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Effect of Applying Some Soil Amendments and Distance between Drains on Quality and Productivity of Soybean Grown under Saline Conditions

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ABSTRACT

In summer seasons of 2015 and 2016, two field experiments were conducted at Gilbana village, east of Suez Canal, North Sinai Governorate, Egypt, to evaluate the effect of spacing between drains in open drain system and some soil amendments *i.e,* gypsum, compost and sulphur on some soil properties and soybean (*Glycine max* L. c.v Giza 35) quality and productivity under saline soil conditions.- Soil pH and soil EC slightly decreased due to the applied amendments and decreasing the space between drains from 15m to 10m.- Available macro and micronutrients under study increased due to the applied amendments under the different spaces between drains.- Proliene content significantly increased as affected by the space between drains in the following decreasing order: 15m > 12m > 10m while, addition of amendments significantly decreased proliene accumulation in the following sequence: gypsum > compost > sulphur.- Seed quality improved due to the applied amendments and decreasing the space between drains. The highest seed oil content and oil yield were obtained due to sulphur addition under 10m distance between drains while the highest protein content and protein yield were found owing to compost addition under 10m distance between drains.- Seed and pod yields as well as N, P, K, Fe, Mn and Zn uptake increased due to appling the amendments and decreasing the space between drains, however, the highest values for the seed and pod yields as well as the above-mentioned nutrients were achieved due to applying the compost and decreasing the distance between drains to 10m i.e. the treatment of compost + 10m distance between drains was superior to the other treatments. Thus, it can be recommended to plant soybean, Giza 35 under saline soil conditions after doing preliminary operations before planting and use of bio-inoculation for seeds and the use of some amendments especially compost with reducing distance between drains to 10m to counteract the salinity problem of soil. on one hand and to avoid overuse of the chemical fertilizers to minimize the potential environmental risks, which negatively affect human health on the other hand.

Keywords: Bio inoculation, drains, soybean, saline soil, soil amendments.

INTRODUCTION

Soybean (*Glycine max* L.) is very important oil and protein crop; it contains about 30% of cholesterol free oil and about 40% of protein beside some vitamins. In Egypt, soybean oil has been used as an edible oil during the past 40 years; and its extraction ratio of oil is about 20.5% (El-Agroudy *et al*., 2011). Recently, attention has been directed to increase productivity of soybean to be used as a protein source (particularly for animal feeds and oil for human food). Total production of soybeans in Egypt reached 23000 Mg in the year 2013, produced from an area of 8000 ha (FAO, 2013). Therefore, it is of great importance to increase its production. Mahmut (2011) found that the total chlorophyll contents in soybean decreased in response to salinity stress, while, proline concentration increased at high salinity.

Drainage systems are designed to remove excess water and soluble salts from agricultural soils. Yield increases of between 10-25 % can be expected depending upon the initial drainage status of the land (Jung *et al.* 2010). Reclamation of saline and saline sodic soils depends on the open drain system which is more effective than the tile drainage in the removal of salts from soil profile. Prasad *et al.* (2007) also found positive results with open sub surface drainage system in reducing the salinity of problematic soils. Arthur *et al.* (2011) found that the compost application can decrease soils pH particularly at high application rate because compost usually has neutral or slight alkaline pH buffering capacity. Rainder and Mandeep (2007) reported that application of organic matter with or without N fertilizers increased the available P, K, Fe, Mn and Zn contents in soil and attributed these increases to production of organic acids like amino acids, glycine, cystien and humic acid during mineralization of the organic materials by heterotrophs and/or nitrification by autorophs which would cause decrease in soil pH and hence increased macro and micronutrients content in soil. Beheiry and Soliman (2005) reported that addition of organic manures decreased soil salinity and attributed that to their improving effect on physical properties of the soil which in turn facilitated the leaching of salts outside from the root zone. (Arthur *et al.*, 2011) indicated that the compost application led to decrease pH of soils particularly at high application rate.

The compost can be a very good organic amendment in saline agriculture as well as for reclamation of salt–affected soils (Zaka, *et al*., 2003). Mohamed and Matloub (2007) reported that the highest reduction in the EC value was in the soil surface of soil treated with town refuse. Raafat and Tharwat (2011) found that the organic amendments improved soil properties and nutritional status even under soil salinity.

Chemical amendments have long been recognized as ameliorators of sodic soils. Many of these amendments include gypsum and sulphur, have been found to be effective in ameliorating sodicity of soil, (Sabir *et al.*, 2007; Mazhar *et al*., 2011 and Bello, 2012).

Gypsum is the most commonly used amendment in Egypt due to its availability at low cost and its efficiency in ameliorating saline-sodic and sodic soils by reducing dispersion of soil particles. So, use of $CaSO_4.2H_2O$ in the amelioration of saline soils is one way of improving global agricultural productivity due to salt stress. (Abdul Rahman *et al,* 2004). Gypsum is a moderately soluble source of plants essential nutrients, calcium and sulphur (Dick *et al.,* 2008). It can improve plant growth and improve the physical and chemical properties of soils primarily by maintaining a favorable soil solution electrolyte concentration. Upon application of gypsum to saline-sodic and sodic soils, adsorbed sodium on the soil complex is being replaced by the calcium. (Choudhary *et al*., 2011). Wong *et al.* (2009) found that both EC and ESP values significantly decreased as affected by the application of farmyard manure mixed with gypsum. Probably, due to reducing the amounts of soluble and exchangeable sodium and at the soume time increasing forms of both soluble and exchangeable calcium. Abd El-Rahman *et al.* (2012) indicated that application of 50 % gypsum mixed with 50 % compost led to decreasing, both soil pH and EC (dSm^{-1}) as well as chemically available Fe, Mn and Zn. El-Banna *et al.* (2004) mentioned that gypsum amendment could be oxidized biologically in presence of organic matter in soil to produce H_2SO_4 which react with native $CaCO_3$ to form $CaSO_4$. The addition of acidyling amendment lowers the soil pH, and hence increases the availability of some nutrients in the soil, then increasing their uptake by plants.

