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COMPARATIVE STUDIES BETWEEN SEAWEEDS AND COMMERCIAL ALGAE IN ALLEVIATION OF HARMFUL EFFECTS OF DROUGHT STRESS OF FABA BEAN (*VICIA FABA* L.) PLANTS

A. D. El-Gamal, M. A. Ismail, M. A. Amin and A. M. Sayed
Botany and Microbiology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt.

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ABSTRACT: **The effect of seaweed extract (SWE) obtained from two macroalgae species (*Sargassum latifolium* and *Corallina elongate*) and two commercial algae (Canada power and oligo x) on drought stress tolerance in faba bean (*Vicia faba* L.) plants was studied. Examination of growth parameters and some physiological and biochemical parameters showed that SWE extract and commercial algae under stress conditions enhanced shoot length and decreased root length, in most cases, at stages 1&2 in faba bean plants with comparison to stress conditions. All treatments, mostly, caused decreases in fresh and dry weight of faba bean plants under drought stress. Maximal increases in shoot and root lengths were observed in stress case in presence sargassum extracts in comparison to drought stress. Number of leaves, flowers and yield parameters decreased in response to drought. Bio stimulant especially sargassum extract caused increasing in these parameters. In most cases, Chl.a, Chl.b, Chl. a+b and carotenoids of leaves of faba bean plants increased at stage 1 and decreased at stage 2 as a result of all treatments. Carbohydrate and protein contents of root, shoot and seed yield showed increases under stress of faba bean plants. Amylase and protease activities revealed different responses to all treatments. With respect to antioxidant enzymes, peroxidase activity of faba bean plants at both stages of growth increased in response to all treatments, with exceptions of stress + sargassum and stress + Canada power at stage1. In case of activities of super oxide dismutase and poly phenol oxidase showed decreases at both stages of growth with comparison to stress conditions, with exception of super oxide dismutase at stag 2 of faba bean plants. Total phenolic content was increased in faba bean plants under different treatments (with exception of treatment with stress + Canada power) with respect to stress conditions. Acidic growth hormones, IAA, GA3 and ABA exhibited increases in GA3 contents of faba bean plants as a result to all treatments as comparison to stress condition, however IAA and ABA contents decreased, with exception of treatment with stress + sargassum extract in case of ABA. The increased total phenolic content and the enhancement of antioxidant enzymatic activity by SWE and commercial algae in stressed faba bean plants may contribute to protection against peroxidation and reduce the severity of water deficit.**

Key words: **Seaweed extract, macroalgae, stress tolerance, antioxidant enzymes, carotenoids, bio stimulates**

INTRODUCTION

The faba bean (*Vicia faba)*, is known for its high protein concentration in its seeds. It ranks fourth among the most important legume crops in the world, after dry beans, dry peas and chickpeas. The crop is a stable food that provides adequate nutrition to many people in the Middle East (Ammar *et al*., 2017). Legumes are a major source of protein in human and animal nutrition and play a key role in crop rotations in most parts of

the world. When it grows in rotation with other crops, under certain environmental conditions, they can improve soil fertility and reduce the incidence of weeds, diseases and pests (Mwanamwenge *et al.*, 1998).

Agriculture is facing the dual challenges of increasing crop production and climate change. Rising temperature, drought, salinity, floods, desertification and weather extreme are adversely affecting agriculture especially in developing world IPCC (2007). Environmental factors are essential components which effect on quality and quantity of crop yield to a great extent. The introduction of resistance to salt, cold, and drought into crop plants have become a topic of major economic interest for agriculture. In the case of drought, scientists have been able now to uncover some of the extremely intricate mechanisms through which seed from orthodox plants acquires tolerance to desiccation during their final maturation period (Oliver *et al.*, 2010). Drought triggers a wide variety of plant responses (Ajum *et al.*, 2011).

Global climate change makes drought a serious threat to food security worldwide. Drought, as an abiotic stress, is multidimensional in nature, and it affects plants at various levels of their organization. Three main mechanisms reduce crop yield by soil water deficit: (1) reduced canopy absorption of photosynthetically active radiation, (2) decreased radiation-use efficiency and (3) reduced harvest index (Earl and Davis, 2003). Therefore, use of foliar application of algae (algal extract and commercial algae) may have become a new trend to reduce the harmful effects of drought on some crops.

Drought stress has pronounced effects on the growth, phenology, water and nutrient relations, photosynthesis, assimilate partitioning, and respiration in the form of physiological, biochemical, and molecular responses (Usman, 2014).

Seaweeds are excellent source of vitamins A, B1, B12, C, D and A, riboflavin, niacin, pantothenic and folic acid. (Thirumaran *et al.*, 2009) stated that recent researches proved that seaweed fertilizers are preferred not only due to their nitrogen, phosphorus and potash content but also because of the presence of trace elements and metabolite similar to plant growth regulators. Recently, seaweed extracts as liquid fertilizers has come in the market for the simple reason that they contain many growth promoting hormones like auxin, gibberellin, trace elements, vitamins, amino acids and micronutrients. (Strik *et al.*, 2004) reported that the seaweeds extracts are effective fertilizers in many crops.

The using of seaweed products improve seeds germination, seedlings development, increase plant tolerance to environmental stresses (Zhang and Ervin, 2008), and enhance plant growth and yield (Kumari *et al.*, 2011). Liquid extracts obtained from seaweeds have gained importance as foliar sprays and soil drench for many crops including various grasses, cereals, flowers and vegetable species. Also, they apply to stimulate seedling germination and rooting. At present one of the most promising applications of seaweeds is their use as plant bio stimulants. For example, aqueous extracts of *Sargassum johnstonii* at concentration from 0.1 to 0.8% (w/v) that is equivalent 1–8 mg SW mL^{-1} used as foliar spray and soil drench enhanced vegetative growth (plant height, shoot length, root length, and number of branches) and reproductive parameters (flower number, fruit number, and fresh weight) of tomato (Kumari *et al.*, 2011).

Seaweed extracts are often regarded as soft or natural products that can influence crop growth and development (Norrie and Hiltz, 1999). A wide range of beneficial effects has been observed including increasing crop yield, nutrient uptake, resistance to frost and stress conditions, longer shelf life of fruit, improved seed germination, and reduced incidence of fungal and insect attack and reduced the effect of salinity stress on membrane permeability (Wang *et al*., 2005). The effect of crude seaweed extracts of three green seaweeds (*Cladophora dalmatica*, *Enteromorpha intestinalis*, *Ulva lactuca*) and the three red algae (*Corallina mediterranea*, *Janiarubens*, *Pterocladia pinnate*) from the Egyptian Mediterranean Sea coast were studied by (El-Sheekh and El-Saied, 2000) on seed germination, growth of seedlings, chlorophyll content and other metabolic activities of *Vicia faba*, They found that the crude extract of *C. dalmatica* showed maximal activity, and it increased seed germination, length of main root and shoot systems and the number of lateral roots. Also, all the crude extracts of seaweed increased protein content in root and shoot systems, total soluble sugars and chlorophyll content in leaves. The cytokinin content of the green algae was higher than that in red algae. Growth of seedlings of *Vicia faba* was stimulated but to different degrees.

