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Impact of Soil Humic Acid Soil Application and Seaweed Extract Foliar Spray on Growth, Yield, and Fruits Quality of Strawberry Plants Grown under Aswan Conditions

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ABSTRACT

Two field experiments were carried out during two consecutive growth seasons (2014/2015 and 2015/2016) in the Experimental Station Farm, Faculty of Agriculture and Natural Resources, Aswan University, Egypt on a sandy textured soil under unheated plastic houses. The aim of this study was to investigate the influence of three levels of humic acid added to the soil with irrigation and three levels of seaweed extract foliar applications as well as their interactions on growth traits, yield, and fruit quality of strawberry) *Fragaria ×ananassa* Dush (.cv. "Festival" grown on the sandy soil under Aswan conditions. The experimental design was a split-plot system arranged in a randomized complete block design with three replications. The humic acid treatments (0, 200 and 400 mg/L) were randomly arranged in the main plots, while seaweed extract concentrations, (0, 500, 1000 and 1500 mg/L) were randomly distributed in the sub-plots. The obtained results revealed that soil humic acid application gave the significant effects in all characters under study and seaweed extract foliar spray .Moreover ,applying soil humic cid at a level of 400) mg/L (combined with seaweed extract spray 1500) mg/L (resulted in significant increases in most studied characters in both seasons.

Keywords: Strawberry**,** Humic acid**,** Seaweed extract**,** growth, flowering, yield, fruit quality

INTRODUCTION

Strawberry (*Fragaria × ananassa* Dush.) is one of the most important untraditional vegetable crops grown in Egypt, for fresh consumption, processing and exportation. Potentially, it is one of the most Egyptian profitable horticultural exports to Europe (El-Shall *et al*., 2003). Its fruits are very popular among berries and are reported to have antioxidant, anticancer, anti-inflammatory and anti-neurodegenerative biological properties. These properties are mainly attributed to the high fruit polyphenolic content, especially anthocyanins – the polyphenols type which is quantitatively is most important in strawberry fruits – as well as flavonoids, phenolic acids and vitamin C (Cordenunsi *et al*., 2005). Strawberry is commonly grown on newly reclaimed sandy textured soils in order to obtain early yields with a high fruit quality (Mohamed and Gabr, 2002).

Strawberry plants are very responsible to humic substances application due to their shallow root system and high productivity, in relation to the plant size. The uptake of humic substances by plant tissue resulting in various biochemical effects through an increased nutrient uptake and maintaining levels of vitamins and amino acids in plant tissues; and thus stimulating root growth and whole plant (Nardi *et al*., 1996). Humic acid (HA) is an effective agent which used as a complement to mineral or organic fertilizers. Soil application of HA; led to improve some physico-chemical soil properties such as aggregation, aeration, permeability and water-holding capacity as well as nutrient ion transport, and availability through the pH buffering (Tan 2003). Many researchers clarified several beneficial effects of HA including increases in cell membrane permeability (Canellas *et al*., 2015), oxygen uptake and photosynthesis (Chen *et al*., 1994), P uptake and root elongation (Bohme and Lue, 1997; Liu *et al*., 1998). Humic acid (HA) has hormone-like activity which not only enhances the plant growth and the nutrient uptake but also shows an anti-stress effect under abiotic stress conditions such as unfavorable temperature, salinity, and pH by ameliorating the negative effect of any stress (El-Hefny, 2010). However, the physiological mechanism has not been well established (Delfine *et al*., 2005). Salama (2009) reported that soil applications of humate alleviated the negative effects of salinity on tomato plants. Therefore, the application of HA improves both the nutrient balance and plant vitality (Boehme *et al*., 2005). Erik *et al*. (2000), on onion and Hafez (2003), on squash reported that HA applications showed a significant increase in soil organic matter which in turn improve of the plant growth and productivity. Moreover, because of the multiple roles of HA, it can greatly benefit the plant growth and yield of vegetables (Zandonadi *et al*., 2007).

On the other hand, the extreme seaweed extract that is a new generation of natural organic fertilizers is highly nutritious, promotes faster germination of seeds and increases yield and resistant ability of many crops (Dhargalkar and Pereira, 2005). Seaweeds are rich in micro and macro nutrients (Chapman and Chapman, 1980). Extracts of brown seaweeds are widely used in horticultural crops largely for their plant growth-promoting effects and for their ameliorating effect on crops that are tolerant to abiotic stresses such as salinity, extreme temperatures, nutrient deficiency and drought. Amongest the brown seaweeds, *Ascophyllum nodosum*, *Ecklonia maxima*, *Macrocystis pyrifera* and *Durvillea potatorum* are the most frequently commercially used by the extract industries (Khan *et al*., 2009). The chemical constituents of seaweed extract include complex polysaccharide, fatty acids, vitamins, phytohormones and mineral nutrients (Battacharyya *et al*., 2015).

Applications of seaweed extract, as a foliar spray, brought an increase in total soluble solids (TSS) and vitamin C of two strawberry cultivars (Masny *et al*. 2004). A commercial extract of *Ascophyllum nodosum*; caused such increases in strawberry yield, fruit diameter, fruit weight and, number of cells per area of parenchymatous tissue, fruits yield, size, and total anthocyanin (Alam *et al*., 2013). Also, regarding some other vegetable crops, foliar applications of seaweed extracts gave rise to an increases in yield of two potato cultivars (Blunden and Paul, 2006), total yield of cucumber (Sarhan and Ismael, 2014) and all growth parameters, total yield, fruit dry weight and TSS of pepper (Mohammed, 2013). Also, using seaweed extract caused increases in okra yield, chlorophyll, carotenoids, fruit length, fruit diameter and, nutritional quality (Zodape *et al*., 2008; Thirumaran *et al*., 2009; Papenfus *et al*., 2013). In tomato, seaweed extract increased Mn, Zn and Fe uptakes, chlorophyll content, enhanced germination, plant height, fruit weight and yield (Hernández-Herrera *et al*., 2014). El Sagan (2015) reported that the using foliar application of algae extract at a level of 1.5 mg/L caused significant increments in cucumber plant length, plant weight, average of leaf area, fruit weights No. of fruit/plant, yield and chemical content (leaves N, P and K content). In Eggplant, Abd El-Gawad and Osman (2014) also showed that the seaweed extract of *Ascophyllum nodosum* induced increases in the vegetative growth and yield. In addition, it increased the yield of watermelon (Abdel-Mawgoud *et al*., 2010).

