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# EVALUATION OF OPEN DRAIN AND SOIL AMENDMENTS ON AVAILABLITY NUTRIENTS AND PRODUCTIVITY OF RICE AND WHEAT UNDER NEWLY RECLAIMED SALINE SOIL

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**ABSTRACT:** *Two field experiments were conducted in the clay saline sodic soil of the Sahl El-Hussinia Agriculture Research Station, El-Sharkia Governorate Egypt, during summer 2014 and winter 2014/2015, to study the effect of different spaces drainage of drain open system with or without soil amendments i.e. (gypsum and compost alone or together) on soil properties and fertility and rice or wheat productivity and quality. In this study either of gypsum or compost were added at 5 ton/fed as alone application and at rate of 2.5 ton/fed of each them together the effect of soil amendments treatments were carried out under three drainage space of open drain system (10, 15 and 25 m). Rice, Sakh 104 variety and wheat, Masr 2 were used as test plants. The experimental design was split plot with three replicates.*

*Results showed that application of gypsum and compost alone or in together resulted in a decreased soil pH and EC soil under (10 and 15 m) drainage space than that at space 25 m. In addition, the effect of applying soil amendments under drainage space of 10 and 15 m resulted in an increase in the soil content of available N, P, K, Fe, Mn and Zn in saline sodic clay soil compared with control.*

*Straw and grains yield of rice and wheat weight of and also, the weight of 1000 grains were significant increase as affected by soil amendments application except the straw yield of wheat where this increase was no significant. As well as, the effect of drain space system on grain yield (ton/fed) and 1000 grain (g) for wheat crop was significant increase, while straw yield, grain yield (ton/fed) and 1000 grains were no significant for rice crops.*

*In addition, all treatments under study resulted, the space of drain system alone or combined with soil amendments in an increase of the protein (%) and N, P, K, Fe, Mn and Zn concentration in grains of both rice and wheat plants with their resulted a decrease proline (µg/g.dwt) content under decrease of space drain condation.*

*The application of soil amendments (gypsum or compost alone and together under drainage space system 10 and 15 m led to improve the saline soil properties , its fertility and productivity of rice or wheat quality.*

***Key words:*** *Saline sodic Soils, soil amendments, Rice and wheat productivity, open drain space system.*

## INTRODUCTION

The South El-Husseinia plain of El-Salam canal project may be considered problematic areas. Soil salinity for the studied area before starting leaching process is very high. Soil salinity ranged between 51.7 and 58.4 dS/m with an average 55.29 dS/m. There was no difference through soil profile up to 75 cm depth for soil salinity (Boulos *et al.* 2008).

Drainage systems are designed to alter field hydrology by removing excess water from water logged soil. The American Society of Agricultural and Biological Engineers, provided scientific criteria from which guidelines are now available to determine the necessity for drain spacing which varies a 7-15 m, with 10 m being a popular distance and trencher depth is about 50 cm and width range from 20 cm to 35 cm depending on the trencher used and diameter of the drain pipe. Drainage improves farm productivity and net returns by adding productive areas without extending farm boundaries. 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 soils were used the open drain system found to be very effective in the removal of salts from soil profile. After three crop seasons, the soil pH and EC have been reduced considerably (Lakshmi *et al.,* 2003). Prasad *et al.* (2007) also reported positive results with open sub surface drainage system in reducing the salinity of problematic soils. Shao *et al* . (2012) indicated that under the condition of drain spacing 8 m the ability of desalination, controlling resalination and increasing crop yield.

The role of compost in salt-affected soils is very vital because the organic source is ultimate opportunity to improve the physical properties of such soils which have been deteriorated to the extent that water and air passage become extremely difficult in such soils. Resultantly, the water stands on the surface of these soils for weeks long. The plants when grown under these conditions often die due to deficiency of root respiration. 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). Organic amendments have a very little effect on improving soil salinity and sodicity when they are applied alone (Madejon *et al.,* 2001).

The compost application has slightly increased pH, EC, and ESP of the soil. Nevertheless, the application of compost would be expected to slightly lower the pH, EC, and ESP, Abdurrahman *et al.* (2004). Compost addition significantly increased microbial activity, expressed through the contents of the C and N biomass (Borken *et al*., 2002). Rainder and Mandeep (2007) reported that application of organic matter with or without N fertilizers was increased the available P, K, Fe, Mn and Zn contents in soil. Nasef *et al.* (2009) found that the application of compost combined with different rates of mineral N fertilizer, in general, reduced the soil pH and EC soil in both seasons of the experiment. These findings could be explained as a result of production of organic acids like amino acid, glycine, cystien and humic acid during mineralization (ammonization and ammonification) of the organic materials by heterotrophs and/or nitrification by autorophs which would have caused this decrease in soil pH and increased of macro-micronutrients content in soil.