Canada power is commercial product contain *Ascophyllum nodosum* as main source of biofertilizer. *Ascophyllum nodosum* is a large brown alga (up to 2m) of the Fucaceae family which is common on both sides of North Atlantic Ocean (Martin *et al*., 2015). Oligo-X is commercial product contain oligosaccharides 3% and alginic acid 5%. oligosaccharides are model compounds to represent domains from the larger, more complex polysaccharides (Kinnaert *et al*., 2017). Alginic acid obtained from brown algae; 61% mannuronic acid and 39% guluronic acid (Parker *et al*., 2015).

This study was conducted to investigate the influence of spray field application of seaweed extract (SWE) and commercial algae for mitigating harmful effects of drought stress on growth, yield and biochemical constituent of faba bean plants in order to select a suitable bio stimulant to this purpose.

MATERIALS AND METHODS

Plant material:

Seeds of faba bean (*Vicia faba* misr 1) plants were obtained from Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt.

Methods of planting, treatments and collection of samples:

Sargassum latifolium (Turner) C. Agardii was collected from Hurgada Red Sea coast in June 2019 and Baltim, while *Corallina elongate* J. Ellis was collected in May 2019 from shallow water beside the shore of Mediterranean Sea at AbouQuair coast in Egypt. Collecting algae were washed with fresh water then were dried in the oven at 60°C for 5 hours, hand crushed and powdered with coffee-grinder, then heated in sterile distilled water in a ratio 1: 100 (w/v) at 60 °C for 45 min. The extracts were filtered through a filter paper and stored at 4 °C for further experimental studies. Concentrations of extracts were prepared by diluting these extracts with distilled water (Mikhail *et al*., 2013). The algal extracts and commercial algae (Canada power and Oligo-x) were applied as a foliar treatment at the rate of 4 g powdered algae/L and 4ml/L of commercial algae , after 30 and 60 days from sowing.

Treatments and experimental design:

Uniform faba bean seeds were planted in natural loamy soil conditions in a plot (12 m width and 15 m length) containing 6 groups representing the following treatments: control (tap water every 7 days), drought stress (tap water every 14 days), drought stress in presence Corallina extract, drought stress in presence Sargassum extract, drought stress in presence Canada power as commercial algae and drought stress in presence Oligo-x as commercial algae The seeds were sown on one side of the ridge, with 10 cm apart between the hills. The in Botanical garden, Botany and Microbiology Dept., Fac. of Sci., Al- Azhar Univ., Nasr City, Cairo, Egypt, developed plants were irrigated whenever required. Concentrations of the used treatments were chosen according to a preliminary experiment in which they caused a maximum germination percentage. The plants were sprayed twice with the above-mentioned treatments, the first and second were added at 30 and 60 days of plant age respectively. The plant samples were collected for analysis when the plants were 37 (Stage I) and 67 (Stage II) days old. At the end of the growth season, analysis of the seeds yielded from the different treatments and the control were done.

Determination of Metabolites content of Faba bean:

Chlorophylls contents of were estimated using the method of (Vernon and Selly, 1966). Carotenoids contents of were estimated according to (Lichtenthaler, 1987). Soluble carbohydrates were measured according to the method of (Umbriet *et al.*, 1969). Contents of soluble proteins were estimated according to the methods of (Lowery *et al.*, 1951). A phenolic compound (mg/100 g of dry wt) was carried out according to that method described by (Daniel and George, 1972). Activities of amylases were determined using the method of (Afifi *et al.*, 1986). Proteases activities were estimated using the method of (Ong and Gaucher, 1972). Peroxidase activity was assayed using the method of (Jaworek, *et al.,* 1974). Superoxide dismutase activity was. determined by measuring the inhibition of the auto-oxidation of pyrogallol using a method described by (Marklund and Marklund, 1974). The activity of polyphenoloxidase enzyme was determined according to the method adopted by (Matta and Dimond, 1963). The method of extraction of endogenous acidic phytohormones extraction was essentially similar to that adopted by (Shindy and Smith, 1975) and described by (Hashem, 2006).

Statistical Analysis:

Results were statistically analyzed by calculating the analysis of variance, in completely randomized design (Snedecor and Cochran, 1982).

RESULTS AND DISCUSSION

Morphological responses and yield parameters:

The present results in Table (1) revealed that algal extracts of (*Sargassum latifolium* and *Corallina elongate*) and two commercial algae (Canada power and oligo x) under stress conditions enhanced shoot length and decreased root length, in most cases, at stages I and II in faba bean plants with comparison to stress treatment. Maximum enhancement increases in shoot lengths were observed in presence sargassum extracts. Our results agree with those of (Bassal and Zahran, 2002) revealed that the blue green algae addition significantly increased flag leaf area, plant height of rice (*Oryza sativa*) plants. The importance of SWE in stress water effect can be correlated to improvement of glycine betaine content in treated plants. In several plant species, a positive correlation between leaf osmotic potential and glycine betaine, β-alanine betaine, and proline betaine has been observed (Rhodes and Hanson, 1993). These organic compounds are now known to also have osmoprotective effects in the cell (Ashraf and Harris 2004). Seaweed concentrate prepared from *Ecklonia maxima* (Kelpak) was found to increase the root length and root number of *Pinus pinea* seedlings (Atzmon *et al*., 1994), increased root and shoot growth in three species of *Eucalyptus* (Van Staden *et al*.,1995) and promoted root formation in a variety of plants (Crouch and Van Staden, 1991), which has been attributed to the relatively high concentrations of indoles present in the extract (Crouch *et al*., 1992).

The obtained results in Tables (2,3 and 4) showed decreases in fresh, dry weight, No. of leaves, flowers and branches of faba bean plants in response to drought stresscompared to the control plants. All treatments caused improvement of this parameters with comparison to stress treatment. The increases in some of growth parameters coincides with results of (Kumari *et al*., 2011) showed thataqueous extracts of *Sargassum johnstonii* at concentration from 0.1 to 0.8% (w/v) that is equivalent 1–8 mg SW mL^{-1} used as foliar spray and soil drench enhanced vegetative growth (plant height, shoot length, root length, and number of branches) and reproductive parameters (flower number, fruit number, and fresh weight) of tomato. The enhancement of growth parameters by spraying of *Vicia faba plants* with commercial or algal extracts may be due to the presence of cytokinins, minerals and many of nutrient in commercial or algal extracts. These ingredients are known to improve the growth and increase cell division and cell enlargement (Ahmed *et al*., 2014). This might explain the remarkable increase in shoot height plants even than their control counter parts.