This study aims was to test the influence of three soil application levels of humic acid and three foliar spray levels of seaweed extracts on the growth traits, yield, and fruit quality of strawberry (*Fragaria × ananassa* Dush.) cv."Festival" grown on a sandy soil under Aswan conditions.

MATERIALS AND METHODS

Two field experiments were conducted during 2014/2015 and 2015/2016 growth seasons in the Experimental Station Farm, Faculty of Agriculture and Nature Resources, Aswan University, Egypt under unheated plastic houses to investigate humic acid and seaweed extract effects on growth, yield and fruit quality of strawberry plants grown on a sandy soil. Before transplanting, random surface soil samples of 30 cm depth were collected from different places of the plastichouse to determinate the soil chemical and physical properties as described by Page *et al*., (1982) and Jackson (1973). These properties are showen in Table (1). The field experiments were done in a sandy soil using the drip irrigation method.

"Festival" strawberry cultivar is which widely cultivated in Egypt, most sugary with excellent flavor and high yielding was used in this study. Frigo transplants of Festival cultivar were obtained from the Non-traditional Crops Research Station, Nubaria, El- Beheira governorate, Egypt. The transplants were transferred into the field on the 20th of October during both growth seasons. The transplants were sown on both sides of the row at 25 cm apart and 0.70 m width of ridge. Each experiment contained 12 treatments representing the combinations of three humic acid levels (0, 200, 400 ppm) that were added through the drip irrigation system and four levels of seaweed extract (0, 500, 1000, 1500 mg/L) as a foliar application. The treatments were applied three times at 15, 30, 45 days from transplanting. The drip irrigation network consisted of lateral's GR of 16 mm in diameter, with emitters at 25 cm distance, with allocating two laterals for each row. The emitters had a discharge rate 4.l h-1. All missing transplants were replaced by another mother one, one week later after transplanting.

The chemical composition of humic acid (soluble potassium humate) used in this experiments was 80% humic acid, 11-13% K2O, 5-7% moisture, 0.83 g/ml density and more than 98 % water solubility. Seaweed extract coined as Oligo-X was used in this study. It is a mixture of *Ascophyllum*, *Laminaria*, *Sargassum*, *Fucus* spp. It was obtained from Union for Agricultural Development Company having the following composition: oligosaccharides 3%, algnic acid 5%, phytin 0.003%, menthol 0.001%, natural growth regulators (cytokinin 0.001%, indol acetic acid 0.0002%), pepsin 0.02 % and minerals (potassium oxide 12%, phosphorus oxide 0.5%, N1%, Zn 0.3%, Fe 0.2% and Mn 0.1%).

The experimental design was split-plot arranged in a randomized complete block with three replications. The humic acid treatments were randomly arranged in the main plots while seaweed extract concentrations were, randomly distributed in the sub-plots. Each sub plot was consisted of one ridge with 6.25 m length and 0.7 m width making an area of 4.375 m2. The newly developed flowers and runners were removed during the first month to enhance the vegetative growth before flowering. The recommended cultural practices for commercial strawberry production were followed. Irrigation was daily achieved according to the applied irrigation water quantity.

Table 1. Some soil physical and chemical properties of the experimental site in growth both seasons (2014/2015 and 2015/2016).

Soil property *	Season	
	2014/2015	2015/2016
Physical properties		
Clay (%)	3.00	3.50
Silt (%)	0.00	0.00
Sand (%)	97.00	96.50
Textural class	Sandy	Sandy
Chemical properties		
Soluble cations in (1:1) soil to water extract mmol/L)		
Ca^{++}	3.06	3.10
Mg^{++}	1.02	1.05
K^{+}	0.83	0.85
Na^{+}	0.76	0.80
Soluble anions in (1:1) soil to water extract(mmol/L)		
CO_3^{--}	0.00	0.00
HCO_3^{-}	7.10	7.06
Cl^{-}	3.60	3.57
SO_4^{--}	0.40	0.44
pH (1:1 soil suspension)	7.64	7.70
EC (dS/cm) at 25° C	0.33	0.32
Available N (mg/kg soil)	128.31	130.00
Available P (mg/kg soil)	8.00	10.00
Available K (mg/kg soil)	175.00	180.00

***The analyses were carried out at Soil Fertility Departement, Faculty of Agricultur (Saba Basha), Alexanderia University, Egypt.**

Experimental Measurements

- **Vegetative growth parameters**

Ten plants were taken randomly from each sub-plot at the full blooming stage to measure and record the number of leaves/plant, number of crowns/plant, and leaf area (cm2).

- **Flowering traits**

Ten randomly chosen plants from each sub-plot were labeled to record the time spanned till flowering as the number of days from the transplanting date until flowering of 25% of plants (earliness of flowering), and to count the number of flowering cluster/plant to the end of experiment.

- **Yield and its components characters**

The total yield per plant (kg) was calculated in random samples of ten plants per sub-plot at each harvest. Early yield was calculated in ton fed.-1 as the fresh weight of harvested fruits from the first four pickings. The total yield per feddan was calculated (ton fed.-1) as the fresh weight of all harvested fruits over the growth seasons. The unmarketable yield (ton fed.-1) was calculated at each harvest including the splitted, malformed, green shouldered, damaged and rotted fruits.

- **Fruit quality characters**

Titratable acidity (TA) was calculated as a percentage of citric acid (A.O.A.C., 1990). The total soluble solids (TSS) in the extracted fruit juice were measured using a refractometer according to the method of Cox and Pearson (1962). Vitamin C (Ascorbic acid) was estimated by the titration with iodide potassium (Ranganna, 1986). Measurements of total phenols with a folin reagent were a determined Snell and Snell (1953) at 660µm using a photoelectric colorimeter and the readings were compared to those obtained from a pyrogallol standard solution. Free, conjugated and total phenol was expressed as µg.g-1fresh weight.

Statistical Analysis

All obtained data of the present study were, statistically, analyzed according to the design used by the MSTAT-C computer software program (Bricker, 1991) and the revised L.S.D. test at 0.05 level of probability was used to compare the differences among the means of the various treatment combinations as illustrated by El-Rawy and Khalf-Allah (1980).

RESULTS AND DISCUSSION

The results, generally, showed, more or less, similar responses to each of the two main studied factors and their interactions in both experiments that were conducted in both seasons of 2014/2015 and 2015/2016. The effects of the different factors used in this study and their interactions on the various characters of strawberry plants are present under four main headings as follows: vegetative growth, flowering, yield and its component and fruit quality characters.

