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Role of Bio green and Deca humic in Improving Wheat Yield in saline soil

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ABSTRACT

Salinity is considered one of the barriers which stand as stumbling block in wheat development in developing countries. The present study was conducted in to study the effect of soil application of Bio green (BG) at 0, 2.5 and 5.0 g kg^{-1} soil and Deca humic (DH) at 0.0, 1.5 and 3.0 g kg^{-1} soil on yield and chemical composition of wheat cultivars grown in saline soil. Results indicated that, application of Bio green and Deca humic within all tested rates, resulted in significant increase in 1000 grain weight, grains and straw yield of wheat compared to control treatment. Application of the Bio green at the rate of 2.5 g kg^{-1} combined with 3.0 g kg^{-1} Deca humic produced the highest values of grain yield, weight of 1000 g grain, as well straw yield of both wheat cultivars compared with other applied treatments. The second best treatment was the application of Bio green 5.0 g kg^{-1} combined with 3.0 g kg^{-1} Deca humic. Application of Bio green and Deca humic significantly increases nitrogen, phosphorus, potassium and carbohydrate content of grain of wheat cultivars. The combined application of Bio green (2.5 g kg^{-1}) and Deca humic (3.0 g kg^{-1}) registered the lowest values of sodium accumulation of Sakha 93 over Gmmayze 9 cultivars of wheat plants. Results concluded that fertilizing of wheat plants with Bio green combined with Deca humic is important to increase the yield production and decrease sodium content of Sakha 93 over Gmmayze 9 cultivars of wheat plants grown in saline soil indicating Sakha cultivar more tolerance for salt stress than Gmmayze cultivars.

Key words: Bio green, Deca humic, nutrient content, carbohydrate, wheat yield.

Introduction

Wheat (*Triticum aestivum* L.) is cultivated worldwide primarily as a food commodity and a strategic commodity. Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than either maize (corn) or rice, the other major cereals (FAO 2004). Egypt is now one of the most world's importers of wheat. Salinity is one of the most serious factors limiting the productivity of many organisms (Rodríguez *et al*., 2006). In accordance with FAO, approximately 7% of the land is affected by salt. Twelve percentage of this land is localized in the south and south east of Asia, where rice is the principal crop. Salted soils are extensive also in northern and southwestern Africa, including the Union of South Africa, Rhodesia, Egypt, Algeria, Morocco and Tunis.

Salt stress affects many aspects of algal metabolism and, as a result, growth rates of several cyanobacteria decrease under increasing salt concentrations, but the extent of growth inhibition can vary (Vonshak *et al.*, 1988). On the other hand, certain algae, especially blue-greens, have the ability to adapt their physiological processes to very large fluctuations in salt concentrations in their environment (Borowitzka, 1986). On the contrary, blue-green algae such as *Aphanothece halophytica* and *Phormidium hypo-limneticum* are known to be extremely halotolerant, growing at salinities in excess of 200 g L^{-1} (Dor and Ehrlic, 1987). Rao *et al*., 2007 indicated that, as a group of microorganisms, like cyanobacteria and green algae exhibit considerable salinity tolerance and many species are adapted to hyper saline environments (Oren, 2000). Algae are very important aspects in order to play an economic role in soil reclamation, to increase soil fertility and to improve the plant conditioners under certain environmental factors (El-Gamal, 1998). Apte and Thomas (1997) showed that amelioration of soil salinity by application of *Anabaena torulosa* during crop growth is possible, since it can also supplement the nitrogen requirements of the crop.