Our results in Table (5) showed that commercial algae and algal extracts caused remarkable improvement in yield parameters comparing to drought stress. These results in agreement to those obtained by (Jayaraj *et al*., 2008); (Khan *et al*., 2009) and (Hernández-Herrera *et al*., 2014), who revealed that, in recent years, the use of bio stimulants, often based on natural extract such as from seaweeds, has been proposed as a sustainable Strategy for improving crop yields without adversely impacting on the environment.

Chemical constituents:

Results recorded in Tables (6 and 7) revealed that, in most cases, Chl.a, Chl.b, Chl. a+b and carotenoids contents of shoot of faba bean plants increased at stage I and decreased at stage II as a result of all treatments. Plants adapt to drought stress through synthesis of osmoprotectants (osmolytes or compatible solutes) which are low-molecular-weight and highly soluble compounds that are usually nontoxic even at high cytosolic concentrations (Tekle and Alemu, 2016). Drought stress caused a significant increase in total soluble carbohydrates and protein contents of *Vicia faba* plants. These results are in harmony with those of (Mohamed and Akladious, 2014). This increases in soluble compounds can protect the cell under stress by balancing the osmotic strength of the cytosol with

Table 1: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on shoot length and root length of bean plants .

Treatments	Shoot length means of 10 replicates		Root length means of 10 replicates	
	Stage I	Stage II	Stage I	Stage II
Control	36.5 ± 1.947	41.056 ± 1.886	14.386 ± 1.302	14.86 ± 1.287
Drought Stress	29.611 ± 1.889	32.111 ± 2.254	12.164 ± 0.952	12.097 ± 1.074
Stress + *Carollina* extract.	30.744 ± 1.59	36.178 ± 1.501	7.744 ± 0.763	7.91 ± 0.68
Stress + *Sargassum* extract.	32.367 ± 0.589	37.3 ± 0.656	14.221 ± 1.008	14.089 ± 1.007
Stress + Canada Power	31.067 ± 0.912	34.467 ± 0.856	9.117 ± 0.763	8.472 ± 0.735
Stress + Oligo-X	30.144 ± 0.542	33.9 ± 0.656	11.283 ± 1.398	11.912 ± 1.557
LSD 5%	2.036	4.012	3.021	2.321

Table 2: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on fresh and dry weights of shoots of bean plants

Treatments	F. Wt. shoot means of ten replicates		D. Wt. shoot means of ten replicates	
	Stage I	Stage II	Stage I	Stage II
Control	31.172 ± 5.76	35.901 ± 5.65	2.87 ± 0.0904	3.855 ± 0.0892
Drought Stress	22.099 ± 3.65	23.472 ± 4.104	2.502 ± 0.254	2.87 ± 0.286
Stress + *Corallina* extract	26.479 ± 1.74	29.332 ± 1.741	2.706 ± 0.156	2.99 ± 0.157
Stress + *Sargassum* extract	27.195 ± 1.49	30.034 ± 1.496	2.951 ± 0.0114	3.254 ± 0.0114
Stress + Canada Power	25.965 ± 1.05	27.093 ± 1.052	2.854 ± 0.0091	3.054 ± 0.00909
Stress + Oligo-X	24.523 ± 1.11	26.487 ± 1.121	2.644 ± 0.0085	2.944 ± 0.00855
LSD 5%	4.321	4.165	0.221	0.435

Table 3: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on Fresh and dry weights of roots of bean plants

Treatments	F. Wt. of root means of ten replicates		D. Wt. of root means of ten replicates	
	Stage I	Stage II	Stage I	Stage II
Control	5.466 ± 0.733	5.376 ± 0.723	0.511 ± 0.0366	0.515 ± 0.0365
Drought Stress	3.6 ± 0.616	3.553 ± 0.693	0.434 ± 0.0496	0.432 ± 0.0557
Stress + *Corallina* extract	2.299 ± 0.301	2.36 ± 0.304	0.278 ± 0.00298	0.278 ± 0.00299
Stress + *Sargassum* extract	4.207 ± 0.625	4.23 ± 0.626	0.327 ± 0.0147	0.327 ± 0.0147
Stress + Canada Power	2.339 ± 0.197	2.217 ± 0.192	0.232 ± 0.00498	0.227 ± 0.00401
Stress + Oligo-X	1.822 ± 0.127	1.806 ± 0.127	0.241 ± 0.000273	0.241 ± 0.000273
LSD 5%	1.023	0.677	0.165	0.136

Table 4: Effects of drought stress and bio stimulant (Canada Power , Oligo X,and *Corallina elongata, Sargassum latifolium* extracts) on leaves, flowers and branches numbers of bean plants

Treatments	No. leaves means of ten replicates		No. flowers means of ten replicates		No. branches means of ten replicates	
	Stage I	Stage II	Stage I	Stage II	Stage I	Stage II
Control	13.68 ± 1.88	15.37±1.89	11.33 ± 1.36	13.585±1.37	1.16 ± 0.42	1.30±0.39
Drought Stress	11.04 ± 2.11	13.583 ± 2.27	9.39±1.31	10.054±1.34	1.46 ± 0.40	1.648 ± 0.36
Stress + *Corallina* extract	12.83 ± 0.84	14.60±0.85	10.16 ± 1.43	12.275±1.43	0.14 ± 0.10	0.136 ± 0.10
Stress+*Sargassum* extract	12.97 ± 0.77	14.74±0.79	10.56± 0.99	15.123±1.01	0.37 ± 0.16	0.395 ± 0.15
Stress + Canada Power	11.72 ± 0.65	14.04±0.67	10.03 ± 0.46	14.841±0.45	0.44 ± 0.22	0.525 ± 0.21
Stress+ Oligo-X	12.30 ± 0.59	13.97±0.59	9.65±0.68	12.725±0.69	0.43 ± 0.22	0.53±0.22
LSD 5%	0.537	0.633	0.645	0.74	0.325	0.215

Table 5: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on yield Parameters of bean plants.