1. Vegetative Growth Characters

The effects of the different humic acid levels and seaweed extract levels as well as their interactions on vegetative growth characters of strawberry plants, during 2014-2015 and 2015-2016 seasons are shown in Tables 2 and 3. Table 2 demonstrated the main effects of both humic acid levels and seaweed extract levels in both growth seasons on number of crowns/plant, number of leaves/plant and leaf area/plant (cm2).

- **Humic acid effects.**

The results declared that the highest applied level of humic acid (400 mg/L) significantly increased all vegetative growth characters i.e. number of crowns/plant, number of leaves/plant and leaf area/plant (cm2), in both seasons, in comparison with the other two humic acid levels. On the other hand, the untreated plants (control) exhibited the lowest, mean values of all vegetative growth characters during both seasons. Humic substances have been reported to influence the plant growth both directly and indirectly. The indirect effects of humic compounds have been attributed to the improvement of soil physical, chemical and biological properties. Directly, these compounds appeared to be capable of affecting plant growth through the acceleration of respiratory processes (Smidova, 1960), via increasing cell permeability and hormonal growth responses (Vaughan, 1974), or due to a combination of these processes. Indirectly, some plant hormone- like substances that are present in the humic acids, exert a possible stimulating effect on growth and development of chlorophyll and proliferation of desirable soil micro-organisms (Liu *et al*., 1998). Also, it could cause an enlarged root system (deeper and greater mass) and increased stimulate of the plant growth due to hormones (Hopkins and Stark, 2003). These results are in an agreement with those obtained by Shafshak *et al*. (2011) and Mohamed (2015) who indicated that soil addition of humic acid, significantly, increased all the studied growth traits.

Table 2. Vegetative growth characters of strawberry plants as affected by humic acid and seaweed extracts during 2014/2015 and 2015/2016 growth seasons.

Treatments	No. of crowns/plant	No. of Leaves/plant	Leaf area/plant (cm^2)	No. of crowns/plant	No. of Leaves/plant	Leaf area/plant (cm^2)
	2014/2015			2015/2016		
			Humic acid (mg/L)			
0	5.283 C	22.88 C	327.1 C	5.358 B	24.12 C	344.4 C
200	5.475 B	27.05 B	415.0 B	5.625 A	29.58 B	437.1 B
400	5.575 A	29.85 A	486.5 A	5.692 A	31.69 A	516.6 A
L.S.D. $_{(0.05)}$	0.051	1.10	19.3	0.095	1.08	38.2
			Seaweed extracts (mg/L)			
0	4.578 D	24.24 D	364.7 D	4.733 D	25.72 D	387.1 B
500	4.933 C	25.66 C	391.2 C	5.022 C	27.20 C	392.8 B
1000	5.867 B	27.56 B	425.8 B	5.967 B	29.84 B	461.1 A
1500	6.400 A	28.92 A	456.4 A	6.511 A	31.08 A	489.8 A
L.S.D. $_{(0.05)}$	0.070	0.66	10.4	0.109	0.60	33.1

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **Seaweed extract effects**

The number of crowns/plant, number of leaves/plant and leaf area/plant (cm2) significantly and successively increased as the seaweed extract levels increased in both seasons. The highest mean values were obtained from the highest seaweed extract level (1500 mg/L). On the contrary, all investigated vegetative growth characters, significantly, decreased with reducing of seaweed extract level, during both seasons. The lowest mean values of the characters were recorded for untreated plants. The positive effect of seaweed extract may be due to its constituents of macro- and micro nutrients as well as some growth regulators, polyamines and vitamins which improve the nutritional status and vegetative growth (Chapman and Chapman, 1980; Hegab *et al.,* 2005; Battacharyya *et al*., 2015). Also, Alam *et al*. (2013) reported that *Ascophyllum* extract application showed significant increases in strawberry total root length, total root surface area, total root volume and number of roots/plant it which enhanced more nutrient absorption and resulted in increases vegetative growth characters. El-Miniawy *et al*. (2014) also found that the seaweed extract foliar spray enhanced strawberry vegetative growth characters, i.e. plant length, number of leaves/plant, leaf area, root and vegetative growth fresh weights.

Table 3. Interaction effects of humic acid and seaweed extract on the vegetative growth characters of strawberry plants during 2014/2015 and 2015/2016 growth seasons.

Humic acid (mg/L)	Seaweed extracts (mg/L)	No. of crowns/plant (2014/2015)	No. of Leaves/plant (2014/2015)	Leaf area/plant (cm^2) (2014/2015)	No. of crowns/plant (2015/2016)	No. of Leaves/plant (2015/2016)	Leaf area/plant (cm^2) (2015/2016)
0	0	4.333 H	21.13 H	295.9 I	4.500 G	22.20 I	311.2 F
	500	4.900 F	22.47 G	317.1 H	4.867 F	23.70 H	335.6 F
	1000	5.767 E	23.93 F	342.3 G	5.867 D	25.43 G	363.9 EF
	1500	6.133 C	24.00 F	353.0 G	6.200 C	25.13 G	366.9 EF
200	0	4.667 G	25.17 E	377.7 F	4.867 F	26.90 F	403.8 DE
	500	4.900 F	26.40 D	401.3 E	5.033 EF	28.57 DE	367.6 EF
	1000	6.000 D	28.00 C	431.2 D	6.133 C	31.73 BC	488.7 BC
	1500	6.333 B	28.63 C	449.6 C	6.467 B	31.10 C	488.3 BC
400	0	4.733 G	26.43 D	420.3 D	4.833 F	28.07 E	446.3 CD
	500	5.000 F	28.10 C	455.2 C	5.167 E	29.33 D	475.2 BC
	1000	5.833 E	30.73 B	504.0 B	5.900 D	32.37 B	530.8 B
	1500	6.733 A	34.13 A	566.6 A	6.867 A	37.00 A	614.2 A
L.S.D. $_{(0.05)}$		0.121	1.15	18.0	0.188	1.05	57.4

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **Interactions effects of humic acid and seaweed extract**

Interaction effects of humic acid levels and seaweed extract levels are shown Table 3, on some vegetative growth characters in both 2014-2015 and 2015-2016 growth seasons. All investigated vegetative growth parameters exhibited significant increments due to the successive increase of the seaweed extract level, at each humic acid level. Obviously, the combination levels of 400 mg/L humic acid and 1500 mg/L seaweed extract gave rise to the highest significant mean values of all vegetative growth traits, in both seasons. On the other hand, the lowest mean values were obtained from untreated plants in both seasons.

