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Approach for Reclamation and Improving Fertility of Saline-Sodic Soils

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A POT experiment was conducted under the greenhouse conditions at the Farm of the Faculty of Agriculture, Zagazig University to try reclamation and cultivation of saline-sodic soils. Soil samples were collected from Sahl El-Tin, Sinai Governorate, Egypt. Plastic pots were filled with soil. Soil was treated with compost or gypsum as soil amendments before filling. The gypsum and compost addition rate were 10.32 and 20 Mg ha^{-1}, respectively. The soils were leached with water having EC 1.2 dSm^{-1}using intermittent method. Reclamation requirements (RR) were calculated based on pore volume (PV). Soil was leached with amount of water equivalent 1.5 PV (1.5 PV was equal 4.85 liter of water). Leaching water amount was divided into 10 equal quantities each one equal 0.49 liter. Following termination of leaching, samples were taken from soils were amended with gypsum and compost and analyzed. After reclamation process, the same pots were planted with wheat (Triticum aestivum cv. Sakha 93) to study the effect of fulvic acid “FA” as application soil and foliar sprays with Moringa leaf extract “MLE” and Marine algae extract “MAE” as Ascophyllum nodosum (*Phaeophyceae*) on photosynthetic pigments, yield and nutrient uptake of wheat (*Triticum aestivum* cv., Sakha 93) under newly reclaimed soils with gypsum and compost. The results of the study indicated that gypsum and compost showed a pronounced decreased in bulk density, EC, pH, SAR and ESP compared with the initial soil with superiority of gypsum on compost in reducing EC, SAR and ESP. The highest values of plant height, leaf area, chlorophyll a, b and caroteniods, yield, straw and grain NPK-uptake,1000 grain weight and protein content were obtained with FA combined with moringa extract spray. However, non-treated plants showed the lowest one. Spraying with moringa leaf extract gave a significant increase in growth yield parameters; yield, photosynthetic pigments, NPK-uptake,1000 grain weight and protein content compared to foliar spray with marine algae extract in the two soils. Soils reclaimed with compost gave higher values of yield, straw and grains NPK- uptake and protein content than the values under application of gypsum under different treatments.

Keywords: Saline, Sodic, Gypsum, Compost, Wheat, Fluvic acid, Moringa leaf extract, Marine algae extract, Newly reclaimed soils

Salt-affected soils occupy wide regions scattered all over the world, particularly in arid and semi-arid climates. Agriculture in Egypt, as in many other countries in the arid and semi-arid regions, is suffering from salinity hazards. While the cultivated area is only 7.2 million feddans, the area of salt-affected soils has been estimated to be about 1.9 millions feddans. Most of these areas are located in the northern and eastern of the Nile Delta as well as patches in Valley and along the two Nile branches. Irrigated agriculture in arid and semi-arid regions of the world has resulted in salinity and water logging problems that are threatening the sustainability of our lands (Chhabra, 1996).

Mashali (1991) classified the management practices of salt-affected soils are (i) hydraulic management including leaching, irrigation, and drainage; (ii) physical involving, tillage, land preparation, and sanding, (iii) chemical including amendments, conditioners, and fertilizer; and (iv) biological including crop rotation and pattern. The kind and amount of chemical amendments to be used for reclamation of saline sodic and non-saline sodic soils are based on several factors. Among them are the followings: physical and chemical properties of the soil, the time available for reclamation, the final required level of exchangeable sodium percent (ESP) and the cost of reclamation amendments and water application.

Abdel-Moez and Saleh (1999) found that the organic materials have different effects on modifications of the physical and chemical properties of soils as well as their influence of their nutrition status and soil fertility. Incorporation of plant residues sustains organic matter in soil, enhances biological activity and improves soil physical properties (Kumar and Goh, 2000; Palm *et al.,* 2001).In addition, compost is a rich source of organic matter which plays an important role in sustaining soil fertility and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physicochemical and biological properties of the soil. As a result of these improvements, the soil: (i) becomes more resistant to stresses such as drought, diseases and toxicity; (ii) helps the crop in improved uptake of plant nutrients; and (iii) possesses an active nutrient cycling capacity because of vigorous microbial activity.