Treatments	Yield (means of ten replicates)			
	no. pods /plant	WT pods (g) /plant	No. seed / plant	WT seed (g) / plant
Control	9.556 ± 0.53	22.344 ± 1.208	27.556 ± 1.215	16.509 ± 1.046
Drought Stress	6.00 ± 0.745	14.031 ± 1.953	19.222 ± 2.067	11.898 ± 1.923
Stress + *Corallina* extract	7.032 ± 0.309	17.098 ± 1.973	22.889 ± 1.968	13.774 ± 1.861
Stress + *Sargassum* extract	8.333 ± 0.333	18.278 ± 1.399	24.111 ± 1.172	14.427 ± 1.241
Stress + Canada Power	7.222 ± 0.364	16.398 ± 1.252	23.667 ± 1.00	12.843 ± 0.943
Stress + Oligo-X	7.078 ± 0.222	15.103 ± 0.593	21.556 ± 0.58	13.729 ± 0.575
LSD 5%	2.014	3.215	4.012	1.854

that of the vacuole and the external environment (Anjum *et al*., 2011). The importance of seaweed extract (SWE) in stress water effect can be correlated to improvement of glycine betaine content in treated plants. In several plant species, a positive correlation between leaf osmotic potential and glycine betaine, β-alanine betaine, and proline betaine has been observed (Rhodes and Hanson, 1993).

Data in the present study are similar to those of (Genard *et al*., 1991) reported that glycine betaine delays the loss of photosynthetic activity by inhibiting chlorophyll degradation during storage conditions in isolated chloroplasts the decrease in chlorophyll under drought stress is mainly due to the damage of chloroplasts by reactive oxygen species (Smirnoff, 1993). The seaweed extract applied as foliar spray enhanced the leaf chlorophyll level in plants (Blunden *et al*., 1996). The effect of water deficit was notably reduced by the foliar application of SWE. The benefit effect of algae extracts in protecting chlorophyll degradation may be attributed to betaine and betaine-like compounds present in seaweed (Khan *et al*., 2009). In plants, betaines serve as a compatible solute that alleviates osmotic stress induced by salinity and drought stress. Glycine betaine protects physiological processes such as photosynthesis and protein synthesis under drought conditions (Sulpice *et al*., 1998). On the other hand, it has been reported (Zhang and Ervin, 2008) that positive anti-stress effects of seaweed extracts may be related to cytokinin activity. Cytokinins mitigate stress-induced free radicals by direct scavenging and by preventing reactive oxygen species (ROS) formation by inhibiting xanthine oxidation (Fike *et al*. 2001).

Table 6: Effects of drought stress (in presence or absence of) and bio stimulant (Canada Power, Oligo X, *and Cor. elongata*, *Sargassum latifolium* extracts) on Chlorophyll a and b of bean plants at I and II stages.

Treatments	chlorophyll (a)		chlorophyll (b)	
	Stage I	Stage II	Stage I	Stage II
Control	2.805 ± 1.281	6.035 ± 0.403	1.512 ± 0.991	6.216 ± 0.782
Drought Stress	2.571 ± 1.46	6.693 ± 0.0844	2.236 ± 0.921	7.627 ± 1.143
Stress + *Corallina* extract.	3.091 ± 0.946	6.639 ± 0.0761	2.489 ± 1.54	6.232 ± 0.177
Stress + *Sargassum* extract.	3.736 ± 0.664	6.512 ± 0.0402	2.621 ± 1.133	5.908 ± 0.125
Stress + Canada Power	4.367 ± 0.555	6.459 ± 0.318	3.34 ± 0.657	5.198 ± 1.725
Stress + Oligo-X	2.677 ± 1.552	6.813 ± 0.211	1.665 ± 1.213	7.545 ± 0.846
LSD 5%	0.845	0.351	0.856	0.505

Table 7: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Cor. elongata*, *Sargassum latifolium* extracts) on total chlorophyll (a+ b) and Carotenoids of bean plants at I & II stages

Treatments	chlorophyll (a + b)		Carotenoids	
	Stage I	Stage II	Stage I	Stage II
Control	4.317 ± 2.272	12.251 ± 1.185	1.214 ± 0.477	1.202 ± 0.989
Drought Stress	4.806 ± 2.381	14.321 ± 1.228	1.087 ± 0.702	1.064 ± 0.845
Stress + *Corallina* extract	5.581 ± 2.486	12.871 ± 0.101	1.251 ± 0.239	0.813 ± 0.105
Stress + *Sargassum* extract	6.357 ± 1.797	12.42 ± 0.165	1.921 ± 0.29	0.996 ± 0.145
Stress + Canada Power	7.707 ± 1.213	11.657 ± 2.043	1.998 ± 0.155	1.314 ± 1.12
Stress + Oligo-X	4.341 ± 2.765	14.358 ± 0.635	1.205 ± 0.626	1.012 ± 0.127
LSD 5%	1.251	0.684	0.154	0.135

As recorded in Table (8) the increase in the protein content at lower concentration of seaweed fertilizer (SLF) might be due to absorption of most of the necessary elements by the seedlings (Kannan and Tamilselvan, 1994; Anantharaj and Venkatesalu, 2001, 2002).

Furthermore, the obtained results in Table (9) indicated that the soluble carbohydrates content increased up to 20% concentration of SLF and the content decreased at higher concentrations. The same trend was observed in the *H. musciformis* with NPK application in blackgram (Tamilselvan and Kannan, 1994), *V. catajung* and *D. bixorus* (Anantharaj and Venkatesalu, 2001, 2002).

Data illustrated in Table (10) showed no apparent trend with respect to amylase and protease activities. The most significant increases in amylase activities were observed in case of treated faba bean plants with stress + Corallina at stage 1 and stress + Oligo-x at stage 2. The highest increases of protease activities were observed in case of treated faba bean plants with stress + Canada power at both stages of growth.

The present results are in accordance with those obtained by (Sivasankari *et al.*, 2006) observed that the α-amylase activity was higher than the β- amylase activity. Th α- amylase and β-amylase activity increased at lower concentrations of both the treatments of seaweeds.

Table 8: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on soluble proteins of bean (plants) Shoot and Root at stages I and II; Values means of three replicates.

Treatments	Protein Shoot		Protein Root	
	Stage I	Stage II	Stage I	Stage II
Control	45.68 ± 0.64	39.21 ± 1.44	25.68 ± 1.2	19.96 ± 0.21
Drought Stress	53.6 ± 1.12	46.8 ± 0.16	29.6 ± 0.24	21.16 ± 0.2
Stress + *Corallina* extract.	48.32 ± 2.21	34.12 ± 0.32	22.52 ± 0.12	17.76 ± 0.12
Stress + *Sargassum* extract.	50.76 ± 1.12	43.12 ± 1.08	33.96 ± 0.48	14.92 ± 0.04
Stress + Canada Power	47.88 ± 0.40	41.21 ± 1.04	28.52 ± 0.12	19.84 ± 0.12
Stress + Oligo-X	43.72 ± 2.08	35.68 ± 2.04	23.4 ± 0.48	16.88 ± 0.52
LSD 5%	7.21	5.35	3.65	1.44

Table 9: Effects of drought stress and bio stimulant (Canada Power, Oligo X,and *Corallina elongata*, *Sargassum latifolium* extracts) on soluble carbohydrates of bean plants (shoot and root) at I and II stages;Values means of 3 replicates.