- **Flowering characters**

The effects of the different levels of humic acid and seaweed extract as well as their interactions on flowering traits of strawberry plants, during the 2014/2015 and 2015/2016 seasons, are present in Tables 4 and 5.

- **The main effect of humic acid**

The main effects of humic acid levels on strawberry flowering character are shown in Table 4. In both growth seasons, the different comparisons within the means of each character indicated that the untreated plants showed significant increases in terms of number of days elapsed from transplanting to flowering (i.e. late flowering) compared to the treated ones which exhibited an earlier flowering, during both growth seasons. However, number of flowering clusters, it was not significantly affected by humic acid levels in both seasons. These results agree with those reported by Feleafel and Mirdad (2014) who showed flowering improvement of tomato plants due to increasing the humic acid level resulting in an earlier flowering and an increase in the number of flowers per cluster.

Table 4. Flowering characters of strawberry plants as affected by the main effects of humic acid and seaweed extract during 2014/2015 and 2015/2016 growth seasons.

Treatments	Earliness of flowering (day) (2014/2015)	No. of Flowering clusters (2014/2015)	Earliness of flowering (day) (2015/2016)	No. of Flowering clusters (2015/2016)
Humic acid (mg/L)				
0	56.87 A	8.917 A	58.19 A	9.333 A
200	53.49 B	8.692 A	54.94 B	8.975 A
400	53.36 B	9.250 A	54.54 B	9.692 A
L.S.D. $_{(0.05)}$	0.69	1.084	1.05	1.285
Seaweed extracts (mg/L)				
0	59.04 A	7.422 C	60.73 A	7.911 D
500	55.77 B	8.778 B	56.73 B	9.156 C
1000	52.50 C	9.611 A	54.09 C	9.800 B
1500	51.00 D	10.000 A	52.01 D	10.47 A
L.S.D. $_{(0.05)}$	1.30	0.492	1.27	0.52

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **The main effect of seaweed extracts.**

Table (4) also showed effects in within both growing seasons; inverse and direct proportionate relationships between the seaweed extract level and studied traits. For instance, increasing the applied level of seaweed extract (from 0 to 500, 1000 and 1500 mg/L) displayed a significant decrease in number of days from transplanting to flowering (i.e. more flowering earliness) in both seasons. Meanwhile, a significant increase in number of flowering clusters occurred as the level of seaweed extract increased (i. e. direct proportionate relationship) in both seasons. These results may be taken place due to the mode of action of seaweed extract which has some natural growth regulators such as cytokinin and indol acetic acid which may enhance the flower initiation and induce more flowering earliness, resulting in increases in the number of flowering clusters (Chapman and Chapman, 1980; Hegab *et al*. 2005 and Battacharyya *et al*., 2015).

2. Interaction effects of humic acid and seaweed extract

The results showed in Table (5) revealed that the combination treatment of applying 400 mg/L humic acid with either 1000 or 1500 mg/L of seaweed resulting in a significant reduction in number of days from transplanting to flowering i.e. more earliness compared to the untreated plants which exhibited late flowering in both growth seasons. However, in the case of number of flowering clusters, the highest significant mean values were obtained when 400 mg/L of humic acid were applied combined with 1500 mg/L of seaweed extract in during both seasons. On the contrary, the lowest significant mean values were obtained for the untreated (control) plants in both seasons.

Table 5. Interaction effects of humic acid and seaweed extracts on flowering characters of strawberry plants during 2014/2015 and 2015/2016 growth seasons.

Humic acid (mg/L)	Seaweed extracts (mg/L)	Earliness of flowering (day) 2014/2015	No. of Flowering clusters 2014/2015	Earliness of flowering (day) 2015/2016	No. of Flowering clusters 2015/2016
0	0	61.44 A	7.333 D	63.40 A	7.900 FG
	500	58.72 B	8.533 C	59.33 BC	9.100 DE
	1000	56.67 BC	9.933 AB	57.70 CD	10.07 B-D
	1500	50.67 F	9.867 AB	52.33 FG	10.27 B
200	0	57.43 BC	7.433 D	58.43 B-D	8.000 FG
	500	55.30 CD	8.600 C	56.20 DE	8.833 EF
	1000	50.38 F	9.000 BC	52.73 FG	9.200 C-E
	1500	50.87 F	9.733 AB	52.40 FG	9.867 B-D
400	0	58.25 B	7.500 D	60.37 B	7.833 G
	500	53.28 DE	9.200 BC	54.65 EF	9.533 B-E
	1000	50.46 F	9.900 AB	51.83 G	10.13 BC
	1500	51.47 EF	10.400 A	51.30 G	11.27 A
L.S.D. $_{(0.05)}$		2.25	0.853	2.19	0.90

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **Yield and Its component.**

Effects of humic acid levels and seaweed extract levels, as well as their interactions on the total yield/ plant and total yield per feddan, early yield, and unmarketable yield/ feddan, are illustrated in Tables 6 and 7.

- **Humic acid effects.**

Table 6 indicated that the highest humic acid level (400 mg/L) significantly gave the highest values of the total yield/plant and total yield per feddan, early yield, and non-marketable yield/ feddan, in both seasons. However, the differences in the early yield, in the first season and the non-marketable yield during in seasons between 200 and 400 mg/L levels of humic acids were insignificant. Humic substances have been reported to influence plant growth both directly and indirectly by increasing cell permeability and by hormonal growth responses (Vaughan, 1974). Therefore, the positive effects of the humic acid on yield potential of strawberry plants might be related to its beneficial effect on the vegetative growth as it probably supplies more photosynthetic substances needed for fruit formation and development and accelerates their translocation to storage plants (Salib, 2002). The obtained results coincide with those indicated Shafshak *et al*. (2011) and Mohamed (2015) on strawberry. The positive effects of humic acid on soil fertility bio-mass and quality of vegetables were also studied by (Chen and Huang, 2009; El-Ghamry *et al*., 2009 and Feleafel and Mirdad 2014.

Table 6. Yield characters of strawberry plants as affected by humic acid and seaweed extract levels during 2014/2015 and 2015/2016 growing seasons.