Many beneficial effects are attributed to foliar application of fulvic acid (FA), including stimulation of plant metabolism, increased enzyme activity (transaminase, invertase), increased bioavailability and uptake of nutrients (Jifon and Lester, 2009), and increased crop growth and yield (Priya *et al.*, 2011).Fulvic acid has maximum influence on chemical reactions because of the presence of more electronegative oxygen atoms than any other humate molecules, which enhances membrane permeability(Priya *et al.*,2014).

Moringa leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants such as ascorbic acid, flavonoid, phenolics and carotenoids

(Dillard and German, 2000; Siddhuraju and Becker, 2003). In addition, moringa leaf is also rich in ascorbates, carotenoids, phenols, potassium and calcium, which have plant growth-promoting capabilities and often applied as exogenous plant growth enhancers (Foidl *et al.*, 2001). Antioxidants such as ascorbic acid and glutathione, which are found at high concentrations in moringa chloroplasts and other cellular compartments, are crucial for plant defense against oxidative stress (Noctor and Foyer, 1998). Merwad (2015) showed that the aqueous and ethanolic leaf Moringa extracts at rate of 3% increase growth, yield, photosynthetic and nutrient uptake (N, P, K, Ca, Mg and Fe) of spinach plants. Siddhuraju and Becker (2003) observed antioxidant properties in the solvent extract of moringa leaves and reported that leaves are potential source of natural antioxidants.

Seaweed extracts have been used for decades in agriculture and horticulture as biostimulants to promote plant growth and increase crop yields. When applied in small amounts, the beneficial effects of seaweed extracts on crop growth have been attributed to plant growth regulators, and possibly micronutrients, that stimulate root growth, mineral uptake, photosynthetic capacity, and stress tolerance (Khan *et al.* 2009). Under conditions of water stress, only few studies have provided evidence of improved plant performance upon treatment with seaweed extracts (Khan *et al.*, 2012;Zhang and Ervin 2004). Anti-stress effects may be related to bioactive chemicals contained in the extracts and increased antioxidant enzyme activity (Fike *et al.*, 2001), but their physiological mechanism of action is largely unknown. In some studies, seaweed extracts from Ecklonia maxima increased yields under adequate nutrient supply (Mooney and van Staden 1985), thereby demonstrating a capacity to enhance the effectiveness of conventional fertilizers. In contrast, other studies indicated that extracts from the same seaweed species increased yield only in nutrient-stressed wheat (Beckett *et al.*, 1994) or even in the absence of mineral fertilizer (Nelson and van Staden 1986). Recently, Khan *et al.* (2011) demonstrated that the extract of different seaweed species, Ascophyllum nodosum, induced cytokinin-like activity in Arabidopsis thaliana when applied as a liquid culture or foliar spray.The use of balanced nutrient solutions in the above studies did not allow the investigation of seaweed extract effects on specific nutrient deficiencies. Beckett and van Staden (1990) reported beneficial seaweed extract effects on K-stressed wheat, and Papenfus *et al.* (2013) detected improved growth of okra seedlings under K or P, but not under N, deficiency. Nitrogen, along with water, is a major limiting and economic factor in crop production that is also associated with environmental degradation resulting from excessive or untimely fertilizer application. Draught stress and N deficiency are constraining winter wheat production and yield stability under rained conditions worldwide (Shangguan *et al.*, 2000).

The aim of the present work is to study the effect of fluvic acid applied through the soil and moringa leaf and marine algae extracts applied as foliar spray on photosynthetic pigments, yield and nutrient uptake of wheat under newly reclaimed soils with compost and gypsum.