Treatments	Carbohydrate Shoot		Carbohydrates Root	
	Stage I	Stage II	Stage I	Stage II
Control	23.182 ± 0.144	21.983 ± 0.12	12.734 ± 2.443	9.536 ± 0.431
Drought Stress	27.672 ± 0.132	29.988 ± 1.67	15.837 ± 1.129	13.636 ± 0.718
Stress + *Corallina* extract	25.773 ± 0.103	22.983 ± 1.12	11.732 ± 0.844	9.744 ± 0.12
Stress + *Sargassum* extract	29.648 ± 0.132	25.98 ± 0.65	14.669 ± 1.02	12.684 ± 0.65
Stress + Canada Power	24.696 ± 0.203	19.636 ± 0.84	12.703 ± 2.167	8.146 ± 0.467
Stress + Oligo-X	22.816 ± 0.13	22.696 ± 0.25	11.038 ± 1.359	11.708 ± 0. 239
LSD 5%	3.012	4.154	1.636	2.68

Table 10: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on Amylase and Protease activities (mg/g dry weight) on bean plants at stages I and II; Values are means of three replicates.

Treatments	Amylase		Protease	
	Stage I	Stage II	Stage I	Stage II
Control	1.998 ± 0.017	2.045 ± 0.106	0.879 ± 0.287	0.00715 ± 0.00715
Drought Stress	1.25 ± 1.097	1.718 ± 0.442	0.245 ± 0.0055	0.0203 ± 0.00165
Stress + *Corallina* extract.	4.082 ± 3.061	1.509 ± 0.463	0.223 ± 0.138	0.0308 ± 0.0077
Stress + *Sargassum* extract.	1.386 ± 0.74	1.658 ± 0.102	0.16 ± 0.0104	0.124 ± 0.0077
Stress + Canada Power	1.25 ± 0.706	0.77 ± 0.174	0.525 ± 0.263	0.321 ± 0.183
Stress + Oligo-X	1.224 ± 1.224	2.1 ± 0.281	0.236 ± 0.088	0.146 ± 0.0407
LSD 5%	0.718	0.141	0.142	0.158

The demonstrated results in Table (11) showed that peroxidase activity of faba bean plants at both stages of growth increased in response to all treatments, with exceptions of stress + sargassum and stress + Canada power at stage1. In case of activities of superoxide dismutase and polyphenol oxidase showed decreases, mostly, in response to all treatments at both stages of growth as compared to stress conditions, with exception of increases in superoxide dismutase as a result of all treatments at stag 2 of faba bean plants. Our result may be explained by the effect of seaweed extract in reducing cell damage caused by reactive oxygen species (ROS) (Khan *et al*., 2009). Application of seaweed extract to turf grasses increased the activity of the antioxidant enzyme superoxide dismutase (SOD), which scavenges superoxide (Fike *et al*. 2001). Similarly, (Ayad, 1998) reported an increase in SOD of plants treated by seaweed extract. Many researchers have reported that seaweed extracts enhance the ascorbate peroxidase activities (Ayad, 1998), demonstrating the strong antioxidant properties of seaweeds which have been correlated to bioactive compounds (Meenakshi *et al*., 2009; O'Sullivan *et al*., 2011).

The obtained results in Tables (12&13) indicated that total phenolic content was increased in faba bean plants because of different treatments (with exception of treatment with stress + Canada power) with respect to stress conditions. Acidic growth hormones, IAA, GA3 and ABA exhibited increases in GA3 contents of faba bean plants as a result to all treatments as comparison to stress condition, however IAA and ABA contents decreased, with exception of increasing ABA contents as a result of treatment with stress + sargassum extract. Our results are similar to findings of (Nilsen and Orcutte, 1996) reported that, under drought, endogenous contents of auxins, gibberellins and cytokinin usually decrease, while those of abscisic acid and ethylene increase Nevertheless, phytohormones play vital roles in drought tolerance of plants. Auxins induce new root formation by breaking root apical dominance induced by cytokinins. As a prolific root system is vital for drought tolerance, auxins have an indirect but key role in this regard. Drought stress limits the production of endogenous auxins, usually when contents of abscisic acid and ethylene increase (Nilsen and Orcutte, 1996).

Table 11: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on Peroxidase, Superoxidase dismutase and Polyphenol oxidase activities (µg/g dry weight) on bean plants at stage I and II; Values are means of three replicates.

Treatments	Peroxidase		Superoxidase dismutase		Polyphenol oxidase	
	Stage I	Stage II	Stage I	Stage II	Stage I	Stage II
Control	82.5±52.5	145.5 ± 1.5	408 ± 42	123 ± 3	6.6 ± 0.6	24 ± 16.8
Drought Stress	102 ± 9	94.5 ± 13.5	189 ± 69	192 ± 84	32.4±19.2	25.2 ± 8.4
Stress+*Corallina* extract	168 ± 111	121.5±91.5	144 ± 96	108 ± 12	6.6 ± 0.6	42.6 ± 6
Stress + Sargassum extract.	64.5±22.5	132 ± 33	111 ± 57	339 ± 9	17.4 ± 0.6	22.2 ± 4.8
Stress+ Canada Power	96 ± 48	141 ± 45	267 ± 39	318 ± 144	5.4 ± 0	12.6 ± 0
Stress + Oligo	115.5±76.5	127.5±61.5	141 ± 81	525 ± 63	10.5 ± 3.3	19.8±13.8
LSD 5%	6.885	11.98	23.32	9.32	7.69	4.494

Table 12: Effects of drought stress and bio stimulant (Canada Power, Oligo X, *and Corallina elongata*, *Sargassum latifolium* extracts) on total phenol (mg of gallic acid / 100 g fr. wt.), seed yield protein and carbohydrates (mg/gm dry wt.) of bean plants. Values are means of three replicates.

Treatments	Phenol	Protein	Carbohydrates
Control	23.103 ± 1.023	213.16 ± 3.12	112.043 ± 3.21
Drought Stress	16.214 ± 0.687	225.76 ± 1.54	127.038 ± 1.25
Stress + *Corallina* extract.	18.325 ± 1.021	197.56 ± 2.08	115.057 ± 3.45
Stress + *Sargassum* extract.	21.216 ± 0.478	205.4 ± 0.16	129.024 ± 0.98
Stress + Canada Power	19.369 ± 0.215	188.12 ± 2.04	116.978 ± 1.75
Stress + Oligo-X	17.236 ± 0.987	209.36 ± 1.04	122.055 ± 2.65
LSD 5%	1. 35	9.21	13.25

Table 13: Effects of drought stress and bio stimulant (Canada Power, Oligo X, and *Cor. elongata*, *Sargassum latifolium* extracts) on Phytohormones of bean plants Values are means of threereplicates.