Gypsum ($Ca_2SO_4.2H_2O$) is the most commonly used amendment due to its availability at low cost. The application of gypsum-alone has successfully reduced the EC and ESP values to 1.98 dS/cm and 6.61%, respectively. Application of gypsum-alone, beyond its inability to improve soil properties except for salinity, sodicity and pH, can even cause some of the properties to worsen during the treatment, Abdurrahman *et al.* (2004). Gypsum ($Ca_2SO_4.2H_2O$), which has been used as ameliorant in saline-sodic and sodic soils for example, has been shown to overcome most of this stress by reducing dispersion and pH. So, use of $Ca_2SO_4.2H_2O$ in the amelioration of saline soils is one way of improving global agricultural productivity due to salt stress. While there is abundant literature on the effect of $Ca_2SO_4.2H_2O$ on salt affected soils, very limited literature is available on the effect of $Ca_2SO_4.2H_2O$ on saline soils and its placement method in the soil, Joachim and Hubert (2010). Chhabra (1999) reported that in rice-wheat cropping sequence gypsum application to alkaline soil increased the yield of rice and wheat up to significant level. Chaudhry (2001) concluded that gypsum application to rice and wheat crops 75% G.R. enhanced the paddy and grain yield by 18 and 17% respectively. Ahmad *et al.* (2001), who reported that wheat yield increase noted in gypsum applied 150 and 200% G.R. Wong *et al.* (2009) found that both EC and ESP values significantly decreased with different treatments, especially with application of farmyard manure mixed with gypsum. Moustafa (2005) found that application of farmyard manure and gypsum reduced pH values in the alkali soil with maximum decrease in the upper layer (0–20 cm). These results could be attributed to the reduced amounts of soluble and exchangeable sodium and increased forms of both soluble and exchangeable calcium due to amendments' applications. Abd El-Rahman *et al.* (2012) indicated that application of 50 % gypsum mixed with 50 % compost led to decrease of soil pH and EC ($dSm^{-1}$) soil. Also, the positive effect on the amount of chemically available Fe, Mn and Zn due to application of 50% gypsum mixed with 50 % compost. This may be due to the beneficial role of organic substances on physico- chemical properties of soil such as inducing chelating agents during organic substances decomposition. Beheiry and Soliman (2005) reported that addition of organic manures decreased soil salinity and they attributed that to improving physical properties of the soil which in turn facilitate the leaching of salts outside from the root zone. El-Banna *et al.* (2004) mentioned that gypsum amendment could be oxidized biologically in presence of organic matter in soil to produce H2SO4 which react with native $CaCO_3$ to form $CaSO_4$. Note worthy, the addition of acid form amendment lowers the soil pH, with well-known effects upon the availability of some nutrients in the soil, then increasing their uptake and concentrations in plants.

Wheat and rice are important cereal crops in Egypt. They are also major cash crops for the farmers and handsome amount of foreign exchange is earned through export of rice. Thus, their role in strengthening the economy of the country may not be neglected Eletr *et al.* (2013).

Rice (*Oryza sativa*) is a staple food of million of people in Egypt and next to wheat. But it's important for Egypt as one of the most important crops cultivated in saline soil at costal area and as a soil reclamation crop. Rice is grown in Egypt in 640 thousand hectares (Production Estimates and Crop Assessment Division, FAS, USDA) and the saline soil is about 200 thousand hectares having the average yield of 7200 kg ha, Zayed *et al.* (2011).

Wheat (*Triricum aestivum* L) is staple food for more than 35 % of world population (Jing and Chang, 2003). Wheat cultivated area in Egypt 2011 was 1.28 million hectare which producing 8.4 million tons, (FAO, 2013).

The present investigation therefore is an attempt to study the evaluation of open drain species system and applied the soil amendments on some chemical and rotation of rice and wheat productivity under saline sodic soil.

## MATERIALS AND METHODS

Two field experiments were conducted in clay soil at Sahl El-Hussinia Agic. Res. Station , Center in El-Sharkia Governorate, Egypt, during summer 2014 and winter 2014/2015 respectively to study the effect of open drain spacing system and soil amendments on some soil properties and rice and wheat productivity under newly reclaimed saline sodic clay soil. Studied area was located at 31$^{o}$ 8' 12.461" N latitude and 31$^{o}$ 52' 15.496" E longitude, Eletr *et al.* (2013). The studied experiments were arranged in split plot design with three replicates. Some soil physical and chemical properties of study soil before planting were determined to methods described by Jackson (1973), Cottenie *et al.* (1982) and page *et al.* (1982). The obtained data were recorded in Table (1).

**Table (1): Physical and chemical properties of the studied soil before planting.**

| Course sand (%) | Fine sand ( %) | Silt (%) | Clay (%) | Texture | | O.M (%) | ESP (%) | $CaCO_3$ (%) |
|---|---|---|---|---|---|---|---|---|
| 4.96 | 22.82 | 26.37 | 45.85 | Clay | | 0.53 | 21.15 | 5.23 |
| pH | EC (dS/m) | Cations (meq/l) | | | | Anions (meq/l) | | |
| | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO^{-}_3$ | $Cl^{-}$ | $SO^{--}_4$ |
| 8.12 | 15.28 | 12.83 | 24.10 | 115.12 | 0.75 | 10.37 | 98.73 | 43.70 |
| Available macronutrients ($mgkg^{-1}$) | | | Available micronutrients ($mgkg^{-1}$) | | | | | |
| N | P | K | Fe | | Mn | | Zn | |
| 39.81 | 4.43 | 200 | 3.22 | | 6.55 | | 0.69 | |

The experimental treatments may be lasted as follows:

1- Control (without soil amendments).
2- Compost at rate 5 ton/fed.
3- Gypsum at rate 5 ton /fed.
4- 2.5 ton/fed compost + 2.5 ton/fed gypsum.
5- The previous four treatments were carried at three spacing of open drainage i.e. 10 – 15 and 25 m with system 80 cm depth. All treatments of soil amendments were applied before rice planting by 25 days.

The compost used in this study was papered from different plants residual and organic farm as mentioned Nasef *et al* (2009).