Materials and Methods

A pot experiment was conducted under the greenhouse conditions at the Farm of the Faculty of Agriculture Zagazig University to try reclamation and cultivation of salt affected soils. Soil samples were collected from Sahl El-Tin, Sinai Governorate, Egypt, which is affected by salinization and sodification. They were air dried, crushed and sieved through a 2-mm sieve and analyzed for their physicochemical characteristics (Table 1). Thirty-six of plastic pots of internal dimensions 20 × 25 cm were filled with 10 kg soil. Soil was treated with compost or gypsum before filling the pots with soil. Gypsum requirements (GR) were calculated to reduce the initial ESP from 19.61 to 10% for 30-cm soil according to USDA (1954). The gypsum was of 97% purity and its addition rate was 10.32 Mgha-1. Concerning compost addition rate was 20 Mg ha-1 and the characteristics of compost are shown in Table 2. After mixing amendments with soil matrix, the soils were leached with water having EC 1.2 dSm-1. Leaching was done using intermittent method so as to add portions to the already saturated soil; and obtain leachates equal to the added portions. Reclamation requirements (RR) were calculated based on pore volume. Pore volume (PV) is amount of water that fill all pore spaces and soil reach to the state of saturation. Soil was leached with amount of water equivalent 1.5 PV (1.5 PV was equal 4.85 liter of water). Leaching water amount was divided into 10 equal quantities each one equal 0.49 liter. Following termination of leaching, samples were taken from soil were amended with gypsum and compost. Soil samples were air dried, crushed, sieved through a 2-mm sieve and analysis according to USDA (1954). Results included in Table 1 as average value.

Following termination of reclamation process, the same pots were planted with wheat (Triticum aestivum cv. Sakha 93) to evaluate the effect of fulvic acid “FA” as application soil and foliar sprays with Moringa leaf extract “MLE” and Marine algae extract “MAE” as Ascophyllum nodosum (Phaeophyceae) on yield and nutrient uptake of wheat under of newly reclaimed soil.

All pots were supplied with the recommended doses of N, P and K. Nitrogen was added in 3 equal splits as ammonium sulfate (210 g N kg-1) at a rate of 120 kg N ha-1, the first was before the 1st irrigation while the second and third splits were added after 40 and 70 days, respectively from the first splits. P and K fertilizers were added to the soil as ordinary super phosphate (65.5 g P kg-1) at a rate of 31 kg P ha-1 and potassium sulphate (410 g K kg-1) at a rate of 50 kg K per ha-1 during soil preparation. Fulvic acid was applied through the soil at a rate of 3 kg ha-1.

An amount of 20 g of young Moringa oleifera leaves was mixed with 675 ml of 80% ethanol as suggested by Makkar and Becker (1996). The suspension was stirred using a homogenizer to help maximize the amount of the extract. The solution was filtered using No.2 whatman filter paper. The extract of Moringa oleifera leaves were used within five hours from cutting and extracting (if not ready to be used,the extract or the solution prepared was stored at 0^{o}C and only taken out when needed for use). The chemical composition of Moringa oleifera leave extract were investigated using (Fuglie, 2000 and Moyo *et al*., 2011) are represented in Table 3. Foliar spraying of extract were done three equal doses at 30, 45 and 60 days after planting at a rate of 3% (30 ml L-1). Foliar spraying of marine algae extract as Ascophyllum nodosum (Phaeophyceae) were done three equal doses at a rate of 0.5 ml L-1 at the same time of spraying moringa extract. The chemical composition of marine algae extract were investigated are represented in Table 4.

The experiment includes different combinations of the former treatments as follows: Control, FA, MAE, MLE, FA+MAE, FA+MLE. Previous treatments were executed on the reclaimed soil by gypsum and at other times on the reclaimed soil by compost. The design was a factorial randomized complete block with three replicates. A random sample of three plants was taken from each treatment at 75 days old (booting stage) to record plant vegetative characters (Plant height and leaf area) and photosynthetic pigments (chlorophyll a, b and caroteniods) were determined spectrophotometrically (Metzner *et al.,* 1965).

At harvest, plant samples were separated into straw and grains , dried at 70 ˚C for 72 hours, weighed, digested with concentration H2SO4/HClO4 and analyzed for total nitrogen, phosphorus and potassium (Chapman and Pratt 1961). Total nitrogen in plant was determined using the microkjeldahl method according to Chapman and Pratt (1961). Total potassium in plant was determined by flame photometer according to Chapman and Pratt (1961). Total phosphorus in plant was determined colourmetrically using ascorbic acid method (Watanabe and Olsen, 1965). Protein percent "yield quality" in grains was calculated by multi plying N% × 5.70 (Bishni and Hughes, 1979).