Treatments	mg/100g		µg/100g
	GA3	IAA	ABA
Control	1.155 ± 0.456	1.182 ± 0.214	2.051 ± 0. 052
Drought Stress	1.165 ± 0.214	2.212 ± 0.145	0.655 ± 0. 154
Stress + *Corallina* extract.	3.021 ± 0.123	0.76 ± 0. 125	0.454 ± 0.215
Stress + *Sargassum* extract	3.245 ± 0.225	0.536 ± 0.069	0.855 ± 0.321
Stress + Canada Power	3.165 ± 0.195	0.863 ± 0.087	0.392 ± 0.055
Stress + Oligo-X	3.155 ± 0.159	0.486 ± 0.051	0.259 ± 0.247

Polyphenols may act as antioxidants to protect the plant against oxidative stress (Grace, 2005). Increase in total phenolic content by application of SWE in bean plans can be explained by enzyme activation. It was reported (André *et al.*, 2009) that treatment with SWE caused significantly enhanced activities of phenylalanine ammonia lyase (PAL) the most important enzyme responsible for biosynthesis of polyphenols.

Conclusion

In the light of the present study, it seems reasonable to suggest that spraying of *Vicia faba* plants with commercial algae (Oligo x and Canada power) and algal extract can successfully ameliorate the deleterious effects of drought stress as well as enhance the plant growth. Furthermore, it is worth noting that Sargassum extract were more effective than commercial algal in raising the plants' tolerance to drought. Therefore, we would venture to recommend the use of spraying *Vicia faba* plants with *Sargassum* extract as a new natural and low-cost method for not only the alleviation of drought stress on plants but also for stimulating growth with no discernible adverse effects.

REFERENCES

Afifi, W.M., M.I.Ahmed, Z.A.Moussa and M.F.Abd El-Hamid (1986). Effect of gamma irradiation and GA3 on amylase activity of pea seedlings. Ann. Agric. Sci., Moshtohor. 24(4):2047-2057.

Ahmed, F., D.M.Baloch, S.A.Sadiq, S.S.Ahmed, A.Hanan, S.A.Taran, N.Ahmed and M.J.Hassan (2014). Plant growth regulators induced drought tolerance in sunflower (*Helianthus annuus* L.) hybrids. The Journal of Animal and Plant Sciences, 24 (3), 886- 890.

Ajum, S.A., X.Y. Xie, L.C. Wang, M.F. Saleem, C. Man and W. Lei. (2011). Morphological, physiological and biochemical responses of plants to drought stress. African Journal of Agricultural Research. 6(9):2026- 32.

Ammar, M. H., A.M.Khan, H.M. Migdadi, S.M.Abdelkhalek and S.S. Alghamdi (2017).Faba bean drought responsive gene identification and validation', *Saudi Journal of Biological Sciences*. King Saud University, 24(1), pp. 80-89. doi: 10.1016/j.sjbs.2016.05.011.

Anantharaj, M. and V.Venkatesalu (2001). Effect of seaweed liquid fertilizer on *Vigna catajung*. Seaweed Res. Utiln. 23 (1&2), 33–39.

Anantharaj, M. and V.Venkatesalu (2002). Studies on the effect of seaweed extracts on *DolichosbiXorus*. Seaweed Res. Utiln. 24 (1): 129–137.

André, C.M., R.Schafleitner, S.Legay, I.Lefèvre, C.A.Alvarado, A.G. Nomberto, L.Hoffmann, J.F. Hausman, Y.Larondelle and D.Evers (2009). Gene expression changes related to the production of phenolic compounds in potato tubers grown under drought stress. Phytochemistry 70:1107–1116.

Anjum, S.A., X.Xie, L.Wang, M.F.Saleem, C.Man and W.Lei (2011). Morphological, physiological and biochemical responses of plants to drought stress. African Journal of Agricultural Res., 6 (9), 2026–2032.

Ashraf, M. and P.J.C. Harris (2004). Potential biochemical indicators of salinity tolerance in plants. Plant Sci 166:13–16.

Atzmon, N. and J.Van Staden (1994). The effect of seaweed concentrates on the growth of *Pinus pinea* seedlings. New Forests 8: 3, 279–288.

Ayad, J.Y. (1998). The effect of seaweed extract (*Ascophyllum nodosum*) on antioxidant activities and drought tolerance of tall fescue (*Festuca arundinacea* Schreb.). Dissertation, Texas Tech University.

Bassal, S.A. and F.A. Zahran (2002). Effect of farmyard manure, bio and mineral nitrogen fertilizer and hill spaces on rice crop productivity. J. Agric. Sci. Mansoura Univ. 27: 1975-1988.

Blunden, G., T.Jenkins and Y.W.Liu (1996). Enhanced chlorophyll levels in plants treated with seaweed extract. J. Appl. Phycol. 8, 535–543.

Crouch, I. J. and J.Van Staden (1991). Evidence for rooting factors in a seaweed concentrate prepared from Ecklonia maxima. J. Plant Physiol. 137: 319–322.

Crouch, I. J., M. T.Smith, J.Van Staden, M. J.Lewis and G. V.Hoad (1992). Identification of auxins in a commercial seaweed concentrate. J. Plant Physiol. 138: 590–594.

Daniel, H.D. and C.M.George (1972). Peach seed dormancy in relation to endogenous inhibitors and applied growth substances. J. Amer. Soc. Hort. Sci. 97:651-654.

Earl, H. and R.F.Davis (2003). Effect of drought stress on leaf and whole canopy radiation use efficiency and yield of maize. Agron. J. 95, 688–696.

El-Sheekh, M. M. and A.El-Saied (2000). Effect of crude seaweed extracts on seed germination, seedling growth and some metabolic processes of *Viciafaba*L. Cytobios, 101:23-35.

Fike, J.H., V.G.Allen, R.E.Schmidt, X. Zhang, J.P.Fontenot, C.P.Bagley, R.L. Ivy, R.R.Evans, R.W.Coelho and D.B. Wester (2001).Tasco Forage: I. Influence of a seaweed extract on antioxidant activity in tall fescue and ruminants. J. Anim. Sci. 79:1011-1021.

Genard, H., J.Le Saos, J.P.Billard, A.Tremolieres and J. Boucaud (1991). Effect of salinity on lipid composition, glycine betaine content and photosynthetic activity in chloroplasts of *Suaeda maritima*. Plant Physiol. Biochem. 29:421 427 .

Grace, S. (2005). Phenolics as antioxidants. In: Smirnoff N (ed) Antioxidants and Reactive Oxygen Species in Plants. Blackwell, Oxford, pp 141–168.