The compost analyses were done according to the standard methods as described by Brunner and Wasmer (1978). Compost analysis of composition is presented in Table (2).

The agricultural grade gypsum powder (90% purity) was sieved to pass through a 2 mm sieve to ensure uniformity and high solubility.

The mineral fertilizers at the recommended doses for both rice and wheat plants were used. Super phosphate (15.5 % $P_2O_5$) at a rate 300 kg /fed during soil tillage before planting. Urea as nitrogen fertilizer was added at a rate of 100 kg N /fed, in three equal doses after 21, 45 and 65 days from sowing. Potassium sulphate (48 % $K_2O$) at rate of 50 kg /fed in two equal doses at 45 and 65 days after planting for rice and wheat.

The experiments were carried out during two successive on summer season (2014) of rice (*Oryzae stiva*) Sakha 104 was sown in 10 May 2014 and wheat (*Triticum aestivum* L.) Masr 2 in winter 2014/2015 was sown in 15 November 2015.

Surface (0- 30 cm) soil sample was taken from each experimental plot after plants harvesting. Each soil sample was air –dried separately and analyzed for some chemical properties and also for its content of some available macro- micronutrients according to the methods described by Cottenie et al. (1982) and Page et al. (1982). Sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) carried out according to Abdel – Fattah (2012). Sodium adsorption ratio (SAR) estimated by using the following equation, where ionic concentration of the saturation extracts is expressed in meq $L^{-1}$.

$$SAR = \frac{Na^{\pm}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}}$$

Exchangeable sodium percentage (ESP) was estimated by using the following equation:

$$ESP = \frac{100(-0.0126 + 0.01475\ SAR)}{1 + (-0.0126 + 0.01475\ SAR)}$$

Rice plants were harvested at 25 September 2014 and wheat harvest on 5 May 2015. For both rice and straw, grains were separated from straw air –dried and oven dried at 70 $C^o$ for 48 hrs. Sample from the grains of each experimental plot was taken ground and wet digested with a mixture of $H_2SO_4$ and $HClO_2$ acids at mixed ratio of 3: 1 and left to analysis (Chapman and Pratt, 1961). Nitrogen was determined by micro Keldahl, according to Cottenie *et al.* (1982). Phosphorus was determined Spectrophotometrcally using ammonium molybdate/ stannus chloride method according to Cottenie *et al.* (1982). Potassium was determined by a flame photometer, according to Page *et al.* (1982). Fe, Mn, and Zn were determined by using Atomic Absorption (model GBC 932). Grains protein content was calculated by multiplying N (%) by 5.75 described by Hymowizer *et al*. (1972). Proline content was estimated according to the methods described by Bates *et al.* (1973).

**Table (2). Some chemical properties of different compost fertilizer used in this study:**

| pH | EC ($dSm^{-1}$) | C/N | N | P | K | Fe | Mn | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|
| | | Total macronutrients (%) | | | | Total micronutrients ($mgkg^{-1}$) | | | |
| 7.42 | 3.98 | 21.86 | 2.15 | 0.65 | 2.41 | 95.32 | 70.69 | 44.92 | 2.70 |

Obtained results were subjected to statistical analysis according to Snedecor and Cochran (1980) and the treatments were compared by using the least significant difference (L.S.D. at 0.05 level of probability).

## RESULTS AND DISCUSSION

## Soil Chemical Properties.

### Soil salinity (EC) and soil pH.

Data presented in Table (3) showed that the effect of open drainage system spacing with or without gypsum or compost on soil electric conductivity (EC) and soil pH after both rice and wheat harvest were decreased both EC and pH compared with initial soil. Also, the mean values of soil treated with gypsum, compost and compost mixed with gypsum were achieved the less EC after rice ranged from 11.16 to 9.94 $dSm^{-1}$ after rice harvest, while its ranged from 12.24 to 8.94 $dSm^{-1}$ after wheat harvest. Mean values of EC decreased significantly for all soil amendments treatments after rice and wheat harvest as compared to the control. The highest reduction in EC (50 %) over the control was obtained from gypsum or compost mixture treatment at drain spacing 10 m, where the lowest EC value was observed at gypsum alone treatments at all drain spacing. The reduction of soil salinity with compost and its mixture with gypsum may be due to compost and gypsum which allows continues supply of $Ca^{++}$ and $Mg^{++}$ and other cations. These cations led to replace the exchangeable $Na^{+}$ from soil matrix and to from new stable aggregates. These process increase by EC and encourage the water to flow down and leach the salt out (Aggag and Mahmoud, 2006). The application of compost to salt affect soil promotes flocculation of clay minerals, which is an essential condition for the aggregates of soil particles. It also, plays an important role in increasing bioprocess spaces, which increase salt leaching consequently, decreased electrical conductivity (Lakhdar *et al.,* 2008).

