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IMPACT OF IRRIGATION WATER SALINITY ON GROWTH, YIELD AND ELEMENTAL COMPOSITION OF BARLEY UNDER SOME SOIL AMENDMENTS APPLICATION IN A NEWLY RECLAIMED SOIL

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ABSTRACT

A field experiment was conducted on a newly sandy loam soil at Dina Farm (Menofiya Governorate, Egypt) to study the effect of different levels of saline irrigation water, i.e., 400, 1500, 3000 and 4500 mg/l in the presence of combined rates of farmyard manure (FYM) and sulphur mixed with fertilizers (SMF) on growth parameters, yield, and elemental composition of barley plants (*Hordeum vulgare*) .

Results indicated that , barley growth parameters and its yield showed a gradually significant decreases with increasing the salinity levels of irrigation water . Also,the NPK contents of barley straw and grains were decreased,while a pronounced increase was found for Na level .A parallel trend was noticed for micronutrients of Fe, Mn, Zn and Cu concentrations and uptake by barley straw and grains , also their values showed, in general, relatively decreases with the progressive levels of salts in irrigation water in treated and /or untreated soils with the used amendments .

The interaction effects between the used amendments (combined FYM and SMF) and salinity levels of irrigation water showed a markedly increases for N , P, K , Fe, Mn and Zn contents,while Na exhibited a slightly decrease .It seems that the previously increases are largely depend on the used rate of FYM regardless the rates of SMF which appear their beneficial effects at rate of 0.5 ton /fed. supported by the highest rate of FYM (20 ton / fed.) specially under 3000 and 4500 mg /l salts in the irrigation waters.

Generally, a similar trend was noticed for the nutrients uptake under consideration,as previously mentioned for their concentrations, parallel to the obtained trend of dry matter weights of both straw and grains yields . Moreover, applying the combined FYM and SMF led to decrease the hazardous effects of irrigation water salinity,consequently a favorable effect on enhanced the availability of macro and micronutrients for supporting growth and yield of barley plants grown on the studied newly sandy loam soils .

INTRODUCTION

The use saline water in agriculture was under taken only after 1950, since the shortage sources of available good water for the newly cultivated and reclaimed land (Gupta,1990) especially in Egypt for increasing the agriculture products with increasing population. The higher yields may be obtained by using saline water and some times even the quality of produce may be better , depending upon the tolerance of the crop , soil amendments management and agro-climatic condition .However , the use saline water for irrigation caused negatively affects for many soil properties such as related to pH, ions exchange equilibrium and salts concentrations (Wilcox and Durrum, 1967). The levels of soil fertility in relation to plant nutrition under using saline water are not often . In this respect. El-Gala *et al.* (1989) suggested that the use of saline irrigation water slightly decreased the K, P and SO_4 in barley plants, while a pronounced increase was found for Na level , furthermore ,

the Fe, Mn, and Zn in dry matter yield were clearly increased as result of increasing sulphur application rates at any level of salinity . The increase in chemically available –P and P-uptake in S-treated calcareous soils was emphasized by Khater (1981) .

Amer *et al.* (1993) reported that the extractable –Mn significantly increased from sandy soil treated by organic manure and poly vinyl alcohol under highly saline water . Bayoumi *et al.* (1997) mentioned that the K, Ca and Zn concentrations and uptake of barely grains were decreased with increasing salinity level than 600 ppm in irrigation water .For sugar beet , the yield was significantly increased in accordance with rates of both residual sulfur and /or organic manure under EC 9.5 dS/m of irrigation water (Hashsem *et al.* 1997) Also , El-Tapey and Hassan (2002) found that the specific effect of SO_4 ions on decreasing soil pH , enhanced the availability of Zn and consequently Zn uptake by sudan grass and sunflower under salinity stress . Abdel-Aziz (2004) reported that the progressive levels of salts in irrigation water more than 5.58 dS/m were significantly decreased the dry matter yield of barely plant after 45 and 90 days from sowing , while Mn and Zn concentrations in barley shoots and seeds were increased .

This work was carried out to asses the effect of different salinity levels of irrigation water in the presence of some mixtures of soil amendments on growth behavior , yield and elemental composition of barley in the newly reclaimed sandy loam soils .