Sulphur is one of major nutrients essential for plant growth, root nodule formation of legumes and plant protection mechanisms. (Blake-Kalff *et al.*, 2000). Sulphur is required in similar amount as that of phosphorus (De Kok *et al*., 2002 and Ali *et al*., 2008). It is a building block of protein and a key ingredient in the formation of chlorophyll (Duke and Reisenaue, 1986).

This research was carried out to study the effect of the spacing open drains and applied some soil amendments on soil fertility and soybean productivity under saline sodic soil condition.

MATERIALS AND METHODS

In summer seasons of 2015 and 2016, two field experiments were conducted at Gilbana village, east of Suez Canal, North Sinai Governorate, Egypt, to evaluate the effect of open drain spacing system and some soil amendments *i.e,* gypsum, compost and sulphur on some soil properties and soybean (*Glycine max* L. c.v Giza 35) quality and productivity under saline soil condition. The site lies in the North-West coast of Sinai, between 32^o- 35' and 32^o – 45' E and 31^o- 00' and 31^o - 250 N. The main physical and chemical properties of the studied soil are presented in Table (1).

Table 1. Physical and chemical properties of soil of the experiment

Property Particle size distribution	Value	Property Soluble ions ($mmolc\ L^{-1}$)	Value
Clay %	12.07	Na^+	81.95
Silt %	8.49	K^+	0.83
Sand %	79.44	Ca^{++}	8.50
Textural class	Sandy loam	Mg^{++}	18.22
EC (dSm^{-1}) in soil paste extract	10.95	Cl^-	65.00
pH [Soil water suspension 1:2.5]	8.32	HCO_3^-	12.83
Organic matter ($g\,kg^{-1}$)	6.61	$SO_4^=$	31.67
$CaCO_3$ ($g\,kg^{-1}$)	94.7	$CO_3^{=}$	nil

Available macro and micronutrients ($mg\ kg^{-1}$ soil)					
N	P	K	Fe	Mn	Zn
38.98	3.69	189	2.55	1.20	0.66

(1) Extractaction of available nutrients: (P, K, Fe, Mn and Zn) by NH_4HCO_3-DTPA, and available N by KCl
(2) Texture according to the international soil texture triangle.

Seeds were inoculated with *Rhizobium radiobacter* strain (salt tolerant PGPR) biofertilizer isolated from the rhizosphere of soil of Sahl El-Tina and deposited in the Gen bank under number of HQ395610 Egypt by Bio-fertilizer Production Unit, Department of Microbiology, Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt. The experiment was a 3-factor factorial split-split plot in a randomized complete block design with three replications. The plot area was (5m width X 10 m length) divided into 5 rows with 5m length and spaced at 50 cm apart. Seeds of soybean were hand sown (2- 4 seeds/hill) using one side of the ridge in hills 20 cm apart during the first and second seasons. Main plots, were assigned to the soil amendments, i.e. gypsum, compost and sulphur. Sub-plots were assigned to spacing of the open ditches i.e. 10, 12 and 15 m distance with 80 cm depth. Sub–sub plots were assigned to the presence or absence of amendments: without and with addition. The experimental treatments were as follows:

1- Control (recommended dose of N, P and K fertilizers)
2- Gypsum at a rate of 5 Mg $fed.^{-1}$. (11.90 Mg ha^{-1}
3- Compost at a rate of 5 Mg $fed.^{-1}$. (11.90 Mg ha^{-1})
4- Sulphur at a rate of 500 kg $fed.^{-1}$. (1.190 Mg ha^{-1})
5- The previous three treatments were carried at three spacing of open ditch system i.e. 10 – 12 and 15 m with 80 cm depth in presence or absence of the amendments. All treatments of soil amendments were applied before soybean planting by 25 days.

The compost used in this study was papered from different plants residues mixed with organic farm as mentioned Nasef *et al.* (2009).The compost analyses were done according to the standard methods described by Brunner and Wasmer (1978) and the results of analyses are shown in Table (2).

Table 2. Chemical properties of the compost under study.

Moisture content %	EC $dS\ m^{-1}$ 1:10	pH 1:2.5	C %	C/N ratio	O.M	N %	P %	K %	Fe ($mg\ kg^{-1}$)	Mn ($mg\ kg^{-1}$)	Zn ($mg\ kg^{-1}$)	Cu ($mg\ kg^{-1}$)
20.5	3.66	7.85	25	14.2	43.1	1.76	0.69	1.94	229	244	96	43

Seeds of soybean (*Glycine max* L. c.v Giza 35) were sown on 20th and 25th April for the first season (2015) and second season (2016), respectively. All farming processes were carried out before planting.

All plots received nitrogen (N) at a rate of 120 kg N ha^{-1} as ammonium sulphate, AS (206 g N kg^{-1}) in three equal splits: immediately after planting as a starter, 40 and 60 day after planting. Phosphorus (P) was added at a rate of 31 kg P ha^{-1} as calcium super phosphate (67.6 g P kg^{-1}) during seedbed preparation; and potassium (K) was added at a rate 100 kg K ha^{-1} as potassium sulphate (400 g K kg^{-1}) in two equal splits 30 and 45 days after sowing. Plants were thinned at the age of 30 days from planting to obtain one plant/hill.

Methods of Analysis

Plant samples of three replicates were taken after 75 days from sowing and prepared for some vegetative growth parameters and some physiological determinations. Proline content was estimated according to the method described by Bates *et al.* (1973). At harvesting stage after 130 days from planting, the plants of the other three replicates were sampled. Each fresh plant sample was separated into straw and pods. Seeds were air- dried and oven dried at 70 C^o for 48 hr. 100 seed weight (g), pod yield (Mg $ha.^{-1}$) and seeds yield (Mg $ha.^{-1}$), Mg = 10^6 g = 1000 kg = 1 tonne were estimated. 0.4 g of each oven dried ground plant sample was digested using H_2SO_4 and $HClO_4$ mixture (4:1ml) according to the method described by Chapman and Pratt (1961). The plant content of N, P, K, Fe, Mn and Zn was determined in plant digestion using the methods described by Jackson (1973), Cottenie *et al.* (1982) and Page *et al.* (1982). Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25 (Hymowitz *et al.* 1972). Seed oil content was determined using Soxhlet method AOAC, (1990).