Humic substances are recognized as a key component of soil fertility properties, since they control chemical and biological properties of the rhizosphere (Nardi *et al*., 2005) that are divided into three main fractions: Deca humics, fulvic acids and humin. Accordingly, Deca humics are the main fractions of humic substances and the most active components of soil and compost organic matter (Ferrara and Brunetti, 2010), which stimulate plant growth by acting on mechanisms involved in cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities (Tahir *et al.*, 2011) and hormones (Trevisan *et al*., 2010). Humic substances have been used on plant production directly on soil or substrate due to the close relation of these substances with soil fertility and availability of nutrients (Eyheraguibel *et al.*, 2008). But due to humic substances effects on plant nutrition and physiology, Trevisan *et al.* (2010) and Tahir *et al.* (2011) have been studied for use as foliar spray for wheat (Asik *et al*., 2009), grape (Ferrara and Brunetti, 2010), common bean (Kaya *et al.,* 2005) and

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maize (*Celik et al.*, 2010). Foliar application of Deca Humic stimulates growth, yield and its quality of wheat crop (Ulukan 2007). The stimulatory effects of humic substances have been directly correlated with enhanced uptake of macronutrients, such as nitrogen, phosphorus and micronutrients, that is, Fe, Zn, Cu and Mn (Verlinden *et al*. 2009).

Improvement of saline soil as well as salt-tolerant crop plants is needed to maintain the food output of the world. Therefore, this work was to investigate the potentiality of wheat to grow in saline soil under application of Bio green and Deca Humic as well as to evaluate their effects on the growth and yield and nutrient accumulation of salt stressed wheat plants.

Materials and Methods

Plant material and growth condition:

This research work was conducted at the wire house of National Research Centre, Dokki, Cairo, Egypt (29.77 N, 31.3 E), from 15 November 2012 to 20 March 2013 to study the effect of Bio green and Deca humic application on yield and nutrient composition of wheat cultivars (Gemmayze 9 and Sakha 93) grown in saline soil. Ten grains of wheat were sown in plastic pots containing about 10.0 Kg of clay loams soil, pH (8.06) and EC (4.17 dS m^{-1}). A hole was made in base for leaching purpose. Initial soil properties are presented in Table 1.

Experimental setup:

The pots were supplied with 0, 2.5 and 5.0 g kg $^{-1}$ of Bio green (BG) commercially known as Bio green power formulated by Algal biotechnology unit, National Research Centre, Dokki, Egypt combined with 0, 1.5 and 3.0 g kg^{-1} of Deca humic (DH) commercially known as Deca produced by Al Hanna Modern Agriculture co., Giza, Egypt. Both of Bio green and Deca humic applied as soil drench at three times during growth season. Bio green power contains a blue green Algae (*Spirulina platensis*), 7-11 % fat, 12-16 % carbohydrate, 50-55 % protein, 0.65 % P, 1.6 % K, 8 % N, 0.4 % Ca, 0.08 % S, 25 ppm Mg, 12 ppm B, 80 ppm Zn, 2000 ppm Fe, 70 ppm Mn, 100 ppm Cu, and pH 5.6-6.5 and Deca contain 15 **%** Deca Humic, 10 **%** Fulvic acid, 1.0 **%** amino acid, 4.0 **%** P, 6.0 **%** K, 1.0 **%** N. Two wheat cultivars (Gmmayze 9 and Sakha 93) were used in this study. This factorial experiment was laid out in randomized block design with four replicates.

Table 1: Initial physical and chemical soil properties of the soil used in pot experiment.

Particle size distribution (%)				Texture class	pH (1: 2.5)	EC dS m^{-1} (1: 5)	Organic matter (%)	$CaCO_3$ (%)
Sand	Silt	Clay						
17.56	32.82	49.22		Clay loam	8.06	4.17	0.82	1.16
Available Macronutrients (mg Kg^{-1})					Available Micronutrients (ppm)			
N	P		K		Fe	Zn	Mn	Cu
38.16	5.03		193		4.86	0.68	2.33	0.78
Soluble cation (me L^{-1})					Soluble anions (me L^{-1})			
Na^+	K^+	Ca^{++}	Mg^{++}		CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
26.05	0.82	7.15	2.92		1.03	2.41	18.57	14.96

Measurements:

The plant samples were collected from each treatment randomly at harvest. Fresh and dry biomass of grain and straw was recorded and 1000 grain weight was also estimated. Total Nitrogen, Phosphorus and potassium content of wheat grain and straw were estimated in the plant digest according to the method described by Faithfull (2002).

