). (4)- Foliar application with licorice extracts (25 ml/l).(5)- Foliar application with limonene oil (2ml/l).(6)- Foliar application with yeast extracts (25 ml/l).(7)- Foliar application with bee pollen extracts (5 g/l). 8- Foliar application with potassium humate (0.5 g/l).

Chemical content of onion bulb

Table (6) shows the effect of the tested bio stimulants on chemical composition of onion bulb tissues. It is clear that the foliar application of bio stimulants treatments significantly increased the percentage of nitrogen, protein and dry matter contents of onion bulb tissues. However, foliar application of yeast, seaweed and licorice extracts treatments greatly improved onion bulb contents of the percentage of nitrogen, protein and dry matter compared with those of control and other foliar applications in the two seasons. The beneficial effect of foliar application with yeast extract may be attributed to the promotion of plant hormones as a result of yeast application; the natural cytokinins content in yeast stimulates cell division and enlargement as well as synthesis of protein, nucleic acid and chlorophyll (Spencer *et al* 1983).

Table 6: Effect of foliar application of natural bio-stimulants on chemical content of onion bulb during 2012 and 2013 seasons.

Treatments	2012 season				2013 season			
	TSS	%			TSS	%		
		N	Protein	Dry matter		N	Protein	Dry matter
1	11.52	1.70	10.65	13.63	11.56	1.59	9.96	13.29
2	11.57	2.13***	13.33**	14.40**	11.60	2.12**	13.23**	14.06**
3	11.42	1.92**	12.39*	14.04*	11.50	1.85*	11.83*	13.71*
4	11.48	1.98**	13.00**	14.34**	11.52	2.09**	12.56**	14.04*
5	11.53	1.91*	11.94*	14.23*	11.59	1.88*	11.73*	13.90*
6	11.45	2.11***	13.18**	14.74**	11.51	2.08**	12.98**	14.41**
7	11.56	1.87*	11.67	14.37*	11.53	1.86*	11.61*	14.00*
8	11.45	1.90*	12.09*	14.33*	11.53	1.90*	11.88*	14.00*
LSD at 5%	N.S.	0.16	1.02	0.21	N.S.	0.21	1.28	0.20

(1)- Foliar application with tap water (control). (2)- Foliar application with seaweed extracts (1 g /l).(3)- Foliar application with garlic oil (2ml/l). (4)- Foliar application with licorice extracts (25 ml/l).(5)- Foliar application with limonene oil (2ml/l).(6)- Foliar application with yeast extracts (25 ml/l).(7)- Foliar application with bee pollen extracts (5 g/l). 8- Foliar application with potassium humate (0.5 g/l).

The beneficial effect of licorice extract on chemical content of onion bulb might be due to their direct and indirect stimulatory and antioxidant protective effect. As reported in Table (2) licorice extract is rich in many essential minerals, i.e. Mg, Fe, Ca and K as well as many natural antioxidants including, total phenols, flavonoids, tannins, saponins and carotenoids (Morsi *et al* 2008)

The promoting effect of seaweed extract on chemical content of onion bulb might be
to great contain high levels of organic matter, micro elements, vitamins and fatty acids and also rich in growth regulators such as auxins, cytokinin and gibberellins. The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still unknown (Shehata *et al.,* 2011).

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