The addition of soil amendments decreased the soil pH compared to the control after rice and wheat harvested (Table 3). Soil pH and electrical conductivity in compared with un amendments treatments in the saline soil (Mohmoud *et al.,* 2009). Joachim and Hubert (2010) indicated that the application of gypsum ($Ca_2SO_4.2H_2O$ in saline-sodic and sodic soils led to reducing of pH. Ayub *et al.* (2007) reported that the gypsum reduced soil pH slowly from (8.5 – 7.5) in about 20 weeks. Saeed and Mahar (2007) reported that the decrease in pH by gypsum could be because of $Na^{+}$ replacement with Ca. The organic materials release organic acids which cause mobilization of the native calcium present as CaCO3 in soil after wheat harvest. Abd El-Kader and El-Shaboury (2013) suggested that the slight reducing of soil pH values may be reflecting the activity of microorganisms in decomposing organic matter, so releasing organic acid. The soil salinity decreased significantly with decreasing in drain spacing for all soil amendments treatments after wheat harvest Table (3). At same time, there is no significant difference among all the interaction between soil amendments and drain spacing. The soil salinity after rice and wheat harvest at drain spacing 10 m was higher reduction than other drain spaces. From these results it could be the increase of soil salinity (EC) reflect increasing spaces open drainage system in both rice and wheat plants. These results are in agreement by Lakshmi *et al.* (2003), Prasad *et al.* (2007) and Abd El-Rahman *et al.* (2012). Shao *et al.* (2012) indicated that under the condition of drain spacing 8 m and depth 0.7 m the ability of desalination and improving saline soil.

**Table (3). Effect of the studied treatments on soil pH, EC (dSm-1) and the content of available macro-micronutrients content in soil after rice and wheat harvest.**

| Treatments | Density between drains (m) | pH (1:2.5) | EC ($dSm^{-1}$) | Available Macronutrients ($mg\ kg^{-1}$) | | | Available Micronutrients ($mg\ kg^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | N | P | K | Fe | Mn | Zn |
| Summer ( 2014) after rice harvest | | | | | | | | | |
| Control | 10 | 8.06 | 14.01 | 47.33 | 4.99 | 216.00 | 3.12 | 7.40 | 0.97 |
| Gypsum | | 8.02 | 10.83 | 66.00 | 4.99 | 218.00 | 3.25 | 7.56 | 1.02 |
| Compost | | 8.01 | 8.00 | 71.67 | 5.09 | 226.33 | 3.57 | 7.70 | 1.07 |
| Compost + gypsum | | 8.00 | 6.91 | 72.33 | 5.16 | 233.00 | 3.74 | 7.91 | 1.13 |
| Mean | | | 9.94 | 64.33 | 5.06 | 223.33 | 3.42 | 7.64 | 1.05 |
| Control | 15 | 8.09 | 14.47 | 40.67 | 4.61 | 206.33 | 3.04 | 6.77 | 0.78 |
| Gypsum | | 8.04 | 11.85 | 59.67 | 4.78 | 214.33 | 3.25 | 7.16 | 0.89 |
| Compost | | 8.03 | 8.72 | 62.67 | 4.80 | 224.67 | 3.42 | 7.39 | 1.05 |
| Compost + gypsum | | 8.00 | 7.72 | 65.67 | 4.94 | 231.00 | 3.52 | 7.46 | 1.10 |
| Mean | | | 10.69 | 57.14 | 4.78 | 219.08 | 3.31 | 7.20 | 0.96 |
| Control | 25 | 8.10 | 14.60 | 41.67 | 4.50 | 204.00 | 3.05 | 6.80 | 0.71 |
| Gypsum | | 8.06 | 12.18 | 55.67 | 4.66 | 208.00 | 3.18 | 7.00 | 0.90 |
| Compost | | 8.05 | 9.70 | 60.00 | 4.77 | 221.33 | 3.29 | 7.03 | 1.00 |
| Compost + gypsum | | 8.03 | 8.17 | 65.00 | 4.97 | 222.33 | 3.38 | 7.08 | 1.06 |
| Mean | | | 11.16 | 55.59 | 4.73 | 213.92 | 3.23 | 6.98 | 0.92 |
| LSD. 5% density drain | | | ns | 0.33 | ns | 0.86 | ns | ns | 0.11 |
| Soil amendments | | | 1.26 | 3.61 | ns | 1.61 | 0.33 | ns | 0.14 |
| Interaction | | | ns | ns | ns | ** | ns | ns | ns |
| Winter 2014 /2015 after wheat harvest | | | | | | | | | |
| Control | 10 | 8.04 | 12.74 | 55.00 | 4.79 | 223.67 | 3.24 | 7.43 | 1.07 |
| Gypsum | | 8.00 | 8.97 | 62.67 | 5.21 | 232.33 | 3.36 | 7.65 | 1.12 |
| Compost | | 7.98 | 7.49 | 74.67 | 5.25 | 240.33 | 3.67 | 7.78 | 1.16 |
| Compost + gypsum | | 7.89 | 6.54 | 76.33 | 5.29 | 242.00 | 3.87 | 7.88 | 1.22 |
| Mean | | | 8.94 | 67.17 | 5.19 | 234.58 | 3.54 | 7.69 | 1.14 |
| Control | 15 | 8.06 | 13.60 | 45.00 | 4.78 | 213.33 | 3.11 | 6.93 | 0.67 |
| Gypsum | | 8.02 | 11.14 | 64.33 | 4.90 | 224.33 | 3.23 | 7.24 | 0.96 |
| Compost | | 8.01 | 8.73 | 63.33 | 5.01 | 226.00 | 3.51 | 7.48 | 1.06 |
| Compost + gypsum | | 8.00 | 6.90 | 72.00 | 5.05 | 241.67 | 3.55 | 7.58 | 1.17 |
| Mean | | | 10.10 | 61.17 | 4.94 | 226.33 | 3.35 | 7.31 | 0.97 |
| Control | 25 | 8.09 | 14.88 | 39.00 | 4.53 | 207.67 | 3.04 | 6.65 | 0.63 |
| Gypsum | | 8.04 | 12.73 | 57.00 | 4.61 | 215.67 | 3.13 | 7.06 | 0.92 |
| Compost | | 8.03 | 9.48 | 58.33 | 4.60 | 228.33 | 3.30 | 7.21 | 1.04 |
| Compost + gypsum | | 8.01 | 7.88 | 63.33 | 4.82 | 232.00 | 3.37 | 7.43 | 1.14 |
| Mean | | | 12.24 | 54.42 | 4.64 | 220.92 | 3.21 | 7.09 | 0.93 |
| LSD. 5% density drain | | | 1.13 | 6.64 | ns | ns | ns | ns | ns |
| Soil amendments | | | 0.99 | 5.61 | ns | 16.34 | ns | ns | 0.19 |
| Interaction | | | ns | ** | ns | ns | ns | ns | ns |