MATERIALS AND METHODS

A field experiment was carried out on a newly sandy loam soil at Dina Farm (Menofiya Governorate , Egypt) in wide scale representing five feddan during 2004 season by using different levels of artificial saline irrigation water prepared by dissolving natural salt crust collected from Rashid region (Baheira Governorate) in well water (400 mg/l) in tank 40 m^3 capacity contacted by five valves line of sprinkler irrigation system (one line for each saline water treatment / fed.). The obtained concentrations were adjusted using EC meter for each irrigation water sample and namely 400,1500, 3000,4500 mg /l . Also , four combined rates of farmyard manure (FYM) and sulphur mixed with fertilizers (SMF) were used as follows : a- 0.0 (control) . b- 10 ton /fed of FYM + 0.25 ton /fed of SMF. c- 10 ton /fed of FYM + 0. 5 ton /fed of SMF . d- 20 ton /fed of FYM + 0.25 ton /fed of SMF. e- 20 ton /fed of FYM +0.5 ton /fed of SMF . Soil plots were treated by both FYM and SMF before tillage ,then irrigated and left two week before sowing as an incubation period .

The plots were received 2500 m^3 of irrigation water / fed. Also, fertilized with ammonium nitrate (33.5 % N) at the rate of 60 kg / fed was applied at three equal doses (at 15, 30 and 60 days from planting) . Superphosphate (15.5 % P_2O_5) at the rate of 31 kg / fed. was added before planting with FYM and SMF .Potassium sulfate (48 % K_2O) at the rate of 48 kg /fed was applied at three equal doses at the same period of nitrogen application . Barley grains (*Hordeum vulgare*) variety bayot with a rate of 60 kg / fed. were sowing . The experiment was laid out in a split plot design, with three replicates . Plot area was 350 m^2 approximately 1/12 fed.

Five soil samples 0-30 cm were randomly collected from the experimental area and subjected to some physical and chemical properties according Piper (1950) , Jackson (1973) and Soltanpour (1985) **,** the obtained data are shown in Table (1). Saline water and the used amendments samples were analyzed for some chemical characteristics according to the previously said ,and data are given in Table (2 and 3) .

After 120 days from planting twenty plants were randomly chosen from each plots for recording the dry weight of shoot and root

At harvest stage after 150 days from sowing , the biological yields were recorded, also some parameters were taken as follows: 1- Grain numbers/ plant. 2– Plant numbers /m^2. 3– Grains weight (g)/plant. 4– Hundred grains weight (g) . 5 – grains weight (g) / m^2 .

The straw and grains of barley plant at harvested were dried at 70 C^0 and ground . The representative portions were wet digested using $HClO_4$ and H_2SO_4 according to Piper,(1950).Total N, P, K, Fe , Mn , Zn and Cu in plant , water and amendments samples were determined using the atomic absorption(Model Philips pu 9100). Data were statistically analyzed according to Sendcor and Cochran (1980) through microstate package of computer program.

RESULTS AND DISCUSSION

1 - Evaluation studies for growth and yield of barley plants .

1.1 – Growth behavior .

Barley growth behavior can be evaluated through different expression of some parameters according to literature cited,i.e. grains number on plant , plant number /m^2 , the weight of hundred grains weight (g) , grains weight / m^2 , shoot and root weight (g/plant) and shoot / root ratio .

Data presented in Table (4) showed that the grains number on plant significantly decreased with increasing salinity level from 400 to 4500 mg / l. for irrigation water without amendments additions, possibly due to the harmful effect of salts stress on plant growth . On the other hand, a slightly increased was obtained at the rates of combined FYM and SMF treatments under all salinity levels of irrigation water , especially 20 ton / fed of FYM and 0.5 ton/ fed of SMF. Data also showed that the plant number / m^2 were significantly increased with increasing the rate of FYM from 10 to 20 ton / fed. regardless the quantity of SMF, which caused slightly increase for the values by increasing SMF rate from 0.25 – 0.5 ton / fed under the same rates of FYM at all levels of salt in irrigation water. Also, a similar trend was observed for each of grains weight (g) /plant, hundred grains weight (g) and grains weight (g)/ m^2. This exception under the high rate of FYM could be attributed to its benefits effect on soil properties such as increasing S-bacterial counts . In this respect , Hashem *et al.* (1997) found that the higher counts of S-oxidizing bacteria in the plots where residual sulphur was found in combination with organic matter .

Concerning the shoot and root weight (g /plant) after 120 days from planting and their shoot root ratio, data in Table (4) showed that increasing salinity levels of irrigation water than1500 meg / l. consistently decreased the dry mater yield of both shoot and root weights particularly root dry matter yield.