Results and Discussion

Soil properties as affected by gypsum and compost

Bulk density (BD) as affected by different amendments (*i.e.* gypsum and compost) is shown in Table 1. It is obvious from the data that BD is influenced by application of all tested treatments compared with initial soil. The minimum BD was recorded with compost followed by gypsum. Amendments application decreased to 1.35 and 1.39 Mg.m-3 due to gypsum and compost compared with initial soil (having BD 1.45 Mg.m-3), respectively. Regarding to soil salinity, the residual total soluble salts in soil at end of the reclamation process, expressed as EC of the saturated soil extract, as shown in Table 1. The obtained data prove that EC in soil are influenced by application of all tested treatments. The initial soil salinity (having 15.63 dSm-1) was reduced to 3.65 and 5.51 dSm-1 for the different treatment of gypsum and compost, respectively. Regarding soil pH, data indicated the application amendments caused an appreciated reduction in soil pH if compared with initial soil. The initial soil pH (having 7.89) was reduced to

7.77 and 7.68 for gypsum and compost, respectively. Results showed a slightly lower in soil pH between treatments, this may be explained by soil must have had high buffering capacity due to the Clay texture. Sodium adsorption ratio (SAR) is a reliable index for testing the remediation efficiency of sodic soils. Data in Table 1 reveal that the initial SAR value was high and dropped sharply to 5.48 and 6.74 after the end of reclamation process for gypsum and compost, respectively. Regarding ESP, respective decreases were 7.90 and 13.55% for gypsum and compost, respectively.

TABLE 1. Physical and chemical properties of studied soil

Property	**Studied soil**		
	Initial soil before reclamation process	**After treated by gypsum**	**After treated by compost**
Texture class	Clay	Clay	Clay
Bulk density, $Mg.m^{-3}$	1.45	1.39	1.35
Organic matter, $g\ kg^{-1}$	2.20	2.50	3.30
Saturation point, %	32.25	------	------
EC, dS/m (soil paste extract)	15.63	3.65	5.51
pH (soil suspension 1: 2.5)	7.89	7.77	7.68
Ca^{2+}, $mmol_c/L$	12.59	16.33	12.33
Mg^{2+}, $mmol_c/L$	69.93	2.94	14.44
Na^{+}, $mmol_c/L$	63.33	14.79	24.65
K^{+}, $mmol_c/L$	10.45	2.44	3.68
HCO_3^{-}, $mmol_c/L$	61.96	14.47	21.84
Cl^{-}, $mmol_c/L$	35.63	8.32	12.56
$SO_4^{=}$, $mmol_c/L$	58.71	13.70	20.70
SAR	9.86	5.48	6.74
CEC, $cmol_c$/kg soil	25.45	25.45	25.45
ESP, %	19.61	7.90	13.55

Gypsum decreases the ratio of sodicity to salinity in percolating solutions and provides a relatively uniform hydraulic gradient throughout the soil profile (Miyamoto and Enriquez 1990). The application of gypsum followed by a mature municipal solid compost mix has been used to restore degraded sodic soils (Hanay *et al.,* 2004). Similarly, Siyal *et al.* (2002) reported that gypsum was effective in the reclamation of sodic soils. The application of gypsum decreases the pH, electrical conductivity (EC), exchangeable sodium percentage (ESP), and bulk density and increases the hydraulic conductivity and infiltration rate (Abdel-Fattah, 2011, 2012 and Abdel-Fattah *et al.,* 2015). The addition of organic matter in conjunction with gypsum has been successful in reducing adverse soil properties associated with sodic soils. Addition of organic matter and gypsum to the surface soil will decrease spontaneous dispersion and EC down to the subsoil, compared to the addition of gypsum alone (Vance *et al.,* 1998).

TABLE 2. Physicochemical characteristics of botanical compost

Characteristics	Value
Moisture, %	23.00
pH	6.87
EC, dSm^{-1} (Compost extract 1:10)	4.57
Total N, %	1.00
$N\text{-}NH_4$, ppm	67.00
$N\text{-}NO_3$, ppm	17.00
Organic matter, %	30.50
Organic carbon, %	14.79
Ash, %	74.50
C/N Ratio	1:14.79
Total $P\text{-}P_2O_5$, %	0.73
Total $K\text{-}K_2O$, %	1.03

TABLE 3. The chemical composition of *Moringa oleifera* leave extract

Characteristics	Values, g 100 g^{-1} d wt
Protein	27.30
Phosphorus (P)	0.39
Potassium (K)	0.11
Calcium (Ca)	2.40
Magnesium (Mg)	0.45
Iron (Fe)	0.033
Vitamin A (β-carotene)	0.02
Vitamin B1(thiamine)	0.0026
Vitamin B2 (riboflavin)	0.021
Vitamin B3(nicotinic acid)	0.008
Vitamin C (ascorbic acid)	0.017
Vitamin E (tochopherol acetate)	0.113