Soil samples were collected from the surface layer (0- 30 cm) air –dried passed through a 2 mm sieve. Total soluble salts were determined in the saturated soil paste extract. The pH was measured using a pH meter in soil suspension (1: 2.5) soil water. Available nitrogen was extracted using KCl and measured according to the modified Kjeldahal method as antlered by Page *et al.* (1982). Available phosphorous was extracted by 0.5 N sodium bicarbonate and determined calorimetrically according to Olsen s' method (Jackson, 1973). Available micronutrients were extracted using (NH_4HCO_3 DTPA) as described by Soltanpour (1985) and determined using Inductively Coupled Plasma (ICP) Spectrometry model 400.

RESULTS AND DISCUSSION

Effect of soil amendments and distance between drains on some soil properties

Soil pH and soil salinity (EC)

Data in Table 3 reveal that soil average pH values of the two studied seasons decreased slightly as compared to pH of the control due to the addition of soil amendments under different drainage spaces. Joachim and Hubert (2010) indicated that the application of gypsum ($CaSO_4.2H_2O$) to saline-sodic and sodic soils led to reducing soil pH. The decrease in soil pH could be discussed as follows: calcium ions react with bicarbonate to precipitate calcite ($CaCO_3$) and release protons (H^+) in soil solution which neutralize the hydroxide ions (OH^-) and decrease the soil pH (Rasouli *et al.*, 2013). Also, the replacement of sodium by calcium and the formation of neutral salts with $SO_4^=$ (Na_2SO_4) leached out of the soil profile can account for such a reduction in soil pH. Besides, large quantities of CO_2 have been evolved during leaching process, some of which would become soluble in soil solution giving carbonic acids (Abdel-Fattah, 2012). These results are in a harmony with those obtained by Saeed and Mahar (2007). Abd El-Kader and El-Shaboury (2013) suggested that the reduction in soil pH may be attributed to the activity of microorganisms in decomposing organic matter, so releasing organic acids which contribute to reducing the soil pH. Farook and Khan (2010) stated that, the use of sulfidic materials decreased soil pH by 0.1 to 0.2 pH units compared with the initial soils pH.

The highest decrease in soil pH occurred owing to treating the soil by sulphur under spacing of 12m between drains.

Table 3. Soil pH and soil EC (dSm^{-1}) as affected by some amendments and distance between drains.

(A)Amendment		Soil pH			Soil EC			
		Distance between drains, m (D)						
		10	12	15	10	12	15	Mean
Gypsum	*Without	8.25	8.20	8.23	8.26	9.67	10.8	9.56
	With	8.14	8.08	8.16	7.52	8.14	9.36	8.34
	Mean				7.89	8.91	10.1	8.95 a
Compost	Without	8.22	8.17	8.19	7.51	7.85	8.19	7.85
	With	8.16	8.07	8.14	5.98	6.10	7.55	6.54
	Mean				6.75	6.98	7.87	7.20 b
Sulphur	Without	8.20	8.15	8.17	7.35	7.65	8.22	7.74
	With	8.14	8.05	8.12	5.10	5.88	6.41	5.80
	Mean				6.23	6.77	7.32	6.77 c
Grand mean (D)					6.95 c	7.55 b	8.41 a	
Grand mean (E)					Without: 8.38 a		With: 6.89 b	
F-test					D: **	A: **	E: **	DxA: NS
					DxE: NS	AxE: NS		DxAxE: NS

- **(E): Effect of amendment; (A): Amendment and (D): distance between drains**

Data in Table 3 declared that a noticeable significant decrease occurred in soil salinity after soybean harvest compared with initial soil due to the effect of open ditch system spacing with or without gypsum, compost or sulphur. The effect was more pronounced due to sulphur addition at 10m drain spacing where the EC value decreased to 5.10 dS m^{-1} compared with control (8.26 dS m^{-1}) causing 38.3% reduction in EC. The studied amendments could be arranged according to effect on reducing EC, in the EC followed the order: sulphur > compost > gypsum. According to the space between drains, the reduction occurred in EC followed the order: 10m > 12m > 15m. In addition, sulphuric acid as a result of sulphur addition was capable to enhance leach ability of the base cations from the soil. The reduction in soil salinity with compost and gypsum may be due to the continuo's supply of Ca^{++} and Mg^{++} which replace the exchangeable Na^+ from soil matrix and encourage the water to flow down and leach the salts out (Aggag and Mahmoud, 2006). The application of compost to salt affected soil promotes flocculation of clay minerals, which is an essential condition for the aggregation of soil particles and consequently increases drainable pores in soil and helps salt leaching causing, decrease in electrical conductivity (Lakhdar *et al.,* 2008). At the same time, there was no significant difference among all the interaction between soil amendments and drain spacing. Shao *et al.* (2012) indicated that under the condition of drain spacing 8 m and depth 0.7 m, the soil desalination was greater.

Available macro and micronutrients in soil after harvest

Data in Tables 4 and 5 show that the mean values of available N, P, K, Fe, Mn and Zn increased due to the applied amendments and reducing distance between drains in soil. The highest values were 42.5, 4.75 and 2.99 mg kg^{-1} for available N, P and Mn, respectively due to using 10m drain spacing and compost addition. The highest content of available K was 216 mg kg^{-1} obtained when soil was treated with sulphur. As for available Fe and Zn, the highest values (7.98 and 0.88 mg kg^{-1}), respectively were observed upon using 12m drain spacing with compost addition. El-Kouny (2009) pointed out that application of elemental sulphur increased total N and availability of P and K in soil as compared with the control.