Statistical analysis:

The data observed from experiment were subjected to the analysis of variance (ANOVA) appropriate to the randomized complete block design. The means were compared with the critical difference test at 5% probability level according to Gomez and Gomez (1984).

Results and Discussion

Wheat yield production:

Salinity is considered one of the barriers which stand as stumbling block in plant development. Therefore, many workers have thought about going beyond such problem that hinders the development process in developing countries. The potentiality of to select blue-green algae was tested to grow in saline soil. Data in Table (2) represent the wheat production under different treatments of Bio green and Deca humic application. Application of Bio green (BG) and Deca humic (DH) within all tested rates, resulted in significant increase in grains, straw yields per plant and 1000 grain weight of wheat compared to control treatment. Generally, application of 2.5 g Bio green kg^{-1} soil or 3.0 g Deca humic kg^{-1} soil individually were more effective in producing grain and straw yield as compare to the rest of the treatment and control in both Gmmayza 9 and Sakha 93 wheat cultivars. The increments in the studied yield parameters were more pronounced in Sakha 93 over Gmmayza 9 and wheat cultivars. The combined applications of 2.5 g BG kg^{-1} soil and 3.0 g DH kg^{-1} soil produced the highest increased the grain (2.26 g $plant^{-1}$) and straw yield (4.72 g $plant^{-1}$) of Gmmayze 9 wheat cultivar and 2.61 g grain $plant^{-1}$ and 4.94 g straw $plant^{-1}$ of Sakha 93 wheat cultivar as compared to the other treatments and control, respectively. Similar trend was observed with 1000 grain weight in both wheat cultivars.

Table 2: Effect of Bio and organic amendments on yield of wheat cultivars.

Treatments		Gmmayze 9			Sakha 93		
Bio green (BG)	Deca humic (DH)	Grain dry weight (g $plant^{-1}$)	Straw dry weight (g $plant^{-1}$)	1000 grain weight (g)	Grain dry weight (g $plant^{-1}$)	Straw dry weight (g $plant^{-1}$)	1000 grain weight (g)
0 g Bg kg^{-1} soil	0.0 g DH kg^{-1} soil	0.91	1.47	22.0	0.83	2.31	25.2
	1.5 g DH kg^{-1} soil	1.60	3.49	23.7	2.02	3.57	34.3
	3.0 g DH kg^{-1} soil	1.71	3.73	28.0	2.11	4.52	36.1
2.5 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	0.97	2.86	26.0	1.27	3.08	34.4
	1.5 g DH kg^{-1} soil	1.76	3.78	29.0	2.15	4.59	37.6
	3.0 g DH kg^{-1} soil	2.26	4.72	34.0	2.61	4.94	44.3
5 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.41	3.11	28.0	1.91	3.26	35.2
	1.5 g DH kg^{-1} soil	1.93	4.07	31.0	2.22	4.87	41.1
	3.0 g DH kg^{-1} soil	1.96	4.52	32.0	2.27	4.92	42.3
LSD 0.05 %	BG	0.013	0.024	1.097	0.007	0.018	1.62
	DH	0.024	0.018	1.22	0.018	0.014	0.59
	BG*DH	1.32	1.82	1.72	2.064	1.114	2.84

The increasing of wheat yield may be attributed to better growth under favorable physical condition of treated saline soil with Bio green and can be related to the beneficial effect of application of Deca humic containing a considerable amount of organic matter and nutritional elements for plant growth (Weil and Magdoff 2004 and Celik, *et al.* 2004). The humic substances, the major component of soil organic matter, have both direct and indirect effects on plant growth (Sangeetha *et al.*, 2006). The direct effects are those that require the uptake of humic substances into the plant tissue resulting in various biochemical outcomes, whereas the indirect effects involve the improvement of soil properties, such as aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability (Tan, 2003). Masciandaro *et al.* (2002) found that using a soil seeded with maize in plant growth test, presented the best result when the mixture of saline solution–humic substances was used.