Treatments	Total yield/plant (Kg/plant) 2014/2015	Total yield/feddan (Ton/fed.) 2014/2015	Early yield/feddan (Ton/fed.) 2014/2015	Non-marketable yield/feddan (Ton/fed.) 2014/2015	Total yield/plant (Kg/plant) 2015/2016	Total yield/feddan (Ton/fed.) 2015/2016	Early yield/feddan (Ton/fed.) 2015/2016	Non-marketable yield/feddan (Ton/fed.) 2015/2016
Humic acid (mg/L)								
0	0.592 B	17.76 C	3.424 B	1.030 B	0.600 B	17.98 C	3.468 C	1.048 B
200	0.617 B	18.52 B	4.264 A	1.133 A	0.628 B	18.84 B	4.339 B	1.151 A
400	0.663 A	19.70 A	4.353 A	1.148 A	0.673 A	20.20 A	4.470 A	1.176 A
L.S.D. $_{(0.05)}$	0.036	0.43	0.108	0.0358	0.036	0.51	0.119	0.036
Seaweed extracts (mg/L)								
0	0.599 B	17.96 D	3.483 D	1.613 A	0.607 B	18.21 D	3.534 D	1.638 A
500	0.616 AB	18.49 C	3.890 C	1.171 B	0.623 B	18.70 C	3.936 C	1.186 B
1000	0.633 A	18.88 B	4.159 B	0.882 C	0.639 AB	19.17 B	4.222 B	0.901 C
1500	0.649 A	19.30 A	4.523 A	0.748 D	0.665 A	19.96 A	4.678 A	0.774 D
L.S.D. $_{(0.05)}$	0.031	0.39	0.094	0.031	0.031	0.31	0.070	0.031

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **Seaweed extracts effect.**

The highest level of seaweed extract (1500 mg/L) caused significant increases in the total yield per plant and per feddan and the early yield per feddan, in both seasons (Table 6). On the other hand, this level of seaweed extract gave the lowest significant mean value of the non-marketable yield per feddan in both seasons. The increase in the total yield per plant and per feddan and early yield per feddan of the plants that were sprayed with the seaweed extract may attributed to its role in enhancing the growth causing as an increase in the number of flowering clustersdue to improving the physiological activities such as photosynthesis and plant nutrient absorption (Al-Saaberi, 2005). Likewise, an increase in the early yield per feddan may take place due to decreasing number of days elapsed from transplanting to flowering using foliar application of seaweed extract. Further decreases in the non-marketable yield of strawberry per feddan after the foliar application of seaweed extract may be attributed to its contents of some natural growth regulators such as cytokinin and Indol acetic acid, and some other elements which improve the pollination and ameliorate the crop tolerance to disease stresses, (Khan *et al*., 2009). These results are in confirmation with those obtained by (Mohammed, 2002; Roussos *et al*., 2009; Spinelli *et al*., 2010 and Alam *et al*. (2013). El-Miniawy *et al*. (2014) also showed found that the seaweed extract foliar spray increased the average values of fruit weight, early and total yields/plant of strawberry.

Table 7. Interactions effects of humic acid and seaweed extract on yield characters of strawberry plants during 2014/2015 and 2015/2016 growth seasons.

Treatments: Humic Acid (mg/L)	Treatments: Seaweed extracts (mg/L)	2014/2015 Total yield /plant (Kg)	2014/2015 Total yield /feddan (Ton)	2014/2015 Early yield /feddan (Ton)	2014/2015 Non-marketable yield/feddan (Ton)	2015/2016 Total yield /plant (Kg)	2015/2016 Total yield /feddan (Ton)	2015/2016 Early yield /feddan (Ton)	2015/2016 Non-marketable yield/feddan (Ton)
0	0	0.566 D	16.97 F	2.887 H	1.697 A	0.575 D	17.22 H	2.937 I	1.727 A
	500	0.592 CD	17.75 E	3.370 G	1.067 E	0.598 CD	17.95 G	3.410 H	1.080 E
	1000	0.605 CD	18.16 DE	3.630 F	0.720 G	0.610 CD	18.30 FG	3.657 G	0.733 H
	1500	0.605 CD	18.15 DE	3.810 E	0.637 H	0.615 B-D	18.45 E-G	3.870 F	0.650 I
200	0	0.607 CD	18.22 DE	3.827 E	1.643 A	0.617 B-D	18.50 E-G	3.887 F	1.673 A
	500	0.615 B-D	18.45 DE	4.247 C	1.290 C	0.622 B-D	18.65 D-F	4.297 D	1.307 C
	1000	0.622 B-D	18.66 CD	4.483 B	0.937 F	0.633 B-D	19.00 C-E	4.560 BC	0.953 G
	1500	0.625 B-D	18.75 CD	4.500 B	0.660 H	0.641 BC	19.22 CD	4.613 B	0.670 I
400	0	0.623 B-D	18.68 CD	3.737 EF	1.500 B	0.630 B-D	18.90 DE	3.780 F	1.513 B
	500	0.643 BC	19.28 BC	4.053 D	1.157 D	0.650 BC	19.50 C	4.100 E	1.170 D
	1000	0.670 AB	19.83 B	4.363 BC	0.990 F	0.673 B	20.20 B	4.450 C	1.017 F
	1500	0.715 A	21.00 A	5.260 A	0.947 F	0.740 A	22.20 A	5.550 A	1.003 FG
L.S.D. $_{(0.05)}$		0.054	0.67	0.162	0.054	0.054	0.53	0.121	0.054

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

Table 8. Quality characters of strawberry fruits as affected by humic acid and seaweed extract during 2014/2015 and 2015/2016 growth

Treatments	2014/2015 Fruit dry weight (%)	2014/2015 Vitamin C. (%)	2014/2015 Total Soluble Solids (%)	2014/2015 Total acidity (%)	2014/2015 Total phenols ($\mu g.g^{-1}$fresh weight)	2015/2016 Fruit dry weight (%)	2015/2016 Vitamin C. (%)	2015/2016 Total soluble solids (%)	2015/2016 Total acidity (%)	2015/2016 Total phenols ($\mu g.g^{-1}$fresh weight)
Humic acid (mg/L)										
0	8.888 C	26.50 C	7.883 C	0.6967 A	2.444 C	8.992C	27.66 C	8.008 C	0.7300 A	2.272 C
200	9.163 B	31.02 B	9.829 B	0.5958 B	3.013 B	9.271B	32.04 B	9.925 B	0.6558 B	3.292 B
400	9.808 A	34.88 A	11.47 A	0.4842 C	3.500 A	9.938A	35.01 A	11.63 A	0.4642 C	3.642 A
L.S.D. $_{(0.05)}$	0.160	0.95	0.14	0.0358	0.190	0.108	2.26	0.11	0.0358	0.080
Seaweed extracts (mg/L)										
0	8.351 D	29.21 B	9.110 D	0.6267 A	2.626 D	8.417 D	30.07 C	9.211 D	0.6522 A	2.806 D
500	9.272 C	29.90 B	9.379 C	0.6067 AB	2.972 C	9.383 C	30.57 BC	9.467 C	0.6511 A	2.982 C
1000	9.622 B	31.18 AB	9.970 B	0.5822 BC	3.100 B	9.733 B	32.12 AB	10.11 B	0.5944 B	3.086 B
1500	9.900 A	32.92 A	10.45 A	0.5533 C	3.244 A	10.07 A	33.52 A	10.63 A	0.5689 B	3.400 A
L.S.D. $_{(0.05)}$	0.077	2.17	0.13	0.0313	0.099	0.08	1.96	0.11	0.0313	0.099