Hashem, H.A. (2006). Physiological and molecular actions of jasmonic acid on soybean plant. Ph.D Thesis, Fac. of Sci., Ain Shams Univ., Cairo, Egypt.

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. doi: 10.1007/s10811-013-0078-4.

IPCC., (2007). Climate change (2007): The physical science basis—Contribution of working group I to the fourth assessment report of the Intergovernmental Panel on climate change. http:// www. ipcc. ch/ publications_ and_ data/ar4/ wg1/en/contents.html.

Jaworek, D., W. Gruber and H.U. Bergmeyer (1974). Adenosine-5′-diphosphate and adenosine -5′-monophosphate', in Methods of enzymatic analysis. Elsevier, pp. 2127–2131.

Jayaraj, J., A.Wan, M.Rahman and Z. K.Punja (2008). Seaweed extract reduces foliar fungal diseases on carrot. Crop Prot. 10, 1360–1366. doi: 10.1016/j.cropro. 2008.05.005

Kannan, L. and C.Tamilselvan (1990). Effect of seaweed manures on *Vigna radiatus*. Perspectives in phycology. (Prof. M.O.P. Iyenger Centenary Celebration Volume) V.N. Rajarao (Ed.), pp. 427–430.

Khan, W., P. Usha and R.Sowmyalakshmi (2009). Seaweed extracts as biostimulants of plant growth and development. J Plant Growth Regul 28:386–399

Kinnaert, C. Mathilde Daugaard, Faranak Nami and Mads H. Clausen (2017). Chemical Synthesis of Oligosaccharides Related to the Cell Walls of Plants and Algae, Chemical Reviews.

doi: 10.1021/acs.chemrev.7b00162.

Kumari, R., I. Kaur and A. K. Bhatnagar (2011). Effect of aqueous extract of

Sargassum johnstonii Setchel & Gardner on growth, yield and quality of *Lycopersicon esculentum* Mill. J. Appl. Phycol. 23: 623 – 633.

Lichtenthaler,H.K. (1987). Photosynthesis IV. Philadelphia. Balaban Internat Science Service. p. 273–285.

Lowery, O.H., N.J.Rosebrough, A.I.Furr and R.J.Randall (1951). Protein measurement with folin phenol reagents. J. Biol. Chem, 193: 265-275.

Marklund, S. and G.Marklund (1974). Involvement of the Super Oxide Anion Radical in the Aut Oxidation of Pyro Gallol and a Convenient Assay for Super Oxide Dis Mutase Ec-1.15.1.1. European Journal of Biochemistry, 47(3), 469–474.

Martin, M., T.Barbeyron, R.Martin, D.Portetelle, G.Michel and M. Vandenbol (2015). The cultivable surface microbiota of the brown alga Ascophyllum nodosum is enriched in macroalgal-polysaccharide-degrading bacteria. Frontiers in Microbiology, 6(DEC), 1–14.

https://doi.org/10.3389/fmicb.2015.01487

Matta, A. and A. E.Dimond (1963). Symptoms of Fusarium wilt in relation to quantity of fungus and enzyme activity in tomato stems, Phytopathology. Amer Phytopath - ological Soc. 3340 Pilot Knob Road, ST Paul, MN 55121, 53(5), p. 574.

Meenakshi, S., D.M.Gnanambigai, S.T.Mozhi, M.Arumugam and T.Balasubramanian (2009). Total flavanoid and in vitro antioxidant activity of two seaweeds of rameshwaram coast. Glob. J. Pharmacol. 3:59–62

Mikhail, M, A. Anna V. Skriptsova , Elena L. Chaikina and Aleksei G. Klykov (2013). 'Effect of Water Extracts of Seaweeds on the Growth of Seedling Roots of Buckwheat (*Fagopyrum esculentum* Moench)', Ijrras, 16(2), pp. 282–287.

Mohamed, H.I. and S.A.Akladious (2014). Influence of garlic extract on enzymatic and nonenzymatic antioxidants in soybean plants (*Glycine max*) grown under drought stress. Life Science Journal, 11 (3s), 46-58.

Mwanamwenge, J., S. P.Loss, K. H. M.Siddique and P. S.Cocks (1998). Growth, seed yield and water use of faba bean (*Vicia faba* L.) in a short season Mediterranean-type environment. Aust. J. Exp. Agric., 38: 171–180.

Nilsen, E.T. and D.M.Orcutte (1996). Phytohormones and plant responses to stress, in: Nilsen E.T., Orcutte D.M. (Eds.), Physiology of Plant under Stress: Abiotic Factors, Wiley, New York, pp: 183–198.

Norrie, J. and D. A.Hiltz (1999).Seaweed extract research and applications in agriculture. Agro-Food-Industry Hi-Tech., March / April: 15-18.

O'Sullivan, A.M., Y.C. O'Callaghan, M.N.O'Grady, B. Queguineur, D. Hanniffy , D.J.Troy, J.P.Kerry and N.H. O'Brien (2011). Vitro and cellular antioxidant of seaweed extracts prepared from five brown seaweeds harvested in spring from the west coast of Ireland. Food Chem. 126:1064–1070

Oliver, H.F., R.H. Orsi, M. Wiedmann and K.J. Boor (2010). Listeria monocytogenes has a small core regulon and a conserved role in virulence but makes differential contributions to stress tolerance across a diverse collection of strains. Appl. Envir. Microb.76:42 16 32.

Ong, P.S. and G.M. Gaucher (1972). Protease production by thermophillic fungi. Can. J. Microbiology, 19:129-133.

Parker, Helen. L., Jennifer R. Dodson, Vitaly L. Budarin, James H. Clark and Andrew J. Hunt (2015). Direct synthesis of Pd nanoparticles on alginic acid and seaweed supports, Green Chemistry. Royal Society of Chemistry, 17(4), pp: 2200–2207. doi: 10.1039/c4gc02375g.

Rhodes, D. and A.D.Hanson (1993). Quaternary ammonium and tertiary sulfonium Compounds in higher plants. Annu. Rev. Plant Physiol. Plant Mol. Biol. 44:357–384.

Shindy, W.W. and O.Smith (1975). Identification of plant hormones from cotton ovules. Plant Physiol., 55: 550-554.

Sivasankari, S., V.Venkatesalu, M. Anantharaj and M.Chandrasekaran (2006). Effect of seaweed extracts on the growth and biochemical constituents of *Vigna sinensis.* Bioresource Technology 97 (2006) 1745–1751.

Smirnoff, N. (1993). The role of active oxygen in the response of plants to water deficit and desiccation. New Phytol., 125: 27–58.

Snedecor, G.M. and W.G.Cochran (1982). Statistical methods 7th edition, Iowa State Univ., Press, Ames, Iowa U.S.A., pp: 325-330.