Table 4. Soil available N, P and K (mg kg^{-1}) after harvest as affected by some amendments and distance between drains

(A)Amendment		Available (N)				Available (P)				Available (K)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	37.5	38.2	35.9	37.2	3.85	3.55	3.20	3.53	189	193	180	187
	With	40.0	39.9	36.0	38.6	4.21	4.85	3.97	4.34	208	201	198	202
	Mean	38.8	39.1	36.0	37.9 b	4.03	4.20	3.59	3.94	199	197	189	195
Compost	Without	40.6	39.7	37.9	39.4	4.10	3.98	3.55	3.88	193	198	185	192
	With	42.5	40.4	39.8	40.9	4.75	4.52	3.74	4.34	214	210	199	208
	Mean	41.5	40.0	38.9	40.2 a	4.43	4.25	3.65	4.11	204	204	192	200
Sulphur	Without	40.2	39.1	36.9	38.7	4.08	3.95	3.74	3.92	198	200	193	197
	With	42.1	40.7	38.9	40.6	4.69	4.37	3.80	4.29	216	213	200	210
	Mean	41.2	39.9	37.9	39.7 a	4.39	4.16	3.77	4.11	207	207	197	203
Grand mean (D)		40.5 a	39.7 b	37.6 c		4.28 a	4.20 a	3.67 b		203	203	193	
Grand mean (E)		Without: 38.4 b		With: 40.0 a		Without: 3.78 b		With: 4.32 a		Without: 192 b		With: 207 a	
F-test		D: **	A: **	E: **	DxA: *	D: **	A: **	E: NS	DxA: NS	D: NS	A: NS	E: **	DxA: NS
		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Table 5. Soil available Fe, Mn and Zn (mg kg^{-1}) after harvest as affected by some amendments and distance between drains

(A)Amendment		Available (Fe)				Available (Mn)				Available (Zn)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	6.15	6.09	5.87	6.04	2.45	2.20	1.98	2.21	0.72	0.67	0.62	0.67
	With	7.89	7.95	6.54	7.46	2.85	2.79	2.10	2.58	0.80	0.84	0.72	0.78
	Mean	7.02	7.02	6.21	6.75 b	2.65	2.50	2.04	2.40	0.77	0.76	0.67	0.73
Compost	Without	6.91	6.22	6.10	6.41	2.56	2.43	2.10	2.36	0.69	0.64	0.58	0.64
	With	7.90	7.98	7.00	7.63	2.99	2.83	2.14	2.65	0.86	0.88	0.74	0.83
	Mean	7.41	7.10	6.55	7.02 a	2.78	2.63	2.12	2.51	0.78	0.76	0.66	0.73
Sulphur	Without	6.85	6.30	6.28	6.48	2.51	2.28	2.16	2.32	0.66	0.63	0.57	0.62
	With	7.75	7.88	7.53	7.72	2.79	2.88	2.29	2.65	0.80	0.83	0.65	0.76
	Mean	7.30	7.09	6.91	7.10 a	2.65	2.58	2.23	2.49	0.73	0.73	0.61	0.69
Grand mean (D)		7.24 a	7.07 a	6.55 b		2.69 a	2.57 a	2.13 b		0.76	0.75	0.65	
Grand mean (E)		Without: 6.31b		With: 7.60 a		Without:2.30 b		With: 2.63 a		Without: 0.64 b		With: 0.79 a	
F-test		D: **	A: **	E: **	DxA: NS	D: **	A: NS	E: **	DxA: NS	D: NS	A: NS	E: **	DxA: NS
		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Khan *et al.* (2007) reported that application of sulfuric acid was effective in enhancing the release of essential plant nutrients into the growing medi. El-Shal *et al.* (2015) found that application of gypsum and compost distances between drain increased available N, P, K, Fe, Mn and Zn contents in soil after both rice and wheat harvest. The effect of reducing distance between drains was significant onr increasing available N, P, Fe and Mn in soil , while it was insignificant available K and Zn. On the other hand, the applied soil amendments had significant effect on increasing available N and P contents in soil, while the effect was insignificant for available K, Fe, Mn and Zn contents in soil after harvest. The interaction effect between soil amendments and space between drains was insignificant on all available nutrients.

Effect of soil amendments and distance between drains on seed quality

Proliene content.

The proliene contents in seeds of soybean plants as affected by all treatments are shown in Table (6), The proliene concentration significantly increased with increasing spacing between drains as follows: 15 m > 12 m> 10 m. Applying of gypsum, compost or sulphur significantly decreased proliene accumulation in soybean seeds however followed the order: gypsum > compost > sulphur. The highest proliene content (38.9 µg/g f.w.) was obtained upon using 15m space between drains in absence of application of any amendment while, lowest value (23.9 µg/g f.w.) was found with plants treated with sulphur at 10m space between drains. Hammad *et al.* (2010) found that the proline concentration increased with increasing salinity of soil and this may be due to the accumulation of osmolytes that do not perturb enzyme functions so as to maintain continuous water absorption at the low soil water potential and preserving osmotic balance and stabilizing the quaternary structure of complex protein, membranes and many functional units like oxygen evolving complex. Gad (2005) reported that proliene content increased under salinity stress than upon addition of some amendments and that might be caused by the induction or activation of proline synthesis from glutamate or decrease in its utilization in protein synthesis or enhancement in protein turnover. Thus, proliene may be the major source of energy and nitrogen during immediate post stress metabolism and accumulated proline apparently supplies energy for growth and survival, thereby inducing salinity tolerance.

Table 6. Proliene content, oil content and oil yield of seeds as affected by some amendments and distance between drains

(A)Amendment		Proliene content (µg/g f.w.)				Oil content (%)				Oil yield (kg fed.$^{-1}$)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	35.9	34.5	38.9	36.4	18.0	17.9	17.3	17.7	133	107	83.0	108
	With	30.5	32.7	35.7	33.0	18.3	18.0	17.6	18.0	183	176	141	167
	Mean	33.2	33.6	37.3	34.7 a	18.2	17.9	17.4	17.8 b	158	142	112	137 b
Compost	Without	33.9	33.9	37.1	35.0	18.0	17.9	17.8	17.9	148	116	90.8	118
	With	24.7	28.8	34.1	29.2	18.8	18.6	18.3	18.6	194	190	179	188
	Mean	29.3	31.3	35.6	32.1 b	18.4	18.3	18.1	18.2 a	171	153	135	153 a
Sulphur	Without	32.7	33.0	36.1	33.9	18.0	17.9	17.7	17.9	146	115	88.5	116
	With	23.9	24.2	33.9	27.3	19.2	19.0	18.9	19.0	196	192	187	192
	Mean	28.3	28.6	35.0	30.6 c	18.6	18.5	18.3	18.5 a	171	153	138	154 a
Grand mean (D)		30.2 c	31.2 b	36.0 a		18.4	18.2	17.9		167 a	149 b	128 c	
Grand mean (E)		Without: 35.1 a		With: 29.8 b		Without: 17.8 b		With: 18.5 a		Without: 114 b		With: 182 a	
F-test		D: **	A: **	E: **	DxA: **	D: NS	A: *	E: **	DxA: NS	D: **	A: **	E: **	DxA: NS
		DxE: **	AxE: **	DxAxE: **		DxE: NS	AxE: NS	DxAxE: NS		DxE: **	AxE: NS	DxAxE: NS	

Nour El-Din and Salama (2006) reported that proliene accumulation is a common metabolic response of higher plants to salinity stress. Also, compost treatments decreased the proline accumulation in wheat plants grown in saline soil. Mazhar *et al*. (2011) found that proliene content decreased by using gypsum or sulphur in *Schefflera arboricola*. These results agree with those obtained by Helmy and Shaban (2013) and Siam *et al*. (2013).