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

- **Interaction effects of humic acid and seaweed extract**

In both seasons, the combination of 400 mg/L of humic acid with 1500 mg/L seaweed extract resulted in the highest significant mean values of the total yield per plant and per feddan and early yield per feddan (Table 7). On the contrary, the highest level of seaweed extract (1500 mg/L) and humic acid application gave the lowest significant mean value of the non-marketable yield per feddan without, while the highest mean value of the non-marketable yield per feddan occurred from untreated plants in both season.

- **Fruit Quality Characters**

Tables 8 and 9 displayed the fruit quality characters of strawberry influenced by humic acid and seaweed extract levels and their interaction during 2014/2015 and 2015/2016 growth seasons.

- **Humic acid effects**

Table 8 showed that humic acid levels had profound and significant effects on some fruit quality characters in both growing seasons. Increasing the humic acid level from 0 to 200 and 400 mg/L was accompanied by successive and significant increases in fruit dry weight, vitamin C, total soluble solids (TSS) and total phenols but and successive and significant decreases in the total acidity in both seasons. Almost, similar results were reported by Shafshak *et al*., 2011 and Ratsep *et al*. 2014.

- **Seaweed extracts effects.**

Significant increases in the fruit dry weight, vitamin C, total soluble solids and total phenols of strawberry occurred with increasing the applied levels of seaweed extract while a completely reversal trends was found in the total acidity in both seasons (Table 8), due to the constituents of seaweed extract (Chapman and Chapman, 1980; Hegab *et al*. 2005; Battacharyya *et al*., 2015). These results are in harmony with those obtained by Masny *et al*., 2004 and El-Miniawy *et al*., 2014.

Table 9. Interactions effects of humic acid and seaweed extract on quality characters of strawberry fruits during 2014/2015 and 2015/2016 growth seasons.

Treatments		2014/2015					2015/2016				
Humic acid (mg/L)	Seaweed extract (mg/L)	Fruit dry weight (%)	Vitamin C. (%)	Total soluble solids (%)	Total acidity (µg.g^{-1}fresh weight)	Total phenols (%)	Fruit dry weight (%)	Vitamin C. (%)	Total Soluble Solids (%)	Total acidity (%)	Total phenols (µg.g^{-1}fresh weight)
0	0	8.120 G	24.33 G	7.453 H	0.7233 A	1.910 G	8.200 G	25.50 G	7.533 I	0.7667 A	1.950 F
	500	8.833 F	25.53 FG	7.513 H	0.6967 AB	2.500 F	8.933 F	26.63 FG	7.633 I	0.7600AB	2.013 EF
	1000	9.200 E	26.60 E-G	8.210 G	0.6900 AB	2.567 F	9.300 E	28.33 E-G	8.300 H	0.7067BC	2.157 E
	1500	9.400 D	29.53 D-F	8.357 G	0.6767 A-C	2.800 E	9.533 D	30.17 D-F	8.567 G	0.6867 C	2.967 D
200	0	8.200 G	29.53 D-F	9.223 F	0.6500 BC	2.767 E	8.250 G	31.17 C-E	9.333 F	0.6567CD	3.067 D
	500	9.250 E	29.83 C-E	9.397 F	0.6233 C	2.983 D	9.400 DE	30.73 C-E	9.467 F	0.6933 C	3.300 C
	1000	9.400 D	31.43 B-D	10.20 E	0.5500 DE	3.100CD	9.500 D	32.20 B-D	10.30 E	0.6533CD	3.400 C
	1500	9.800 C	33.30 A-D	10.50 D	0.5600 D	3.200 C	9.933 C	34.07 A-C	10.60 D	0.6200 D	3.400 C
400	0	8.733 F	33.77 A-C	10.65 D	0.5067 DE	3.200 C	8.800 F	33.53 A-D	10.77 D	0.5333 E	3.400 C
	500	9.733 C	34.33 AB	11.23 C	0.5000 E	3.433 B	9.817 C	34.33 A-C	11.30 C	0.5000 E	3.633 B
	1000	10.27 B	35.50 AB	11.50 B	0.5067 DE	3.633 A	10.40 B	35.83AB	11.73 B	0.4233 F	3.700 AB
	1500	10.50 A	35.93 A	12.50 A	0.4233 F	3.733 A	10.73 A	36.33 A	12.73 A	0.4000 F	3.833 A
L.S.D. $_{(0.05)}$		0.13	3.76	0.22	0.0543	0.172	0.14	3.39	0.19	0.0543	0.172

Values having the same alphabetical letter in common, within a particular group of means in each character, do not significantly differ, using the revised L.S.D test at 0.05 level of probability.

3. Interactions effect between humic acid and seaweed extract

The highest applied level of humic acid (400 mg/L) combined with the highest applied level of seaweed extract (1500 mg/L), brought about a significant increase in the fruit dry weight, vitamin C, total soluble solids and total phenols; whereas, it caused a completely reversal trends regarding the total acidity in both seasons (Table 9), (Abdel Mawgaud *et al*., 2007 and Sarhan, 2011) they found that humic acid and seaweed extracts applications improved the plant growth through improving soil structure, soil water holding capacity and penetration root and thereby they stimulate soil microorganisms activity. The lowest significant mean values of studied fruit quality characters occurred from untreated plants with exception of the total acidity which gave the highest mean value.

CONCLUSION

In conclusion, the present study demonstrated that the soil application of humic acid at 400 mg/L, and the foliar spray foliar application of seaweed extract at 1500 mg/L, individually, or in combination resulted in the highest significant positive effects on growth, yield, flowering and fruit quality of strawberry plants grown in unheated plastic house under Aswan conditions. Likewise, in this context, this combination of both variables is beneficial for good agricultural practices for strawberry farmers or large-scale produce.

REFERENCES

A.O.A.C. (1990). Association of Official Agriculture Chemists 2 vols. 15th Ed. Washington, D.C. U.S.A.