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This case reflected on the shoot / root ratio , which increased with progressive concentration of salts in irrigation water . Similar variations in barley plant parts under the same conditions were also reported by Amer *et al.* (1993) and Khalil *et al.* (1999) .So , the hazard effects of the higher salts concentrations of irrigation water were increased the osmotic pressure in root media and / or due to the accumulation of Na^+ and Cl^- in the root plant , which caused toxic effects (Gupta , 1990 and Abdel-Aziz , 2004) . As a general trend , a significantly pronounced increased was obtained for these plant parameters as a results of applying combined rates of FYM and SMF, due to improving soil properties , i. e. lowering soil pH , nutrients availability and water balance as well as prevent toxicity damage for plant growth.

1.2 – Grains and straw yields of barley plants.

The results obtained from Table (4) confirm that the increase in the applied combined FYM and SMF rates, especially , at the highest rate of 20 ton FYM /fed was significantly increased the grains and straw yields under 3000 and 4500 mg /l. salts in irrigation water . However , the percentage increased relative to control for grains and straw yields were (61.6 and 71.0 %) , (58.9 and 62.5 %) , (47.3 and 42.9 %) and (16.2 and 23.5 %) under 400 , 1500 ,3000 and 4500 mg / l. of salts in irrigation water at the rate of 20 ton of FYM and 0.5 ton SMF per feddan .

Undoubtedly , the response to combined farmyard manure and sulphur mixed with fertilizers under the applied salinity levels of irrigation water is important for improving the physico-chemical and biological properties of the newly reclaimed sandy soil. Consequently, parley plants grown on a favorable soil media and yields will have a good environmental conditions and more tolerance for salinity stress to grow well and more productivity .

2- Evaluation studies for some nutritional elements of barley plants.

2.1 – Macronutrient concentrations and uptake .

Presence of salinity in irrigation water is well known to have negatively effects on nutrients concentrations and uptake by plant organs . In General, data in Table (5) showed that increasing water salinity levels in the present of FYM and SMF was associated with a marked improvement in the NPK status for both straw and grains of barley plants . However , the higher values of N- concentration and uptake for straw and grains were 1.7 % & 18.02 kg /fed. and , 1.93 % & 45.5 kg /fed. at 20 ton /fed of FYM and 0.5 ton /fed of SMF , respectively , under 400 mg /l of salts in irrigation water . While the lowest corresponding values were 0.72 % & 2.45 kg fed. , and 0.81 % & 6.97 kg /fed , respectively , under 4500 mg /l. salts in irrigation water . In this respect, Hashem *et al.* (1997) reported that the application of organic manure mixed by residual sulphur has greatly increased the counts of nitrogen fixing bacteria namely ; *Azotobactre sp., Azospirillum sp. and Clostridia sp*.

Concerning the P and K concentrations and uptake by straw and grains , results in Table (5) showed that their values were significantly increased with the progressive amendments additions, particularly under the high rate of SMF which was 0.5 ton /fed. The favorable effect of sulphur mixed with fertilizer on reducing soil pH , EC and soluble ions may be due to

its transformation to sulfuric acid along with increasing the infiltration rate of the soil (Alawi *et al.*, 1980) , beside the possible released phosphate ions from soil colloids by sulfate ions (El-Gala *et al.*, 1989) . In addition , the SMF contain some plant nutrients (Fayed , 1998) and as shown in Table (2) . Such conditions well be enhanced the availability of macronutrients for barley uptake.

Also it has been noticed in Table (5) that the opposite trend was noticed for sodium concentrations in barley straw and grains,which significantly increased with progressive levels of salinity in irrigation water till 4500 mg /l due to its concentration in irrigation water as shown in Table (2) . While, under the progressive studied rates of amendments , Na was significantly decreased in barley straw and grains, this may be due to buffering capacity of FYM under this condition .On the other hand , the highest sodium uptake by straw and grains of barley plants were showed at 1500 mg /l salts in irrigation water in the present of all treatments of FYM and SMF as a constant trend . This case may be due to the adjustment of osmotic pressure by barley plants under this level of salinity of irrigation water . This agrees with results of Besford (1978) , Gorham *et al.* (1985) and Gawish *et al.* (1999) whose suggested that,osmotic adjustment of halophytic chenopdiaceae was achieved mainly by accumulation of high levels of Na in the shoot plants .However , farther increase in salinity levels than 1500 mg /l, the Na-uptake by straw and grains of barley plants were gradually decreased due to the harmful effects of Na concentrations on root media , and consequently decreasing the dry matter yield .

2.2 – Micronutrient concentrations and uptake .