Seed oil content and seed oil yield:

As shown in Table 6, seed oil content and seed oil yield increased due to addition of gypsum, compost and sulphur. The increase ranged from 17.3 to 19.2 %. The highest seed oil content and oil yield values of 19.2% and 196 kg fed-1 respectively were obtained due to sulphur addition upon using 10m distance between drains corresponding to increases of 11% and 136%, respectively as compared with the lowest values of seed oil content and oil yield, respectively. The oil content of soybean seeds in the present study is within the range of the oil content in seeds of cotton (15.0-24.0 %), as reported by Pritchard, (1991). Main effect of amendments shows the following order: sulphur ≥ compost > gypsum for both oil content and oil yield. Increasing that distance between drains led to decreased seed oil content and seed oil yield of soybean plants. Data showed insignificant effect interaction between the applied amendments and distance between drains.

100-seed weight, seed yield and pod yield:

Table 7 shows that addition of gypsum, compost and sulphur as well as the spacing between drains and their combinations significantly increased the 100-seeds weight of soybean most probably due to increasing the availability of the nutritive elements. Therefore, an increase in accumulation of carbohydrates in seed would occur and would subsequently result in an enhancement in seed weight. As for the main effect of spacing between drains on the seed weight it followed the order: 10m > 12m > 15m. The main effect of the amendments followed the descending order: compost > sulphur > gypsum. The treatment of applying compost and using 10m spacing between drains was superior to the other treatments and caused the highest increase in 100-seed weight (93%). These increases may be due basified other nutritive elements to calcium, which is very important in cell wall structure and it provides normal transport and retention of other elements as well as strength in the plant. Also, the increases in Ca and K and the decrease in Na contents result in healthy environment for plant growth. These results are in harmony with those obtained Mazhar *et al*. (2011).

The interaction between amendments t and space between drains was of insignificant effect on 100-seed weight.

Seed and pod yields:

Data presents in Table 7 show that seed and pod yields were significantly increased due to the amendments and the spacing between drains. The increases occurred upon application of gypsum might attributed to its amelorcting effect on soil properties beside of its content of calcium, which is essential for many plant functions, among which proper cell division and elongation, enzyme activity and metabolism.

On the other hand, the favorable effect of sulphur might be due to its influence on reducing soil pH, improving soil structure and increasing the availability of certain nutrients. These results agre with the findings of Sabir *et al*. (2007) and Farook and Khan (2010). The organic manure treated soil plots became more enriched nutrient, , which directly or indirectly the part in the formation of starch, protein and other biological components through their roles in the respiratory and photosynthesis mechanisms as well as in the activity of various enzymes. In addition, the organic manure, leads to improve soil physicochemical, hydrological and biological characteristics, which facilitate nutrients uptake by barley, and hence increases straw and grain yields (Hegazi, 2004).

The maximum seed and pod yields (1.03 and 1.20 Mg fed.$^{-1}$, respectively) were achieved due to application of the compost at 10m between drains. The increases over the lowest values were 115 and 82% for seed and pod yield, respectively. These results stand in well agreement with those of Ghaudhry (2001), who concluded that gypsum application to rice and wheat crops at 75% gypsum requirement enhanced the paddy and grain yield by 18 and 17%, respectively. In this regard, Farook and Khan, (2010) pointed out that the application of sulphur increased the grain yield of rice plant by 108% over the control. Jena and Kabi, (2012) went almost to similar findings.

Table 7. 100-seed weight, seed yield and pod yield of soybean as affected by some amendments and distance between drains

(A)Amendment		100-seed weight (g)				Seed yield (Mg fed.$^{-1}$)				Pod yield (Mg fed.$^{-1}$)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	18.3	16.2	14.3	16.3	0.74	0.60	0.48	0.60	0.95	0.84	0.66	0.82
	With	22.6	20.7	18.6	20.6	1.00	0.98	0.80	0.93	1.18	1.06	1.03	1.09
	Mean	20.5	18.5	16.5	18.5 c	0.87	0.79	0.64	0.77 b	1.07	0.95	0.84	0.95
Compost	Without	19.6	18.3	17.5	18.5	0.82	0.65	0.51	0.66	0.98	0.88	0.75	0.87
	With	27.6	24.6	21.4	24.5	1.03	1.02	0.98	1.01	1.20	1.15	1.09	1.14
	Mean	23.6	21.5	19.5	21.5 a	0.93	0.83	0.75	0.84 a	1.09	1.01	0.92	1.00
Sulphur	Without	18.7	17.2	15.8	17.2	0.81	0.64	0.50	0.65	0.97	0.73	0.71	0.80
	With	26.8	25.0	20.9	24.2	1.02	1.01	0.99	1.01	1.18	1.12	1.04	1.11
	Mean	22.7	21.1	18.3	20.7 b	0.92	0.83	0.74	0.83 a	1.07	0.93	0.88	0.96
Grand mean (D)		22.3 a	20.3 b	18.1 c		0.90 a	0.82 b	0.71 c		1.08 a	0.96 b	0.88 c	
Grand mean (E)		Without: 17.3 b		With: 23.1 a		Without: 0.64 b		With: 0.98 a		Without: 0.83 b		With: 1.11 a	
F-test		D: **	A: **	E: **	DxA: NS	D: **	A: *	E: **	DxA: NS	D: **	A: NS	E: **	DxA: NS
		DxE: **	AxE: **	DxAxE: **		DxE: *	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Seed protein content and seed protein yield.