Abdel-Mawgoud, A. M. R., N. H. M, El- Greudy, Y. I. Helmy and S. M. Singer (2007). Responses of tomato plants to different rates of humic based fertilizer and NPK fertilization. J. Applied Sci. Research. 3(2):169-174.

Alam, M.Z., G. Braun, J. Norrie and D. M. Hodges (2013). Effect of Ascophyllum extract application on plant growth, fruit yield and soil microbial communities of strawberry. Can. J. Pl. Sci., 93: 23–36.

Al-Saaberi, M.R.S., (2005). Effect of some agricultural treatments on growth, yield of lettuce (Lactuca Sativa L.), M.Sc. Thesis, Hortic. Sci. Univ. Mosul, Coll. Agric. &Forest.

Battacharyya, D., M. Z. Babgohari, P. Rathor and B. Prithiviraj (2015). Seaweed extracts as biostimulants in hortic. Sci. Hortic., http://dx. doi.org /10.1016/j.scienta.2015.09.012.

Blunden, G. and P. B. Paul. (2006). The effect of aqueous seaweed extracts and kinetin on potato yields", J. Sci. food & Agric., 28 (2): 535-543.

Boehme, M., J. Schevtschenko and I. Pinker (2005). Iron Supply of Cucumbers in Substrate Culture with Humate. ActaHort., 697 ISHS.41: 329-335.

Bohme, M. and H.T. Lue (1997). Influence of mineral and organic treatments in the photosphere on the growth of tomato plants. Acta Hort., 450:161- 168.

Bricker, B. (1991). MSTATC: A Micro Computer Program from the Design Management and Analysis of Agronomic Research Experiments. Michigan State University, USA.

Canellas, L. P., F. L. Olivares, N. O. Aguiar, D. L. Jones, A. Nebbioso, P. Mazzei and A.Piccoloc. (2015). Humic and fulvic acids as biostimulants in horticulture. Sci. Hortic., http://dx.doi.org/10.1016/ j.scienta. 2015. 09.013.

Chapman V.J. and D. J. Chapman (1980). Seaweeds and their uses. 3rd edition, Chapman and Hall. London Newyork.

Chen, J. and X. Huang. (2009). Effect of humic acid compound fertilizer on chinese cabbage growth and contents of soil nutrients. http://en.cnki.com.cn/ Article_en/CJFDTOTAL-FZSA200902009.htm.

Chen, Y., H. Magenand and J. Riov (1994). Humic substances originating from rapidly decomposing organic matter: properties and effects on plant growth. pp: 427-443. In: Senesi, N. and T.M. Miano (eds.). Humic Substances in the Global Environment and Implication on Human Health,. Elsevier, Amsterdam, The Netherlands.

Cordenunsi, B.R., M. I. Genovese, J. R. O. do Nascimento, N. M. A. Hassimoto, R. J. dos Santos and F. M. Lajolo. (2005). Effects of temperature on the chemical composition and antioxidant activity of three strawberry cultivars. Food Chem., 91: 113–121.

Cox, H. E. and D. Pearson (1962). The chemical analysis of foods. Chemical Publishing Co., Inc. New York, N.Y., pp. 136-144.

Delfine, S., R. Tognetti, E. Desiderio, A. Alvino. (2005). Effect of foliar application of N and humic acids on growth and yield of durum wheat. Agron. Sustain. Dev., 25: 183-191.

Dhargalkar, V. and K. Pereira (2005). Seaweed: promising plant of the millennium, Sci. Cult., 71: 60-66.

EL-Shall, M.A., S.M. El- Araby, I.M. Goneim and H. Anter. (2003). Effect of bio-fertilization under varying NPK levels on growth, yield, and fruit quality of strawberry plants. J. Agric. &Env. Sci., 2: 106-129.

El-Hefny, E. M. (2010). Effect of saline irrigation water and humic acid application on growth and productivity of two cultivars of Cowpea (Vigna unguiculata L. Walp). Aust. J. Basic Appl. Sci., 4: 6154-6168.

El-Miniawy, S.M., M.E. Ragab, S.M. Youssef and A.A. Metwally (2014). Influence of foliar spraying of seaweed extract on growth, yield and quality of strawberry plants. J. Appl. Sci. Res., 10(2): 88-94

El-Rawi, K. M. and A. M. Khalf-Allah (1980). Design and analysis of agricultural experiments. Textbook. El-Mousl Univ. Press. Ninawa, Iraq. 487 P.

El-Sagan, M. A. M. (2015). Effect of some nutral extracts on growth and productivity of cucumber under sandy soil conditions. Internat. J. Advan. Res., 9 (3): 677-686

Erik, B. G., C. Feibert, G. Shock and L.D. Saundres (2000). Evaluation of humic acid and other nonconventional fertilizer additions for onion production. Malheur Exp. Stat. Oregon State Univ. Ontario, OR.

Eris, A., H. O. Sirritepe and N. Sirritepe (2008). The effect of Seaweed (Ascophylum nodosum) extract on yield and quality Criteria in peppers, Acta Horticulturae., (ISHS). 412: 733-737.

Feleafel, M. N. and Z. M. Mirdad. (2014). Alleviating the deterious effects of water salinity on greenhouse grown tomato. Int. J. Appl. Sci., 19: 293-309.

Hafez, M. M. (2003). Effect of some sources of nitrogen fertilizer and concentration of humic acid on the productivity of squash plant. Egypt J. Appl. Sci., 19: 293-309.

Hegab, M.Y., A.M.A. Sharawy, S.A.G. El-Saida (2005). Effect of algae extract and mono potassium phosphate on growth and fruiting of Balady orange trees (Citrus sinensis). Proc. First Sci. Conf. Agric. Sci. Fac. of Agric., Assuit Univ., (1): 73-84. in the plant of licorice Glycyrrhizin glnbra - L - doctoral thesis. Fac. Agric. Univ. Baghdad. Iraq.

Hernández-Herrera, R.M., F. Santacruz-Ruvalcaba, M. A. Ruiz-López, J. Norrie and G. Hernández-Carmona (2014). Effect of liquid seaweed extracts on growth of tomato seedlings (Solanum lycopersicum L.). J. Appl. Phycol., 26: 619–628.

Hopkins, B and J. Stark, (2003). Humic acid effects on potato response to phosphorus. Presented at the Idaho potato January 22- 23. http://www.horizonag.com/

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Ltd. New Delhi.

Jensen, E. (2004). Seaweed; Fact or Fanc. From the Organic Broadcaster, Published by Moses the Midwest Organic and Sustainable Education. From the Broad Caster. 12(3): 164-170.