TABLE 4. The chemical composition of marine algae extract

Characteristics	Values, %
N	1.33
P	0.46
K	12.4
Ca	0.55
Mg	0.35
Fe	0.008
Alginic acid	5.60
Cytokinine	0.001
indol acetic acid	0.002
Pepsin	0.02
Oligo saccharide	3.50
Phytin	0.003

Yield parameters, photosynthetic pigments and yield

Data presented in Table 5 show the effect of fulvic acid application and foliar sprays with moringa leaf extract and marine algae extracton growth yield parameters, yield and photosynthetic pigments of wheat plants grown under soils reclaimed with gypsum and compost. All the values of treatments significantly increased yield parameters and photosynthetic pigments (chlorophyll a, b and caroteniods) as compared to control (without application) under all the soils.The highest values of plant height, leaf area, straw and grain yield and photosynthetic pigments occurred with FA+MLE treatment followed by FA+MAE, MLE, MAE,FA, respectively and control in descending order in the two soils.These results are in agreement with those obtained by Celik *et al*.(2008).Fluvic acids influence on soil physical and chemical properties, and absorption of nutrients has increased by use of fluvic acids, leading to improved root growth and fresh and dry yield of plants. In many cases, fluvic compounds reduced required amount of fertilizers and improved soil conditions (Kao and Govindaraju, 2010).

TABLE 5. Effect of fulvic acid and foliar sprays of moringa leaf and marine algae extracts on yield and photosynthetic pigments of wheat plants under soils reclaimed with gypsum and compost

Factors of study effects		Plant height cm	Leaf area cm^2	straw yield g $plant^{-1}$	grain yield g $plant^{-1}$	Bio. yield g $plant^{-1}$	Photosynthetic pigments mg g^{-1} fresh weight		
							cho a	cho b	chrotein
Amendment type effect									
Gypsum		81.64	18.20	1.25	1.02	2.28	1.36	0.64	0.52
Compost		90.11	19.81	1.30	1.11	2.30	1.44	0.68	0.62
LSD 0.05%		1.24	0.67	0.01	0.02	Ns	0.02	0.004	0.01
Foliar spray effect									
Without		74.77	15.74	0.95	0.75	1.70	1.16	0.54	0.44
FA		78.38	17.59	1.27	0.90	2.10	1.26	0.59	0.49
MAE		82.93	18.96	1.31	1.00	2.25	1.34	0.64	0.56
MLE		86.35	19.84	1.34	1.13	2.41	1.44	0.68	0.60
FA+MAE		92.83	20.80	1.37	1.23	2.54	1.56	0.73	0.65
FA+MLE		99.97	21.12	1.43	1.39	2.71	1.67	0.77	0.67
LSD 0.05%		2.14	1.16	0.02	0.04	0.05	0.03	0.01	0.02
Interaction effect									
Gypsum	Without	71.17	14.77	0.92	0.72	1.65	1.12	0.52	0.40
	FA	75.43	17.20	1.25	0.87	2.12	1.23	0.56	0.44
	MAE	78.30	18.56	1.29	0.94	2.23	1.33	0.62	0.50
	MLE	81.73	19.01	1.32	1.10	2.42	1.42	0.66	0.54
	FA+MAE	87.80	20.11	1.35	1.20	2.55	1.49	0.72	0.62
	FA+MLE	95.38	19.54	1.39	1.31	2.70	1.60	0.75	0.64
Compost	Without	78.37	16.71	0.97	0.79	1.76	1.20	0.56	0.48
	FA	81.33	17.97	1.29	0.93	2.08	1.28	0.62	0.54
	MAE	87.57	19.37	1.33	1.05	2.26	1.34	0.66	0.62
	MLE	90.97	20.67	1.36	1.15	2.41	1.46	0.69	0.66
	FA+MAE	97.87	21.48	1.39	1.25	2.54	1.63	0.75	0.69
	FA+MLE	104.57	22.69	1.48	1.46	2.73	1.74	0.79	0.70
LSD 0.05%		Ns	Ns	Ns	Ns	Ns	0.04	0.01	0.02