## Soil content of available macronutrients.

The obtained data in Table (3) indicated also that application of gypsum and compost under different spacing drainage system in N, P and K available contents in soil after both rice and wheat were increase with all treatments after wheat harvest than rice harvest. The available N, P and K content in soil increased with application compost, gypsum and compost mixed with gypsum under different drain spacing in soil after rice and wheat harvest (Table 3).The addition of soil amendments increased significantly the N and K as compared to the control. However, the increment of the P resulting from the addition soil amendments was not significant after rice harvest. The increase effect of drain spacing system on the soil content of available N and K content of soil were significant, while this effect on the soil content of available the P was no significant after rice harvest. The interaction between soil amendments and drain spacing on N and P contents in soil were no significant, while K was significant after rice harvested. On the other hand, the content of N available in soil was significant increase as affected by drain spacing and soil amendments alone or the interaction between soil amendments and drain space , while the content of the P available was not significant with all treatments after wheat harvest. As well as the effect of drain spacing system and interaction between of gypsum and compost on content of K available were no significant, while the effect of soil amendments on the soil content of K available in soil were significant after wheat harvest. The increase of available N, P and K in soil as affected by compost and gypsum combination was higher than that found in their individual application after both rice and wheat harvest. Monoara and Harunor (2014) suggest that the application of gypsum and rice-hull on saline soil improve N, P and K status of that soil. Also, the increase of macronutrients available in soil under low space drain system in wheat than rice under applied of soil amendments. These results are in agreement with those obtained by Sharma et al. (2000) reported that the increase of available N, P and K content in soil differently in the three drain spacing (20-50 and 75 m). Dhanushkodi and Subrahmaniyan, 2012) found that the application of compost increased the available N, P and K.

## Soil content of available micronutrients.

The data representing the soil content of available micronutrients (Fe, Mn and Zn) after rice and wheat harvesting are presented in Table (3). Statistical analysis for these data showed that the different spacing drainage system were no significant on the soil content of available Fe and Mn in soil after rice and wheat harvest, while the content of Zn in soil was significant increase after rice harvest. As well as, the content available of Zn after wheat harvest was no significant under the different spacing drainage system. On the other hand, the applied soil amendments had significantly effect on Fe and Zn contents in soil, while the available Mn content in soil was no significant after rice harvest. Also, the content of available Fe and Mn were no significantly, while the content available of Zn was significant affected by addition soil amendments after wheat harvest. The interaction between soil amendments and spacing drainage system on the soil content of available Fe, Mn and Zn were no significantly after rice and wheat harvest. The highest mean values of available micronutrients were found in the soil treated with compost together with gypsum under drainage system spacing 10 m compared with other treatments. These results are in agreement with those found by Abd El-Rahman *et al.* (2012) found that the using 50 % gypsum + 50 % compost were increase of DTPA extractable Fe, Mn and Zn in soil. This may be due to the beneficial role of organic substances on physico-chemical properties of soil such as inducing chelating agents during organic substances decomposition. Singh and Singh (2014) found that the application of gypsum had increase of Fe, Mn and Zn in saline sodic soil.

Generally, the Fe, Mn and Zn contents in soil after both rice and wheat harvested decreased with increasing drain spaces system under soil amendment treatments. The availability of all nutrients in soil remarkably improved due to application of gypsum combined with compost under less space drain system conditions.

## Plant growth.

### Straw and grains yield

Data in presented in Table (4) Show that the effect of spacing drain system on weight of straw yield (ton/fed), grains yield (ton/fed) and 1000 grains (g) were no significantly for rice plants, while the weight of grains (ton/fed) for wheat plant was significant as affected spaces drain. Also, the applied soil amendments were significant in straw and grain yield (ton/fed) of rice plants, while the found increase of weight 1000 grains (g) was no significant for rice plants. As well as, the grain yield (ton/fed) and 1000 grains (g) of wheat plants were significantly increase as affected by soil amendments application, while the found increase straw yield (ton/fed) was no significant for wheat plants. The interaction between soil amendments and different spaces drain on straw and grain yield (ton/fed) and 1000 grains (g) were no significant for rice plants, while the increase of grain yield (ton/fed) for wheat plants was significant. The high values of grain yield and straw yield (ton/fed) were found in compost combined with gypsum under space 10 m of drain system. Gypsum or compost alone caused a slight increase in rice and wheat crops yield reflected to improvement of the soil physical and chemical properties. These results are in agreement with those obtained Singh (1990) also reported that gypsum significantly increased yield of rice and wheat over control. Saeed and Mahar (2007) found that the increase of grain yield in soil treated with gypsum can be result of increase in $Ca^{++}$ availability which replaces the exchangeable $Na^{+}$ from the soil exchange complex. The organic farm applied alone increased grain yield perhaps because the organic farm increase infiltration rate of soil. Dhanushkodi and Subrahmaniyan (2012) pointed out that the application of gypsum improve soil physico- chemical environment in the root zone and lowering the pH and ESP leading to increase the rice yield.