Results presented in Table 8 show that protein content and protein yield of soybean seeds increased owing to the effect of spacing between drains and the amendments. The decrease in spacing between drains increased protein content and protein yield of soybean seeds. The highest increases in protein content (18.3%) and protein yield (188 kg fed.$^{-1}$) were recorded for the plants treated with compost when the distance between drains was 10m. The main effect of amendments shows increases with a descending order of: compost ≥ sulphur > gypsum. As for the effect of the distance between drains, the trend was followed the order: 10m > 12m > 15m. It is worthy to indicate that the interaction between type of amendment and spacing between drains could not affect seed protein content and yield . The integrated effect of compost and reducing spacing between drains led to increasing available nutrients for plant growth and accordingly maximized the biological yield and grain quality (Ewees and Abdel Hafeez, 2010).

Helmy and Shaban (2013) pointed out that protein content and protein yield of wheat grains significantly increased due to sulphur and gypsum addition. These results are in agreement with those obtained by Helmy *et al*. (2013). The increase in protein content and protein yield in soybean seeds due to decreasing space between drains may be attributed to the occurred decrease of soil salinity, soil pH and on the other hand the increase N and other nutrient concentration in grains.

Table 8. Protein content, protein yield and N-content of seeds as affected by some amendments and distance between drains.

(A)Amendment		Protein content (%)				Protein yield (kg fed.$^{-1}$)				N-content (%)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	15.3	15.2	14.3	14.9	113	91.2	68.6	91.0	2.45	2.43	2.29	2.39
	With	17.8	17.3	15.8	17.0	178	170	126	158	2.85	2.77	2.53	2.72
	Mean	16.6	16.3	15.1	16.0	146	130	97.5	125 b	2.65	2.60	2.41	2.55
Compost	Without	15.8	15.4	14.4	15.2	130	100	73.4	101	2.52	2.47	2.30	2.43
	With	18.3	17.8	16.1	17.4	188	182	158	176	2.93	2.84	2.57	2.78
	Mean	17.0	16.6	15.2	16.3	159	141	116	138 a	2.73	2.66	2.44	2.61
Sulphur	Without	16.0	15.6	14.7	15.4	130	100	73.5	101	2.56	2.49	2.35	2.47
	With	17.6	17.1	16.1	16.9	180	173	159	171	2.82	2.73	2.57	2.71
	Mean	16.8	16.3	15.4	16.2	155	136	116	136 a	2.69	2.61	2.46	2.59
Grand mean (D)		16.8	16.4	15.2		153 a	136 b	110 c		2.69	2.62	2.44	
Grand mean (E)		Without: 15.2 b		With: 17.1 a		Without: 98.3 b		With: 169 a		Without: 2.43 b		With: 2.73 a	
F-test		D: NS	A: NS	E: **	DxA: NS	D: **	A: *	E: **	DxA: NS	D: NS	A: NS	E: **	DxA: NS
		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Macronutrients Content.

It can be seen from the results presented in the Tables (8, 9 and 10) that N, P and K content and uptake by soybean seeds increased due to all the studied treatments. Also, the treatment consisting of compost + 10m space between drains was superior for increasing the uptake of N, P and K as compared to the other treatments. This promoting effect could be related to the supplementary effect of compost which might create favorable soil physical and chemical conditions, which affect the solubility and availability of nutrients and thus uptake of nutritional elements. Moreover, the released N is known to be an essential nutrient for plant growth and development involved in vital plant functions such as photosynthesis, DNA synthesis, protein formation and respiration (Diacono *et al*., 2013).

These results coincide with these of Abbas *et al*. (2011) and Namvar and Teymur (2013). On the other hand, the positive effect of gypsum and sulphur on reducing soil pH, improving soil structure and increasing the availability of nutrients in soil and also, improves the use efficiency of other essential plant nutrients, particularly nitrogen and phosphorus (Mazhar *et al*., 2011). These results are in a harmony with those obtained by Ali *et al*. (2008) and Haq *et al*. (2007). The individual effect of amendments was in the ascending order of compost > sulphur > gypsum for N-content, P-uptake and K-uptake; compost > sulphur ≥ gypsum for N-uptake and P-content as well as compost > gypsum > sulphur for K-content. The effect of spacing between drains followed the descending order: 10m > 12m > 15m for all nutrients under study. The highest values (30.2, 4.01 and 25.6 kg fed.$^{-1}$) for N, P and K uptake respectively were obtained owing to the addition of compost at 10m distance between drains corresponding to increase percentages of 175, 261 and 153%, respectively as compared with the control.

Table 9. N-uptake, P-content and P-uptake of seeds as affected by some amendments and distance between drains

(A)Amendment and its Effect (E)		N-uptake (kg fed.$^{-1}$)				P-content (%)				P-uptake (kg fed.$^{-1}$)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	18.1	14.6	11.0	14.6	0.26	0.24	0.23	0.24	1.93	1.38	1.11	1.47
	With	28.5	27.1	20.2	25.3	0.34	0.28	0.26	0.29	3.38	2.67	2.13	2.73
	Mean	23.3	20.9	15.6	19.9 b	0.30	0.26	0.25	0.27	2.65	2.03	1.62	2.10
Compost	Without	20.7	16.1	11.7	16.1	0.31	0.28	0.25	0.28	2.57	1.85	1.24	1.89
	With	30.2	29.0	25.2	28.1	0.38	0.34	0.30	0.34	4.01	3.53	2.89	3.48
	Mean	25.4	22.5	18.5	22.1 a	0.35	0.31	0.28	0.31	3.29	2.69	2.07	2.68
Sulphur	Without	20.7	15.9	11.8	16.1	0.28	0.24	0.20	0.24	2.32	1.57	1.04	1.64
	With	28.8	27.6	25.4	27.3	0.34	0.31	0.27	0.31	3.60	3.21	2.73	3.18
	Mean	24.8	21.8	18.6	21.7 a	0.31	0.28	0.24	0.27	2.96	2.39	1.89	2.41
Grand mean (D)		24.5 a	21.7 b	17.6 c		0.32	0.28	0.25		2.97 a	2.37 ab	1.86 b	
Grand mean (E)		Without: 15.7 b		With: 26.9 a		Without: 0.25		With: 0.31		Without: 1.67 b		With: 3.13 a	
F-test		D: **	A: *	E: **	DxA: NS	D: NS	A: NS	E: NS	DxA: NS	D: **	A: NS	E: **	DxA: NS
		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Table 10. K-content and K-uptake of seeds as affected by some amendments and distance between drains