Liu, C. R., J. Cooper and D. C. Bowman. (1998). Humic acid application affects photosynthesis, root development and nutrient content of creeping bentgrass, Hort. Science, 33: 1023-1025.

Liu, V.L., L. Kant and A. Joshi (1998). Study of nodulation, leghaemo glob in contents and nitrate reductase activity in black gram (Vigna mungo L.). J. Legume Res., 21: 221–224.

Masny A., A. Basak and E. śurawicz (2004). Effects of foliar applications of Kelpak Sl and GoëmarBm Preparations on yield and fruit quality in two Strawberry cultivars. J. Fruit & Ornam. Pl. Res., 12: 23-27.

Mohamed, F.H. and S.M. Gabr (2002). Effect of organic manure and chemical fertilization on the growth, yield and quality characteristics of strawberries. J. Agric. Sci., Mansoura Univ., 27 (1): 561-572.

Mohamed, M. H. M. (2015). Effect of some growth stimulants on production and quality of strawberry transplants. Ann. Agric. Sci., Moshtohor, 53(4): 693–708.

Nardi, S., G. Concheri and G. Dell'Agnola (1996). Humus and soil conservation.pp: 225-264. In: Humic Substances in Terrestrial Ecosysystem. 2nd Ed.

Page, A. L., R. H. Miller and D. R. Keeney (1982). Methods of Soil Analysis. Part 2. Chemical and microbiological properties. Amer. Soc. Agron. Madison Wisconsom, USA.

Papenfus, H.B., M. G. Kulkarni, W. A. Stirk, J. F. Finnie and J. Van Staden (2013). Effect of a commercial seaweed extract (Kelpak®) and polyamines on nutrient-deprived (N, P and K) okra seedlings. Sci. Hortic., 151: 142–146.

Ranganna, S. (1986). Handbook of Analysis and Quality Control for Fruit and Vegetable Products.2nd Edition.Tata McGraw-Hill Publ. Comp. Ltd., New Delhi, India. 1112p.

Ratsep, R., E. Vool and K. Karp (2014). Influence of Humic Fertilizer on the Quality of Strawberry Cultivar 'Darselect'. Acta Hort., 1049: 911-916.

Salama, Y. A. (2009). Effect of some agricultural treatments on tomato plants adaptation to tolerate salinity stress. Ph.D. thesis, Fac. Agric., Benha Univ., Egypt.

Salib, M. M. (2002). The integrated effect of humic acid and micronutrients in combination with effective microorganisms on wheat and peanut growth on sand soils. Zagazig J.Agric. Res., 29(6): 2033-2050.

Sarhan, T. Z. (2011). Effect of humic acid and seaweed extracts on growth and yield of potato plants (Solanum tubersum L.) desiree cv. Mesopotamia j. of Agric. 39 (2): 19-27.

Shafshak, N. S., S. M. Eid, F. A. Abo Sedera and M. H. M.Mohamed (2011). Improving growth and productivity of strawberry via soil addition and foliar application of some safety growth stimulating compounds. Annals of Agric. Sci., Moshtohor, 49(2): 153 –162.

Snell, F.D and C.T. Snell (1953). Colorimetric methods of analysis, including some turbidimetric and nephelometric methods.3 edition. New York. D. van Nostrand comp., Inc., 606pp.

Spinelli, F., G. Fiori, M. Noferini, M. Sprocatti and G. Costa (2010). A novel type of seaweed extract as a natural alternative to the use of iron chelates in strawberry production. Sci. Hortic., 125: 263–269.

Tan, K. H. (2003). Colloidal chemistry of organic soil constituents. Pp 177-258. In: Chemistry,. Tan, H. (ed.). Principles of Soil Marcel Dekker, New York, USA.

Thirumaran, G., M. Arumugam, R. Arumugam and P. Anantharaman (2009). Effect of seaweed liquid fertilizer on growth and pigment concentration of Abelmoschus esculentus (I) Medikus. Am.-Eurasian J. Agron., 2: 57–66.

Vaughan, D. (1974). A possible mechanism for humic acid action on cell elongation in root segments of Pisum sativum under aseptic condition. Soil Biol. Biochem., 6: 241-247.

Zandonadi, D.B., L.P. Canellas and A.R. Facanha (2007). Indolecetic and humic acid endure lateral root development through a concerted plasma lemma and tonoplast H+ pumps activation. Planta., 225: 1583-1595.

Zodape, S.T., V. J. Kawarkhe, J. S. Patolia and A. D. Warade (2008). Effect of liquid seaweed fertilizer on yield and quality of okra (Abelmoschus esculentus L.). J. Sci. Ind. Res., 67: 1115–1117.

تأثير الإضافة الأرضية لحامض الهيوميك والرش الورقي بمستخلصات الطحالب البحرية على النمو والمحصول وجودة ثمار الفراولة النامية تحت ظروف محافظة أسوان

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أجريت تجربتان حقليتان بمحطة التجارب بكلية الزراعة والموارد الطبيعية- جامعة أسوان خلال موسمي 2014-2015 و 2015-2016 لدراسة تأثيرالإضافة الأرضية لحامض الهيوميك والرش الورقي من مستخلص الطحالب البحرية والتفاعل بينهما علي النمو الخضري والمحصول الثمري الناتج وصفات الجودة لثمار الفراولة صنف "فستيفال" النامي في تربة رملية في صوب بلاستيكية غير المدفأة تحت ظروف محافظة أسوان. وقد اشتملت التجربة على 12 معاملة ناتجة من التداخل بين ثلاث مستويات من الإضافة الأرضية لحامض الهيوميك (0- 200- 400 ملجم/لتر) وأربع معاملات رش ورقي بمستخلص الطحالب البحرية (0- 500 -1000- 1500 ملجم/لتر). وقد أدت الإضافة الأرضية لحامض الهيوميك عند مستوي 400 ملجم/لتر وكذلك الرش الورقي بمستخلص الطحالب البحرية عند مستوي 1500 ملجم/لتر وكذلك التداخل بينهما إلى الحصول علي أفضل صفات نمو خضري وزهري ومحصول ثمري وجودة ثمار متمثلة في عدد التيجان والأوراق للنبات والمساحة الورقية والتبكير في الإزهار والمحصول الكلي للنبات وللفدان والمحصول المبكر والمحصول غير القابل للتسويق والنسبة المئوية للمادة الجافة في الثمار وكذلك نسبة فيتامين ج والمادة الصلبة الذائبة الكلية والفينولات الكلية خلال موسمي النمو.