In general, data in Table (6) showed relatively decreases for Fe, Mn, Zn and Cu concentrations and uptake by barley straw and grains with the progressive levels of salts in irrigation water either in the untreated soils or treated ones with the used amendments . This results could be attributed to the nutrients unbalance that may be resulted from the effect of salinity on micronutrients availability and /or may be caused by physiological inactivation of a given nutrients, resulting in an increase in the plants internal requirement for that essential elements (Pessarakli , 1994) .

Noteworthy, that the Fe, Mn, Zn and Cu concentrations and uptake by barley straw and grains were significantly increased at the rate of 10 ton /fed of FYM and 0.5 ton /fed of SMF under the low salinity level of irrigation water (400 mg/l). Farther that, progressive increases were pronounced in their values with increasing the rate of FYM (20 ton / fed) . This reflects the relative beneficial effects of FYM and SMF on improving the fertility statues of sandy soil , might be quickly oxidized to sulfuric acid which in turn lowered the pH values (Hashem *et al.* 1997, Fayed, 1998, El-Tapey, 1998 and El-Tapey and Hassan, 2002), therefore, more availability and slow release during growth season of micronutrients under salinity irrigation water. Generally, almost similar trend was obtained for micronutrients uptake as found for dry matter yield of straw and grains.

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Lastly, from the present study it can be concluded that the grown barley crop in the newly reclaimed sandy soil under high level of salinity irrigation water depends on the rates of combined farmyard manure and sulphur mixed with fertilizers as well as the efficiency of sulphur depend on the rate of applied organic matter .

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تأثير ملوحة مياة الرى على النمو، المحصول و التركيب العنصرى للشعير تحت ظروف إضافة بعض محسنات التربة فى أرض حديثة الاستصلاح

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معهد بحوث الأراضي و المياه و البيئة – مركز البحوث الزراعية

أجريت تجربة حقلية على أرض حديثة الاستصلاح ذات قوام رملى طمى بمزرعة دينا (محافظة المنوفية – مصر) ، تهدف إلى دراسة تأثير مستويات مختلفة من ملوحة مياة الرى (٤٠٠ ، ١٥٠٠ ، ٣٠٠٠ و ٤٥٠٠ مجم /لتر) فى وجود نسب مختلفة لمخلوط كل من السماد البلدى و الكبريت المحسن بالعناصر الغذائية على النمو ، المحصول و محتوى نبات الشعير من المغذيات الكبرى و الصغرى .

و تشير النتائج إلى أن زيادة ملوحة مياة الرى قد أدت إلى أنخفاض معنوى و تدريجى فى مقايس النمو مثل عدد الحبوب على النبات ، عدد النباتات / م٢ ...الخ و كذلك محتوى كل من القش و الحبوب من المغذيات الكبرى (النتروجين ، الفوسفور و البوتاسيوم) ، بينما زاد تركيز المحتوى من عنصر الصوديوم . كما أظهرت قيم تركيزات و أمتصاص العناصر الصغرى ممثلة فى الحديد ، المنجنيز ، الزنك و النحاس نقص نسبى وذلك بالزيادة التدريجية لملوحة مياة الرى سواء فى حالة عدم أو أضافة محسنات التربة تحت الدراسة .

أظهرت نتائج التفاعلات المتبادلة بين كل من محسنات التربة المستخدمة وملوحة مياة الرى وخاصة تحت تركيز ٣٠٠٠ و٤٥٠٠ مليجرام / لتر إلى ذيادة معنوية للقيم سابقة الذكر بينما أنخفض تركيز عنصر الصوديوم فى القش و الحبوب لنبات الشعير . وجدت أعلى القيم المتحصل عليها تحت المعدل المرتفع لمخلوط السماد البلدى والكبريت المحسن (٢٠ طن سماد بلدى و ٠,٥ طن كبريت محسن للفدان). وعموما فأن قيم العناصر الكبرى و الصغرى الممتصة بواسطة محصولى القش و الحبوب لنبات الشعير قد أخذت أتجاة موازى لقيم الوزن الجاف لكلا المحصولين .

ويمكن القول أن أضافة مخلوط السماد البلدى و الكبريت المحسن بالعناصر الغذائية قد قلل من التأثير السلبى لملوحة مياة الرى وأن تأثير المادة العضوية بالمعدل المرتفع كان لة التاثير الأكبر فى ذلك بغض النظر عن معدل الكبريت المحسن والذي يظهر تأثير الأيجابى عند معدلة المرتفع بزيادة معدل السماد البلدى و ذلك لاستفادة نبات الشعير من العناصر الكبرى و الصغرى في الأراضي الرملية الطميية حديثة الأستصلاح تحت الدراسة .