(A)Amendment		K-content (%)				K-uptake (kg fed.$^{-1}$)			
		Distance between drains, m (D)							
		10	12	15	Mean	10	12	15	Mean
Gypsum	Without	2.34	2.31	2.10	2.25	17.3	13.9	10.1	13.8
	With	2.41	2.35	2.29	2.35	24.1	23.0	18.3	21.8
	Mean	2.38	2.33	2.20	2.30	20.7	18.4	14.2	17.8
Compost	Without	2.39	2.34	2.27	2.33	19.6	15.2	11.6	15.5
	With	2.49	2.41	2.31	2.40	25.6	24.6	22.6	24.3
	Mean	2.44	2.38	2.29	2.37	22.6	19.9	17.1	19.9
Sulphur	Without	2.33	2.25	2.20	2.26	18.9	14.4	11.0	14.8
	With	2.38	2.35	2.24	2.32	24.3	23.7	22.2	23.4
	Mean	2.36	2.30	2.22	2.29	21.6	19.1	16.6	19.1
Grand mean (D)		2.39	2.34	2.24		21.6 a	19.1 b	16.0 c	
Grand mean (E)		Without: 2.28		With: 2.36		Without: 14.7 b		With: 23.3 a	
F-test		D: NS	A: NS	E: NS	DxA: NS	D: **	A: NS	E: **	DxA: NS
		DxE: NS	AxE: NS	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

Micronutrients content and uptake

As shown in Tables (11 and 12) Fe, Mn and Zn contents and uptake values followed the same trend of the macronutrients. Hence, all treatments significantly increased Fe, Mn and Zn contents and uptake values. Jena and Kabi (2012) stated that sulphur application increased Fe, Mn, and Zn uptake by rice plants. Also, significant improvement is usually expected in the use of gypsum on saline soils as a source of both Ca and S. Bello (2012) found that the improvement in yield and nutrient content is due to the displacement of sodium by calcium and increase in nutrient use efficiency of rice crop. Sulphur fertilization enhanced the uptake of N, P, K and Zn in the plant due to its synergistic effect. Application of S fertilizer is useful not only for increasing crop production and quality of the product but also for improving conditions for healthy crop growth. These results are in a harmony with those obtained by Badr *et al*. (2002).

These increases in these micronutrients availability might be attributed to several reasons: 1) releasing of these nutrients through microbial decomposition of organic materials in soil; 2) reducing the pH of the soil making the nutrients more available; and 3) lowering the redox statues of iron and manganese leading to reduction of higher Fe^{3+}& Mn^{4+} to Fe^{2+} and Mn^{2+} and/or transformation of insoluble chelated forms of micronutrients into more soluble ions (Castilho *et al*. 1993). These results are in a harmony with those obtained by Poraas *et al*., (2008).

Table 11. Fe-content, Fe-uptake and Mn-content of seeds as affected by some amendments and distance between drains.

(A)Amendment and its Effect (E)		Fe-content (mg kg^{-1})				Fe-uptake (g fed.$^{-1}$)				Mn-content (mg kg^{-1})			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	84.5	80.2	74.4	79.7	62.5	48.1	35.7	48.8	48.9	41.3	32.1	40.8
	With	97.5	87.3	79.3	88.0	97.5	85.6	63.4	82.2	57.2	52.1	40.3	49.9
	Mean	91.0	83.8	76.8	83.9 b	80.0	66.8	49.6	65.5 b	53.1	46.7	36.2	45.3 a
Compost	Without	86.0	76.3	62.1	74.8	70.5	49.6	31.7	50.6	49.6	37.5	32.2	39.8
	With	103.1	98.5	83.0	94.9	106	101	81.3	96.0	62.4	57.0	43.1	54.2
	Mean	94.6	87.4	72.6	84.8 a	88.4	75.0	56.5	73.3 a	56.0	47.3	37.6	47.0 a
Sulphur	Without	80.5	73.5	66.1	73.4	65.2	47.0	33.1	48.4	45.7	34.2	22.1	34.0
	With	95.7	80.1	71.6	82.5	97.6	80.9	70.9	83.1	55.7	48.9	40.9	48.5
	Mean	88.1	76.8	68.9	77.9 c	81.4	64.0	52.0	65.8 b	50.7	41.5	31.5	41.2 c
Grand mean (D)		91.2 a	82.7 b	72.8 c		83.3 a	68.6 b	52.7 c		53.3 a	45.2 b	35.1 c	
Grand mean (E)		Without: 75.9 b		With: 88.5 a		Without: 49.2 b		With: 87.2 a		Without: 38.2 b		With: 50.9 a	
F-test		D: **	A: **	E: **	DxA: **	D: **	A: **	E: **	DxA: NS	D: **	A: **	E: **	DxA: NS
		DxE: **	AxE: **	DxAxE: **		DxE: NS	AxE: *	DxAxE: NS		DxE: **	AxE: **	DxAxE: **	

Table 12. Mn-uptake, Zn-content and Zn-uptake of seeds as affected by some amendments and distance between drains