## Chemical composition.

Effect of soil amendments and different spacing of open drainage system on prolien, Macronutrients , protein and Micronutrients content in grains of rice and wheat are show in Table (5).

The proline (µg/g dwt.) content in grains of both rice and wheat plants as affected by all treatments were showed in Table (5), these data indicated that the praline concentration was significantly increased with increase drainage space, applied of gypsum or compost alone and combined for rice plants, while the effect of all treatments on proline concentration in wheat grains were no significant, as an increase in prolien is due to increased soil salinity. These results are in agreement with these obtained Hammad *et al.* (2010) found that the proline concentration increase with increasing of saline soil. These results may be due to the accumulating 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.

Concerning, the N, P and K concentration (%) in grains of rice and wheat in saline soil treated with different drain space and applied compost and gypsum was recorded in Table (5). Data indicated that all studied treatments tended to increase of N, P and K concentration in grain as compared with control treatments. Increase of N, P and K concentration with compost application may be attributed to the mineralization of organic minerals and slow release of minerals in an available form, compost may be due to the effect of several organic acid produced. The high increase of N concentration in grain of rice and wheat in soil treated with gypsum combined with compost compared with control. In addation, the increase in P and K as affect by soil amendments were enhanced

**Table (4). Straw and grains yield and weight 1000 grains of rice and wheat plants affected by the studied treatments.**

| Treatments | Density between drains (m) | Weight of straw yield (ton/fed) | Weight of grains yield (ton/fed) | Weight of 1000 grains (g) |
|---|---|---|---|---|
| after rice harvest | | | | |
| Control | 10 | 0.982 | 0.597 | 18.22 |
| Gypsum | | 3.856 | 2.159 | 19.37 |
| Compost | | 4.189 | 2.483 | 19.85 |
| Compost + gypsum | | 4.260 | 2.761 | 20.37 |
| Mean | | 3.320 | 2.000 | 19.45 |
| Control | 15 | 0.976 | 0.576 | 17.98 |
| Gypsum | | 3.589 | 2.098 | 18.14 |
| Compost | | 3.982 | 2.377 | 18.33 |
| Compost + gypsum | | 4.123 | 2.596 | 19.64 |
| Mean | | 3.170 | 1.910 | 18.52 |
| Control | 25 | 0.659 | 0.469 | 17.52 |
| Gypsum | | 3.648 | 1.864 | 17.55 |
| Compost | | 3.721 | 1.880 | 18.14 |
| Compost + gypsum | | 3.850 | 1.953 | 18.48 |
| Mean | | 2.970 | 1.540 | 17.92 |
| LSD. 5% density drain | | ns | ns | ns |
| Soil amendments | | 0.62 | 0.36 | ns |
| Interaction | | ns | ns | ns |
| after wheat harvest | | | | |
| Control | 10 | 1.896 | 1.048 | 25.49 |
| Gypsum | | 1.953 | 1.089 | 34.18 |
| Compost | | 1.985 | 1.122 | 39.47 |
| Compost + gypsum | | 2.047 | 1.148 | 41.20 |
| Mean | | 1.970 | 1.100 | 35.09 |
| Control | 15 | 1.746 | 1.036 | 22.98 |
| Gypsum | | 1.793 | 1.135 | 30.78 |
| Compost | | 1.855 | 1.157 | 35.96 |
| Compost + gypsum | | 1.923 | 1.182 | 39.78 |
| Mean | | 1.830 | 1.130 | 32.38 |
| Control | 25 | 1.698 | 1.015 | 20.79 |
| Gypsum | | 1.731 | 1.059 | 25.78 |
| Compost | | 1.755 | 1.119 | 29.46 |
| Compost + gypsum | | 1.806 | 1.126 | 33.41 |
| Mean | | 1.750 | 1.080 | 27.36 |
| LSD. 5% density drain | | ns | 0.005 | 1.18 |
| Soil amendments | | ns | 0.003 | 1.63 |
| Interaction | | ns | ** | ns |

**Table (5). Protein, prolien and macro and micronutrients contents in grains of rice and wheat plants as affected by the studied treatments.**