FA: fulvic acid, MAE: marine algae extract, MLE: moringa leaf extract, cho a: chlorophyll a, cho b: chlorophyll b

From statistical analysis, results showed that the foliar spray with moringa leaf extract gave a significant increase in growth yield parameters, dry weight of straw and grain and photosynthetic pigments compared to foliar spray with marine algae extract in the two soils. This result confirmed by Merwad (2015). The aqueous extracts of leaf and twigs of moringa oleifera were foliar sprayed onto rocket plants at rates of 1, 2 and 3%. Among these concentrations, fertilizations of rocket plants with 2% leaf and 3% twig extracts potentially increased all measured growth criteria (plant height, fresh and herb weight), chlorophyll a and b, total sugars , ascorbic acid, phenols (Abdalla, 2013).

Application of fluvic acid positively affected plant growth under saline soil conditions, but higher doses of FA inhibited plant growth (Türkmen *et al.*, 2004). Young suggested that fluvic materials can affect physiological processes of plant growth directly or indirectly (Yang *et al.*, 2004). Fluvic substances might show anti-stress effects under abiotic stress conditions such as, unfavorable temperature, pH, salinity etc. Fluvic substances could improve plant growth under soil condition with enhancing the uptake of nutrients and reducing the uptake of some toxic elements (Kulikova *et al.*, 2005).

Nutrients uptake

Data presented in Table 6 show the effect of fulvic acid application and foliar sprays with moringa leaf extract and marine algae extract on straw and grain N, P and K uptake of wheat plants grown under soils reclaimed with gypsum and compost. All the values of treatments significantly increased NPK uptake as compared to control under all the soils. The highest values of straw and grain NPK-uptake were obtained with FA combined with moringa extract spray. However, non-treated plants showed the lowest NPK- uptake. Treatments could be arranged in the following order regarding the main effects FA+ MLE> FA+MAE>MLE > MAE>FA>without under different soils. Several studies have shown that fluvic substances can have a positive effect on plant growth (Arancon *et al.*, 2006). Under salt stress, the lowest doses of both soil and foliar application of fluvic substances increased the nutrient uptake of wheat (Asik *et al.*, 2009). Different part of Moringa oleifera plants have been reported to be a rich source of important minerals as Ca, Mg, K, P, S, Cu, Zn, Mn and Fe which can be valorized for a balanced nutrition of population (Yameogo *et al.*, 2011 and Moyo *et al.*, 2011).

Regarding the mean effect of using soil amendments in reclaimed soils , the data show that soils reclaimed with compost gave higher values of straw and grains NPK- uptake than the values under application of gypsum under different treatments. This result could be due to the high nutrient content and the low C/N rates in compost. This result is in agreement with that obtained by Palm *et al.*, (2001). Positive effects of organic waste on soil structure, aggregate stability and water-holding capacity were reported in several studies (Odlare *et al.*, 2008).Soil physical properties were improved after municipal solid waste compost addition. In medium and high doses, augmentations in organic matter reduced bulk density and enhanced water infiltration (Civeira, 2010).

TABLE 6. Effect of fulvic acid and foliar sprays of moringa leaf and marine algae extracts on straw and grain NPK-uptake of wheat plants under soils reclaimed with gypsum and compost

Factors of study effects		Straw N-uptake	Straw P-uptake	Straw K-uptake	Grain N-uptake	Grain P-uptake	Grain K-uptake
Amendment type effect							
Gypsum		15.23	3.02	17.06	14.08	2.89	13.28
Compost		17.65	3.81	19.03	16.02	3.95	15.57
LSD 0.05%		0.35	0.11	0.39	0.41	0.15	0.45
Foliar spray effect							
Without		8.68	1.47	11.29	7.56	1.38	8.29
FA		13.72	2.53	16.20	10.65	2.03	10.93
MAE		16.04	3.18	17.50	13.13	2.81	12.87
MLE		17.77	3.65	18.88	16.23	3.60	15.47
FA+MAE		19.78	4.34	20.63	19.20	4.53	17.49
FA+MLE		22.63	5.34	23.75	23.56	6.17	21.50
LSD 0.05%		0.60	0.19	0.67	0.71	0.27	0.78
Interaction effect							
Gypsum	Without	7.92	1.23	10.71	6.75	1.21	7.33
	FA	12.00	2.25	15.25	9.71	1.71	10.23
	MAE	15.01	2.71	16.55	12.29	2.30	11.57
	MLE	16.76	3.31	18.04	15.72	3.04	14.67
	FA+MAE	18.77	3.86	19.49	18.32	3.88	16.48
	FA+MLE	20.90	4.77	22.29	21.69	5.23	19.38
Compost	Without	9.44	1.72	11.87	8.36	1.54	9.25
	FA	15.43	2.80	17.16	11.60	2.36	11.63
	MAE	17.07	3.65	18.44	13.96	3.32	14.17
	MLE	18.77	3.99	19.72	16.74	4.15	16.27
	FA+MAE	20.80	4.81	21.77	20.07	5.19	18.49
	FA+MLE	24.37	5.91	25.22	25.42	7.12	23.63
LSD 0.05%		0.86	0.27	Ns	1.00	0.38	1.10