Nitrogen and phosphorus:

Data presented in Table (3) reported that the effect of Bio green and Deca humic application on total nitrogen and phosphorus content of wheat plants. All treatments tended to increase nitrogen and phosphorus content of grain and straw as compared with the control treatments. Comparing between application Bio green and Deca humic data showed that Bio green application increased nitrogen and phosphorus content of grain and straw as compared with Deca humic application in both wheat cultivars.

The results obtained indicated that, Bio green and Deca humic levels had positive effect on mineral elements uptake (N and P) of wheat especially at high rate of applied materials. Data also, indicated that application of Bio green at a rate of 2.5 g kg^{-1} soil and Deca humic at a rate of 3.0 g kg^{-1} soil gave significant increase in nitrogen and phosphorus content in grain (1.93 and 0.56 %) and (0.35 and 0.18 %) and in straw of Gmmayze 9 and (2.66 and 0.66 %) in grain and (0.38 and 0.26 %) in straw of Sakha 93 wheat cultivars as compared with control and the other treatments, respectively. Fagbenro and Agboda (1993) and Verlinden *et al.* (2009) indicated that humic substances enhanced uptake of nitrogen, phosphorus and potassium of teak seedlings.

According to the analysis results, Bio green and Deca humic levels had positive effect on mineral elements uptake (N, P and K) of the wheat especially for Sakha 93 cultivar over Gmmayze 9 wheat cultivars. Data also, indicated that application of 5.0 g kg^{-1} Bio green combined with 3.0 g kg^{-1} Deca humic gave significant increase in nitrogen and phosphorus content in grain and straw as compared with control and rest of the treatments. Bio fertilizers were very safe for human, animal and environment and using them reduced at the lower extent the great pollution occurred in our environment. The various positive effects and benefits of applying Bio green as a newly used bio fertilizers were attributed to its content of different nutrients, higher percentage of nitrogen, greater amounts of vitamins B_1, B_2 and B_6 and the natural plant hormone namely cytokinins safe cultivation can be greatly achieved by using bio fertilizers (Kannaiyan 2002 and Abd El-Aziz 2002).

Table 3: Effect of Bio and organic amendments on nitrogen and phosphorus content (%).

Treatments		Gmmayze 9				Sakha 93			
Bio green (BG)	Deca humic (DH)	Total nitrogen %		Total phosphorus %		Total nitrogen %		Total phosphorus %	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
0.0 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.45	0.07	0.07	0.03	2.04	0.18	0.21	0.10
	1.5 g DH kg^{-1} soil	1.70	0.13	0.19	0.08	2.35	0.24	0.33	0.15
	3.0 g DH kg^{-1} soil	1.72	0.24	0.22	0.10	2.41	0.27	0.35	0.16
2.5 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.59	0.10	0.16	0.08	2.12	0.21	0.28	0.14
	1.5 g DH kg^{-1} soil	1.78	0.26	0.26	0.11	2.45	0.28	0.38	0.16
	3.0 g DH kg^{-1} soil	1.93	0.35	0.56	0.18	2.66	0.38	0.66	0.26
5.0 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.61	0.14	0.20	0.10	2.29	0.23	0.31	0.14
	1.5 g DH kg^{-1} soil	1.77	0.26	0.38	0.13	2.54	0.33	0.49	0.19
	3.0 g DH kg^{-1} soil	1.87	0.29	0.47	0.16	2.56	0.35	0.56	0.22
LSD 0.05 %	BG	0.029	0.023	0.029	0.008	0.020	0.018	0.027	0.0037
	DH	0.021	0.024	0.011	0.016	0.015	0.009	0.013	0.0044
	BG*DH	0.180	0.643	0.528	0.425	0.335	NS	0.525	NS