Strik, W. A., G. D.Arthur, A. F.Lourens, O.Novok, M.Strand and J.Van-Staden (2004). Changes in seaweed concentrates when stores at an elevated temperature. Journal of Applied Phycology 16: 31-39.

Sulpice, R., Y.Gibon, A. Bouchereau and F.Larher (1998). Exogenously supplied glycine betaine in spinach and rapeseed leaf discs: Compatibility or non-compatibility? Plant Cell Environ 21:1285–1292

Tamilselvan, C. and L.Kannan (1994). Studies on the utilization of seaweeds as fertilizer for black gram. Indian J. Agric. Res. 28 (2): 121–126.

Tekle, A.T. and M.A.Alemu (2016). Drought tolerance mechanisms in field crops. World Journal of Biology and Medical Sciences, 3 (2): 15-39.

Thirumaran, G., M.Arumugam, R. Arumugam and P. Anantharaman (2009). Effect of Seaweed Liquid Fertilizer on Growth and Pigment Concentration of *Abelmoschus esculentus* (L.) Medikus. American Eurasian Journal of Agronomy 2 (2): 57-66.

Umbreit, W.W., R.H. Burris, J.F. stauffer, P.P. Cohen, W.J. Johnson, L. G.A. page and W.C. Schneider (1969). Manometric techniques, manual describing methods applicable to the studs of tissue metabolism. Burgess publishing Co., U.S.A., pp: 239.

Usman, M. (2014). Impact of heat and drought stress on physiological, biological processes in plants, technology times. Faisalabad, Pakistan: University of Agriculture. http://www.technologytimes.pk/

Van Staden, J., R. P.Beckett and M. J. Rijkenberg (1995). Effect of seaweed concentrate on the growth of the seedlings of three species of *Eucalyptus*. S. Afr. J. Bot. 61(4): 169–172.

Vernon, L.P. and G.R.Selly (1966). The chlorophylls. Acad. Press, New York, London.

Wang, Q., W.Y.Shi, F. J.Rong, J. W.Ma, C. H.Guan and L. N.Jiang (2005). The effect of the liquid seaweed extract on resisting salinity stress of cucumber. Acta Agriculturae Zhejiangensis. 17: 268-272.

Zhang, X. and E. H. Ervin (2008). Impact of seaweed extract-based cytokinins and zeatin riboside on creeping bent grass heat tolerance. Crop Sci. 48: 364 – 370.

دراسات مقارنة بين مستخلصات الطحالب البحرية والطحالب التجارية لتخفيف التأثير الضار للاجهاد المائى على نبات الفول البلدى

أحمد درويش الجمل، محمد عبدالحميد إسماعيل، محمد عبدالعال أمين، عبد الرحمن محمود سيد

قسم النبات والميكروبيولوجي، كلية العلوم، جامعة الأزهر، القاهرة، مصر.

الملخص العربي

أجريت هذه التجربة فى الحديقة النباتية لكلية العلوم جامعة الأزهر بمدينة نصر القاهرة. تم دراسة تأثير نوعين من الطحالب البحرية وهما طحلب السرجاسم وطحلب الكارولينا بالاضافة الى إثنين من الطحالب التجارية وهما كاندا بور وأوليجو أكس على نباتات الفول البلدى صنف مصر 1 .

أظهرت النتائج أن معظم المعاملات أدت الى زيادة فى طول المجموع الخضرى ونقص فى طول المجموع الجذرى بالمقارنة بنباتات الفول تحت الاجهاد المائى فى مرحلتى النمو الخضرى. سجلت أكبر زيادة فى طول كلا من المجموع الخضرى فى النباتات المعاملة بمستخلص طحلب السرجاسم تحت ظروف الاجهاد المائى. أدي الاجهاد المائي الى نقص فى الوزن الطازج والجاف لكلا من المجموع الخضرى والجذرى وعدد الأزهار والأفرع فى مرحلتى النمو لنبات الفول . أدت المعاملة بمستخلص السرجاسم الى زيادة معنوية فى عدد الأزهار والأفرع ودلالات الانتاجية لنبات الفول مقارنة بنباتات الفول تحت ظروف الاجهاد. معظم المعاملات أدت الى زيادة محتوى المجموع الخضرى لنبات الفول البلدى من صبغات الكلوروفيل والكاروتينيدات فى مرحلة النموالخضرى الأولى ونقص فى محتوى المجموع الخضرى لهذه المركبات السابقة فى مرحلة النمو الثانية.

أظهرت نباتات الفول تحت ظروف الاجهاد تحسنا معنويا في محتوي النبات (الجذور والمجموع الخضري والبذور) من الكربوهيدرات والبروتين مقارنة بالمجموعة المقارنة. أما بالنسبة لمحتوى النباتات من أنزيمى الأميليز والبروتييز، لم تظهر النتائج منحى محدد. بالنسبة لأنزيمات مضادات الأكسدة، زاد محتوى أنزيم البيروكسيديز لنباتات الفول البلدى فى مرحلتى النمو الخضرى كإستجابة لجميع المعاملات تحت الدراسة فيما عدا المعاملة بمستخلص السرجاسم والكاندا بور تحت تأثير نقص المياه. بالنسبة لأنزيمى السوبر أكسيد ديسميوتيز والبولى فينول أكسيديز، أدت جميع المعاملات الى زيادة محتواهم فى نباتات الفول البلدى فى مرحلتى النمو الخضرى، فيما عدا أنزيم السوبر أكسيد ديسميوتيز فى المرحلة الثانية من النمو الخضرى. أما بالنسبة لمحتوى الفينولات الكلية فان معظم المعاملات المستخدمة أدت الى زيادة محتوى الفينولات الكلية ماعدا فى حالة المعاملة بـ الكاندا بور تحت تأثير نقص المياة بالمقارنة بالنباتات التى توجد تحت تأثير نقص المياه. أما بالنسبة لمحتوى نباتات الفول البلدى من الهرمونات الحامضية،اندول حامض الخليك، حمض الجيبريليك وحمض الأبسيسيك، فان جميع المعاملات أظهرت زيادة فى محتوى نباتات الفول البلدى من حمض الجيبريليك بالمقارنة بنباتات الاجهاد المائى بينما جميع المعاملات أدت الى نقص فى محتوى نباتات الفول من أندول حامض الخليك وحامض الأبسيسك باستثناء المعامله بمستخلص طحلب السرجاسم تحت تأثير نقص المياه حيث أدت الى زيادة محتوى نباتات الفول البلدى من حامض الأبسيسيك.

السادة المحكمين

أ.د عماد الدين عباس كلية العلوم – جامعة الأزهر، أ.د مرفت إدوارد سوريا ل كلية الزراعة – جامعة المنوفية