Yield quality and weight of 1000 grains

Data presented in Table 7 show the effect of fulvic acid application and foliar sprays with moringa leaf extract and marine algae extract on weight of 1000 grains, protein content and harvest index of wheat plants grown under soils reclaimed with gypsum and compost. All the values of treatments significantly increased weight of 1000 grains and yield quality as compared to control under all the soils. Also, the highest percentage increase in 1000 grains, protein content and harvest index of 25.81, 77.81 and 10.31%, respectively were recorded from the treatment of FA+MLE under soil reclaimed with gypsum. On the other hand, the highest percentage increase in 1000 grains, protein content and harvest index of 26.13, 63.36 and 19.96%, respectively was recorded from the same treatment under soil reclaimed with compost**.**These results are agreement with those obtained by Türkmen *et al.* (2004).

From statistical analysis, results showed that the foliar spray with moringa leaf extract gave a significant increase in protein content and harvest index compared to foliar spray with marine algae extract in the two soils. Consistent results were obtained by Culver *et al*. (2013). Moringa leaf has been purported to be a good source of nutrition and a naturally organic health supplement that used in many therapeutic ways (McBurney *et al.*, 2004; Fahey, 2005; DanMalam *et al.,* 2001). Foidl *et al.* (2001) reported that foliar spraying of some plant leaves with moringa extract produced some notable effects as overall increase in plant yield between 20 and 35% and higher sugar and mineral levels.

TABLE 7. Effect of fulvic acid and foliar sprays of moringa leaf and marine algae extracts on weight1000 grain, protein and harvest index of wheat plants under soils reclaimed with gypsum and compost

Factors of study effects		Weight of 1000 grain	protein	harvest index
Amendment type effect				
Gypsum		49.51	7.57	44.68
Compost		51.75	8.01	47.75
LSD 0.05%		0.69	0.09	0.66
Foliar spray effect				
Without		45.75	5.69	44.30
FA		47.03	6.74	42.88
MAE		48.12	7.51	44.23
MLE		50.57	8.22	46.60
FA+MAE		54.69	8.91	48.23
FA+MLE		57.63	9.68	51.03
LSD 0.05%		1.20	0.16	1.14
Interaction effect				
Gypsum	Without	44.89	5.32	43.93
	FA	46.55	6.37	41.02
	MAE	47.46	7.43	42.24
	MLE	48.90	8.17	45.29
	FA+MAE	52.77	8.70	47.12
	FA+MLE	56.48	9.46	48.46
Compost	Without	46.60	6.06	44.68
	FA	47.51	7.11	44.73
	MAE	48.78	7.60	46.23
	MLE	52.23	8.27	47.91
	FA+MAE	56.62	9.12	49.33
	FA+MLE	58.78	9.90	53.60
LSD 0.05%		Ns	0.23	1.61