| Treatments | Density between drains (m) | Protein (%) | Proline µg/g dwt. | Macronutrients (%) | | | Micronutrients (mg $kg^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | N | P | K | Fe | Mn | Zn |
| after rice harvest | | | | | | | | | |
| Control | 10 | 5.64 | 215.27 | 0.98 | 0.34 | 1.47 | 89.37 | 54.69 | 31.56 |
| Gypsum | | 7.71 | 179.36 | 1.34 | 0.41 | 1.63 | 96.71 | 57.31 | 34.63 |
| Compost | | 7.99 | 162.17 | 1.39 | 0.48 | 1.78 | 112.04 | 59.87 | 37.25 |
| Compost + gypsum | | 8.34 | 148.52 | 1.45 | 0.53 | 1.85 | 115.30 | 62.89 | 41.20 |
| Mean | | 7.42 | 176.33 | 1.29 | 0.44 | 1.68 | 103.36 | 58.69 | 36.16 |
| Control | 15 | 5.35 | 238.17 | 0.93 | 0.30 | 1.45 | 85.76 | 52.79 | 27.96 |
| Gypsum | | 6.90 | 214.00 | 1.20 | 0.38 | 1.59 | 88.93 | 54.63 | 32.55 |
| Compost | | 7.42 | 198.63 | 1.29 | 0.44 | 1.72 | 95.42 | 55.12 | 35.84 |
| Compost + gypsum | | 7.65 | 175.20 | 1.33 | 0.49 | 1.79 | 109.34 | 58.36 | 36.20 |
| Mean | | 6.83 | 206.50 | 1.19 | 0.40 | 1.64 | 94.86 | 55.23 | 33.14 |
| Control | 25 | 5.00 | 245.09 | 0.87 | 0.23 | 1.42 | 83.94 | 50.49 | 26.98 |
| Gypsum | | 6.73 | 231.96 | 1.17 | 0.32 | 1.55 | 87.83 | 53.75 | 30.14 |
| Compost | | 7.02 | 214.86 | 1.22 | 0.38 | 1.69 | 94.33 | 56.12 | 33.25 |
| Compost + gypsum | | 7.25 | 204.97 | 1.26 | 0.41 | 1.73 | 98.73 | 57.33 | 36.17 |
| Mean | | 6.50 | 224.22 | 1.13 | 0.34 | 1.60 | 91.21 | 54.42 | 31.64 |
| LSD. 5% density drain | | ns | 2.14 | ns | 0.04 | 0.005 | 3.64 | 1.13 | 1.36 |
| Soil amendments | | 1.34 | 2.46 | 0.16 | 0.02 | 0.012 | 1.92 | 2.53 | 2.35 |
| Interaction | | ns | ** | ns | ns | ** | ** | ns | ns |
| after wheat harvest | | | | | | | | | |
| Control | 10 | 7.71 | 201.93 | 1.34 | 0.42 | 1.96 | 104.23 | 60.27 | 37.59 |
| Gypsum | | 8.86 | 198.35 | 1.54 | 0.51 | 2.06 | 112.63 | 66.89 | 42.59 |
| Compost | | 9.66 | 184.97 | 1.68 | 0.58 | 2.13 | 117.25 | 70.25 | 45.38 |
| Compost + gypsum | | 9.89 | 170.38 | 1.72 | 0.63 | 2.17 | 119.23 | 73.68 | 46.28 |
| Mean | | 9.03 | 188.91 | 1.57 | 0.54 | 2.08 | 113.34 | 67.77 | 42.96 |
| Control | 15 | 7.59 | 218.36 | 1.32 | 0.38 | 1.92 | 120.40 | 58.96 | 36.85 |
| Gypsum | | 8.63 | 205.77 | 1.50 | 0.47 | 2.03 | 102.43 | 62.17 | 39.88 |
| Compost | | 9.55 | 196.14 | 1.66 | 0.53 | 2.08 | 109.85 | 64.39 | 42.17 |
| Compost + gypsum | | 9.72 | 183.12 | 1.69 | 0.59 | 2.13 | 113.58 | 68.25 | 43.62 |
| Mean | | 8.87 | 200.85 | 1.54 | 0.49 | 2.04 | 111.57 | 63.44 | 40.63 |
| Control | 25 | 7.42 | 228.34 | 1.29 | 0.37 | 1.88 | 98.76 | 54.39 | 33.96 |
| Gypsum | | 8.28 | 215.67 | 1.44 | 0.45 | 1.93 | 105.69 | 59.41 | 35.85 |
| Compost | | 9.09 | 199.66 | 1.58 | 0.49 | 1.97 | 10.9.75 | 60.85 | 36.94 |
| Compost + gypsum | | 9.37 | 185.33 | 1.63 | 0.52 | 2.04 | 112.52 | 63.71 | 39.57 |
| Mean | | 8.54 | 207.25 | 1.49 | 0.46 | 1.96 | 105.66 | 59.59 | 36.58 |
| LSD. 5% density drain | | ns | ns | 0.012 | 0.011 | ns | 1.13 | 1.99 | 2.29 |
| Soil amendments | | 0.81 | ns | 0.011 | 0.012 | ns | 3.23 | 2.30 | 1.57 |
| Interaction | | ns | ns | * | ** | ns | ** | ns | ns |

microorganisms activation which increase nutrient availability and their concentration and increasing root distribution. Statically analysis of data in Table (5) raveled that, the effect of drainage spaces system on N, P and K concentration in grains for rice and wheat plants were positive effect and significant increase of P and K, while the found increase with N concentration was no significant in grains for rice plants. As, well as the increase of N and P concentration in grain for wheat were significant , while K concentration was no significant as affected by different drainage space system. With respect to concentration of N, P and K for rice and wheat grains, generally, results indicated that the application of different soil amendments gave a significant increase in N, P and K concentration in grains for rice plants and this increases in N and P concentration in grain for wheat plants were significantly than K concentration in grains was no significant for wheat. The interaction between soil amendments and space of drain system effect on N and P concentration in grains were no significant , while this effect on K concentration in rice grins was significant, but the effect on N and P concentration in wheat grains and this effected was no significant with K concentration. The application of gypsum and compost together increased N, P and K concentration in both rice and wheat grains. On the other hand, the same interaction treatments were associated by significant. Yaduvanshi and Sharma (2008) found that application farmyard manure with chemical amendment increased wheat yield and N, P and K uptake in grain. Izhar *et al.* (2007) suggested that the gypsum alone or combined with organic farm helped improve P and K uptake in wheat plants.