(A)Amendment		Mn-uptake (g fed.$^{-1}$)				Zn-content (mg kg^{-1})				Zn-uptake(g fed.$^{-1}$)			
		Distance between drains, m (D)											
		10	12	15	Mean	10	12	15	Mean	10	12	15	Mean
Gypsum	Without	36.2	24.8	15.4	25.5	24.1	22.9	20.4	22.5	17.8	13.7	9.79	13.8
	With	57.2	51.1	32.2	46.8	32.6	30.9	25.8	29.8	32.6	30.3	20.6	27.8
	Mean	46.7	37.9	23.8	36.1 b	28.3	26.9	23.1	26.1 b	25.2	22.0	15.2	20.8 b
Compost	Without	40.7	24.4	16.4	27.2	26.7	24.4	19.5	23.5	21.9	15.9	9.9	15.9
	With	64.3	58.1	42.2	54.9	35.9	30.7	27.4	31.3	37.0	31.3	26.9	31.7
	Mean	52.5	41.3	29.3	41.0 a	31.3	27.5	23.5	27.4 a	29.4	23.6	18.4	23.8 a
Sulphur	Without	37.0	21.9	11.1	23.3	28.4	25.1	20.7	24.7	23.0	16.1	10.4	16.5
	With	56.8	49.4	40.5	48.9	34.9	31.0	24.6	30.2	35.6	31.3	24.4	30.4
	Mean	46.9	35.6	25.8	36.1 b	31.6	28.1	22.6	27.4 a	29.3	23.7	17.4	23.4 a
Grand mean (D)		48.7 a	38.3 b	26.3 c		30.4 a	27.5 b	23.1 c		28.0 a	23.1 b	17.0 c	
Grand mean (E)		Without: 25.3 b		With: 50.3 a		Without: 23.6 b		With: 30.4 a		Without: 15.4 b		With: 30.1 a	
F-test		D: **	A: **	E: **	DxA: NS	D: **	A: **	E: **	DxA: **	D: **	A: **	E: **	DxA: NS
		DxE: *	AxE: NS	DxAxE: NS		DxE: **	AxE: **	DxAxE: NS		DxE: NS	AxE: NS	DxAxE: NS	

The highest Fe, Mn and K-contents in seeds were 103, 62.4 and 35.9 mg kg^{-1}, respectively and 106, 64.3 and 37.0 g fed.$^{-1}$ for Fe, Mn and Zn-uptake, respectively these values were obtained owing to addition of compost combined with 10m space between drains which resulted in 38.6, 94.4 and 75.9% increases for Fe, Mn and Zn-content, respectively as well as 197, 318 and 278% for Fe, Mn and Zn-uptake, respectively. Statistically, the individual effect of the used amendments, followed the descending order: compost > sulphur ≥ gypsum for Fe and Mn-uptake where's the descending order: compost ≥ sulphur > gypsum for Zn-uptake. In addition, the effect of the space between drains followed the order: 10m > 12m > 15m was found true for Fe, Mn and Zn-uptake. Concerning the interaction effect between amendments and spacing between drains the effect was not significant for Fe, Mn and Zn uptake while, it was significant for Fe, Mn and Zn-content for soybean seeds.

CONCLUSION

It can be conclude that soil amendments such as compost, gypsum and sulphur proved to be beneficial to soybean growth, yield components, seed quality and nutrients content and uptake by soybean plants grown on a saline soil. Such effects were more obvious upon combination with a low spacing between drains (10 m) due to their in improving effects on properties and nutritional contents of saline soil accelerating downtrend movement of soil and hence leaching the excess soluble salts of the soil profile.

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تاثير اضافى بعض محسنات التربة والمسافة بين المصارف على انتاجية وجودة فول الصويا تحت الظروف الملحية

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أجريت تجربتان حقليتان فى قرية جلبانة شرق قناة السويس بمحافظة شمال سيناء ، مصر خلال موسمي ٢٠١٥ و ٢٠١٦ لتقييم تأثير المسافة بين المصارف لنظام الصرف المكشوف و أضافة بعض محسنات التربة (جبس ، كمبوست و كبريت) علي بعض خواص التربة وجودة وأنتاجية فول الصويا صنف جيزة ٣٥ النامي تحت ظروف الأراضي الملحية. ويمكن تلخيص أهم النتائج المتحصل عليها كما يأتي:١) أنخفض رقم حموضة التربة pH وكذلك درجة التوصيل الكهربي EC أنخفاضاً طفيفاً نتيجة تأثير أضافات محسنات التربة المستخدمة وأنخفاض المسافات بين المصارف من ١٥م حتي ١٠م.٢) أزداد تيسر العناصر الكبري و الصغري بالتربة بعد الزراعة نتيجة تأثير أضافات محسنات التربة المستخدمة والمسفات بين المصارف.٣) أزداد محتوي البرولين المتراكم نتيجة زيادة المسافات بين المصارف كما يلي: ١٥م > ١٢م > ١٠م بينما أدي أستخدام محسنات التربة إلي خفض معنوي للبرولين المتراكم كما يلي: الجبس > الكمبوست > الكبريت.٤) أزدادت جودة البذور نتيجة الأضافات المستخدمة والمسافات بين المصارف. أعلي محتوي الزيت ومحصولة تم التحصل عليهما نتيجة لأستخدام الكبريت خاصة مع مسافة ١٠م بين المصارف وكانت أعلي قيم لمحتوي البروتين ومحصولة قد وجدت عند المعاملة بالكمبوست مع مسافة ١٠م بين المصارف.٥) أزداد محصول البذور و القرون وكذلك محتوي العناصر الممتصة بواسطة البذور (ن ، فو ، بو ، حديد ، منجنيز و زنك) نتيجة لتأثير الأضافات المستخدمة والمسفة بين المصارف وأعطت جميعها أعلي قيم لها عندما تم معاملة النباتات بالكمبوست خاصة مع مسافة ١٠م بين المصارف.٦) تفوقت المعاملة (كمبوست مع مسافة ١٠م بين المصارف) علي باقي المعاملات تحت الدراسة. من النتائج المتحصل عليها يمكن التوصية بزراعة فول الصويا صنف جيزة ٣٥ تحت ظروف الأراضي المستصلحة حديثا "الملحية" بعد القيام بالعمليات الأولية قبل الزراعة وأستخدام التلقيح الحيوي للبذور وأستخدام بعض الأضافات الأرضية خاصة الكمبوست مع خفض المسافات بين المصارف إلي ١٠م لمواجهة مشكلة ملوحة التربة والإسراف في أستخدام الأسمدة المعدنية بتقليل الأثار الضارة الناجمة عن ذلك مثل التلوث الكيمائي للبذور و المخاطر البيئية الأخرى و التي تؤثر بالسلب علي صحة الإنسان وبالتالي ترشيد استخدامها مما يدعم فكرة الزراعة المستدامة.