FA: fulvic acid, MAE: marine algae extract, MLE: moringa leaf extract

Conclusion

A pot experiment was conducted under the greenhouse conditions at the Farm of the Faculty of Agriculture Zagazig University to try reclamation and cultivation of saline-sodic soils. Soil materials were collected from Sahl El-Tin, Sinai Governorate, Egypt. After reclamation process, the same pots were planted with wheat to study the effect of fulvic acid as soil application and foliar sprays with Moringa leaf extract and Marine algae extract as Ascophyllum nodosum onphotosynthetic pigments, yield and nutrient uptake of wheat (*Triticum aestivum* cv., Sakha 93) under newly reclaimed soils with gypsum and compost. The results of the study indicated that gypsum and compost showed a pronounced decreased in bulk density, EC, pH, SAR and ESP compared with the initial soil with superiority of gypsum on compost in reducing EC, SAR and ESP.The highest values of plant height, leaf area, chlorophyll a, b and caroteniods, yield, straw and grain NPK-uptake, 1000 grain weight and protein content were obtained with FA combined with moringa extract spray. However, non-treated plants showed the lowest one. Spraying with moringa leaf extract gave a significant increase in growth yield parameters; yield, photosynthetic pigments, NPK-uptake, 1000 grain weight and protein content compared to foliar spray with marine algae extract in the two soils. Soils reclaimed with compost gave higher values of yield, straw and grains NPK- uptake and protein content than the values under application of gypsum under different treatments.

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اتجاه لاستصلاح وتحسين خصوبة الأراضي المتأثرة بالأملاح

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أقيمت تجربة أصص تحت ظروف الصوبة بمزرعة كلية الزراعة جامعة الزقازيق في محاولة لاستصلاح وزراعة الأراضي المتأثرة بالأملاح. جُمعت عينات التربة من منطقة سهل الطينة، محافظة سيناء، مصر. تم تعبئة الأصص بالتربة التي سبق معاملتها بالجبس والكمبوست كمحسنات تربة. كان معدل إضافة الجبس والكمبوست 10.32، 20 طن للهكتار علي الترتيب. تم غسيل التربة بماء ذو درجة توصيل كهربي 1.2 ديسيسيمنز / م وقد اتبع نظام الغسيل المتقطع عند إجراء عملية الغسيل. تم حساب احتياجات الاستصلاح علي أساس حجم المسام Pore Volume (PV) وهي كمية الماء التي تملأ المسام تماماً وتصل بالأرض لحالة التشبع حيث تم غسل التربة بكمية من الماء تكافئ 1.5PV وهي تساوي 4.85 لتر من الماء. بعد الانتهاء من عملية الغسيل تم أخذ عينات من التربة المغسولة والمعاملة بالجبس أو الكمبوست وحُللت. وبعد تمام الانتهاء من عملية الاستصلاح تم زراعة نفس الأصص بالقمح لدراسة تأثير حامض الفالفيك (مُضاف للتربة) والرش بمستخلصات المورينجا والطحالب البحرية علي التمثيل الضوئي، ومحصول القمح وامتصاص العناصر الغذائية بواسطة نبات القمح (صنف سخا 93) تحت ظروف الأرض المستصلحة حديثاً بواسطة الجبس والكمبوست.

أظهرت نتائج التجربة أن الجبس والكمبوست كمحسنات تربة لهما تأثير واضح في خفض الكثافة الظاهرية، درجة التوصيل الكهربي، درجة حموضة التربة، النسبة الإدمصاصية للصوديوم والنسبة المئوية للصوديوم المتبادل مقارنة بالتربة قبل الاستصلاح مع تفوق الجبس علي الكمبوست في خفض درجة التوصيل الكهربي، النسبة الإدمصاصية للصوديوم والنسبة المئوية للصوديوم المتبادل. أوضحت نتائج تجربة الزراعة أن أعلى قيمة لطول النبات، مساحة الورقة، كلورفيل أ، كلورفيل ب، كاروتين، محصول القش والحبوب، النيتروجين والفوسفور والبوتاسيوم الممتص في القش أو الحبوب ووزن 1000 حبة ومحتوى البروتين وجد أن التربة المعاملة بالفالفيك مع الرش بمستخلص المورينجا بينما النباتات الغير معاملة أظهرت أقل القيم للصفات السابقة وأظهرت النتائج أن الرش بمستخلص المورينجا كان ذو تأثير معنوي علي كل الصفات السابقة مقارنة بالرش بمستخلص الطحالب البحرية في كلا الأرضين. كما أظهرت النتائج أيضا أن الأرض المستصلحة بواسطة الكمبوست كانت أفضل من المستصلحة بواسطة الجبس في صفات المحصول المختلفة والنيتروجين والفوسفور والبوتاسيوم الممتص فى القش والحبوب.