Potassium and sodium:

Application of Bio green and Deca humic had statistically significant effect on potassium and sodium content as compared with the control treatment as presented in Table (4). The applied rate of 2.5 g Bio green kg^{-1} combined with 2.5 g Deca humic kg^{-1} soil gave the highest increase in K content in grain and straw (1.82 and 4.19 %) in Gmmayze 9 and (2.22 and 5.44 %) in Sakha 93 wheat cultivars as compared with the control treatment, respectively. Comparing between the rates of applied Bio green and Deca humic, data showed that the rate of 2.5 g Bio green kg^{-1} combined with 3.0 g Deca humic kg^{-1} soil gave the lowest values in sodium content in grain and straw (0.13 and 0.91 %) of Gmmayze 9 and (0.11 and 0.51 %) in Sakha 93 wheat cultivars as compared with the control treatment, respectively. Çelik *et al.* (2008) stated that the soil application of humus at 1 and 2 g kg^{-1} doses had statistically significant effect on nutrient uptake of maize plant. It is seemed that the mucilaginous sheath had a role in an ameliorative effect on salt stress as more than 90 % of the cell-bound Na^+ remained extracellulary trapped in the mucopolysaccharide sheath of cyanobacteria (Apte and Thomas, 1997).

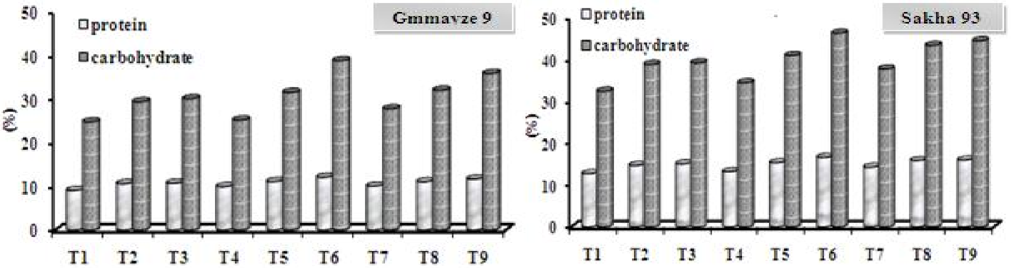
Sodium accumulation in garin and straw of Sakha 93 was lower as compared to Gmmayze 9 wheat varieties. This indicates that Sakha 93 is tolerating salinity over Gmmayza 9 wheat cultivars. In wheat, salt tolerance is associated with low rates of transport of Na^+ to shoots, with high selectivity for K^+ over Na^+ (Gorham *et al.*, 1990). Most plants, in fact, do exclude about 98% of the salt in the soil solution, allowing only 2% to be transported in the xylem to the shoots. Differences between cereal genotypes with contrasting rates of Na^+ uptake, when grown in 50 mM NaCl, range from 99% for Janz to 98% for other bread wheat (Munns, 2005)

Table 4: Effect of Bio and organic amendments on potassium and sodium content (%).

Treatments		Gmmayze 9				Sakha 93			
Bio green (BG)	Deca humic (DH)	Total potassium %		Total sodium %		Total potassium %		Total sodium %	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
0.0 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.02	1.07	0.230	1.45	1.26	1.54	0.169	1.31
	1.5 g DH kg^{-1} soil	1.23	2.43	0.153	1.25	1.58	4.10	0.133	1.23
	3.0 g DH kg^{-1} soil	1.29	2.52	0.153	1.23	1.62	4.29	0.130	1.12
2.5 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.10	1.28	0.210	1.40	1.34	2.73	0.161	1.13
	1.5 g DH kg^{-1} soil	1.50	3.21	0.140	1.12	1.81	4.75	0.129	0.84
	3.0 g DH kg^{-1} soil	1.82	4.19	0.127	0.91	2.22	5.44	0.111	0.51
5.0 g BG kg^{-1} soil	0.0 g DH kg^{-1} soil	1.21	1.78	0.171	1.33	1.46	4.04	0.147	1.08
	1.5 g DH kg^{-1} soil	1.55	3.32	0.142	0.97	2.02	4.86	0.123	0.66
	3.0 g DH kg^{-1} soil	1.71	4.08	0.133	0.93	2.09	4.95	0.116	0.62
LSD (0.05 %)	BG	0.005	0.019	0.019	0.017	0.017	0.027	0.016	0.017
	DH	0.037	0.029	0.006	0.009	0.040	0.030	0.012	0.028
	BG*DH	0.776	1.467	NS	0.413	0.970	2.775	1.130	0.611