These data show that, the increase effect of decrease in spaces drain system on protein (%) content in grains rice and wheat was no significant, while the soil amendments gave a significant increase for both rice and wheat grains. The interaction between space of drainage system and soil amendments on protein (%) content in grains of rice and wheat were no significant. The highest values of protein (%) content in grains of rice and wheat were found in the plant grown on the soil treated with compost or gypsum alone or together under spacing at 10 m than control. These results are in agreements with these found Mahmoud *et al.* (2006) found that crud protein content in wheat was increased by application of 75% of N with 25% composting rice. Generally, the increase of protein content in grains of rice and wheat reflect to decrease space density drainage system attributed to decrease of saline soil, soil pH and increase of N concentration in grains of both crops.

Data presented in Table (5) showed that the effect of different drainage spaces with or without gypsum, compost alone and combined on Fe, Mn and Zn concentration in grains of rice and wheat plants were affected significantly. The interaction between drainage spaces system and soil amendments have no significant affect on Mn and Zn concentration in grains of rice and wheat plants, while concentration Fe concentration in grains of rice and wheat plants was significant. The highest content of Fe, Mn and Zn (mg $kg^{-1}$) in rice and wheat grains as affected by soil amendments (2.5 ton /fed gypsum + 2.5 ton/fed compost) combined with space drainage system, followed by compost > gypsum > control. These results are in agreement with those found Soheil et al. (2012) reported that the applying compost to soil increases Fe, Mn and Zn absorption by plants. Izhar *et al.* (2007) reported that the gypsum applied alone or in combination with organic manure was improving Fe uptake and increase of Zn concentration. It might be due to the fact that organic manure and gypsum tends to lower the soil pH led to the solubility of Zn.

## Conclusion

It may be conclude that soil amendments such as gypsum and compost proved to be effective, especially when used combination and low space drain (10 m) in improving properties of saline soil under rice and wheat productivity. It can use open drain ditches in combination with gypsum and compost to overcome the slow water movement and accelerate the leaching salt.

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# تقييم مسافات الصرف المكشوف ومحسنات التربة على تيسر العناصر وانتاجية محصولى الأرز والقمح فى الاراضى الملحية المستصلحة حديثا

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## الملخص العربى

أجريت تجربتين حقليتان فى ارض طنية ملحية صودية فى محطة بالبحوث الزراعية بسل الحسنية – محافظة الشرقية اثناء الموسم الصيفى ٢٠١٤ والموسم الشتوى ٢٠١٥/٢٠١٤، لدراسة تقيم مسافات الصرف المكشوف منفردا او متداخل مع محسنات التربة (جبس وكمبوست منفردين او متحدين) تحت ظروف ارض طينية ملحية صودية على خصوبة التربة وانتاجية محصول الارز والقمح.

وكانت المعاملات ، كنترول بدون محسنات تربة – ٢– اضافة ٥ طن /فدان كمبوست – ٣– اضافة ٥ طن /فدان جبس – ٤– اضافة ٢.٥ طن للفدان كمبوست + ٢.٥ طن جبس زراعى تحت ظروف ثلاث مسافات من الصرف المكشوف ( ١٠– ١٥– ٢٥ متر ) . استخدم تقاوى الأرز صنف سخا ١٠٤ والقمح صنف مصر ٢. قسمت التجربة قطاعات منشقة مرة واحدة مع ٣ مكررات.

اظهرت النتائج : اضافة الكمبوست او الجبس منفردين او متحدين الى انخفاض درجة ملوحة التربة و حموضة التربة ( EC and soil pH) تحت ظروف مسافات الصرف المكشوف (١٠ و ١٥ متر ) بالمقارنة بالكنترول و المسافة ٢٥ متر.

اضافة محسنات التربة المدروسة ومسافات الصرف المكشوف (١٠ و ١٥متر) ادت الى زيادة فى تيسر العناصر النتروجين – الفوسفور– البوتاسيوم– حديد– ومنجنيز – والزنك فى التربة الطنية الملحية الصودية بالمقارنة بالكنترول بدون محسنات تربة.

كذلك وزن محصول القش والحبوب بالطن لكل فدان لكلا المحصولين (الأرز – والقمح) زاد زيادة معنوية بتاثير المحسنات لمحصول الارز بينما محصول القش فى القمح كان غير معنوى.

كان لتاثير مسافات الصرف المكشوف على محصول الحبوب بالطن لكل فدان و ١٠٠٠ حبة (جم) لمحصول القمح تاثير معنوى بينما محصول القش والحبوب بالطن للفدان و ١٠٠٠ حبة كان تاثير الصرف غير معنوى مع محصول الأرز.

من ناحية اخرى وجد ان تاثير مسافات الصرف المكشوف منفرد او متحد مع محسنات التربة ادت الى زيادة فى نسبة البروتين (%) و تركيز النتروجين – الفوسفور– البوتاسيوم– الحديد والمنجنيز والزنك فى حبوب كلا من الارز والقمح . لوحظ ان زيادة المسافات بين المصارف ادت الى زيادة فى محتوى البرولين فى كلا المحصولين تحت استحدام محسنات التربة منفردة او متحدة.

من النتائج السابقة نوجز ان اضافة محسنات التربة متحدة او منفردة مع مسافات صرف ١٠ او ١٥ م بين المصارف ادى الى تحسين صفات الأرض الطنية الملحية الصودية وزيادة انتاجية محصولى الأرز والقمح.