Protein and carbohydrate content:

Data presented in Figure (1) reported that the effect of Bio green and Deca humic application on protein and carbohydrate content of wheat plants grown in saline soil were significant. All Bio green and Deca humic treatments tended to increase protein and carbohydrate content in wheat grains in both Gmmayze 9 and Sakha 93 wheat cultivars as compared with the control treatments. Application of 3.0 g DH per kg soil showed significant improvement in protein and carbohydrate content (10.7 and 30.1 %) of Gmmayze and (15.1 and 39.3 %) Sakha 93 wheat cultivars as compared control, respectively. Whereas, the combined application of 2.5 g BG per kg soil and 3.0 g Deca humic kg^{-1} soil produce the highest protein (12.1 and 16.6 %) and carbohydrate content (38.8 and 46.4 %) in both Gmmayze 9 and Sakha 93 wheat cultivars, respectively as compared with the all treatments. The significant increase in Protein and carbohydrate content could be due to the bio green contains 50-55 % protein and 12-16 % carbohydrate even Deca humic contains amino acids which is important for protein synthesis.



T1: 0.0 g BG kg^{-1} + 0.0 g DH kg^{-1} soil	T2: 0.0 g BG kg^{-1} + 1.5 g DH kg^{-1} soil	T3: 0.0 g BG kg^{-1} + 3.0 g DH kg^{-1} soil
T4: 2.5 g BG kg^{-1} + 0.0 g DH kg^{-1} soil	T5: 2.5 BG kg^{-1} + 1.5 g DH kg^{-1} soil	T6: 2.5 BG kg^{-1} + 3.0 g DH kg^{-1} soil
T7: 5.0 g BG kg^{-1} + 0.0 g DH kg^{-1} soil	T8: 5.0 g BG kg^{-1} + 1.5 g DH kg^{-1} soil	T9: 5.0 g BG kg^{-1} + 3.0 g DH kg^{-1} soil

Fig. 1: Protein and carbohydrate as affected by Bio green (BG) and Deca humic (DH) application for wheat Cultivars.

Correlation:

The results of the correlation coefficients between grain wheat yield and N, P, K, Na, protein and carbohydrate are presented in (Table 5). Grain wheat yield were highly significant and positively correlated with macro nutrients except sodium which is negatively correlated with grain yield of both wheat cultivars. This means that, application of Bio green and Deca humic improved the nutrient uptake consequently enhanced the increase in grain yield of wheat grown under saline soil conditions.

Table 5: Correlation coefficient of grain weight of wheat cultivars and the studied parameters

	N	P	K	Na	Protein	Carbohydrate
Grain weight of Gammayze 9	0.956	0.897	0.935	-0.989	0.955	0.952
Grain weight of Sakha 93	0.964	0.833	0.870	-0.985	0.965	0.940

Conclusions:

Bio green and Deca humic combination produced the highest values of wheat straw and grain yields of both Gmmayze 9 and Sakha 93 wheat cultivars grown in saline soil as well as nutrients, protein and carbohydrate content. Sodium accumulation was lowest under same treatment. So, it could be recommended for better growth and yield of wheat under the saline soil condition.

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