Effects of Zeolite, Compost and Unisal on Growth and Elemental Composition of Barley (*Hordeum sp.*) Plants Irrigated With Saline Water

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ABSTRACT

Soil salinity is a major abiotic factor limiting crop production but an amendment with compost, zeolite or unisal may mitigate the effects of salinity stress on plants. The objective of the present study was to determine the effects of compost, zeolite and unisal on growth of barley plant irrigated with diluted seawater. Barley was the grown on a calcareaus soil treated with compst, zeolite and unisal at the rates of 0 , 4, 8 and 12 % and irrigated with seawater diluted to electrical conductivity (EC) levels of 2.5, 5.0 and 7.5 dS m^{-1} while tap water was as the control (EC = 0.44 dS/m. Irrigation with 5.0 and 7.5 dS m^{-1} saline waters significantly suppressed fresh and dry weight of barely plants. However, a substantial increase in plant biomass of salt stressed barley was observed with the three amendments followed the order, compost > unisal > unisal. The application of compost, zeolite or unisal also enhanced K^+, Ca^{+2} and Mg^{+2} absorption and decreased Na^+, $Cl^-$and $SO4^=$ in barely shoot. Post-harvest soil analysis showed high EC values of soil due to saline water irrigation but concentrations were lower in soils treated with the tested amendments especially zeolite. The overall results indicated that soil amendment with compost or zeolite could effectively ameliorate salinity stress and improve nutrient balance barley plant grown on a calcareous soil.

Keywords: barley, saline water, zeolite, soil salinity, compost, unisal.

INTRODUCTION

The demand for fresh water is increasing worldwide due to increasing population growth and improvement in living standards. Conflicts between water use for irrigation and other uses have created interest in exploring the use of sea and other recyclable sources such as wastewater. However, use of poor quality water for irrigation may lead to soil salinity and its associated problems.

Accumulation of salts in the root zone affects plant performance through creation of water deficit and disruption of ion homeostasis (Munns, 2002) which in turn cause metabolic dynamics functions. These stresses change hormonal status and impair basic metabolic processes (Munns, 2002; Loreto *et al*., 2003) resulting in growth inhibition and reduction in yield (Mass, 1993).

Irrigation management practices aim for the efficient use of saline water by maintaining salt accumulation in the root zone at lower levels and cultural practices may dramatically improve the performance of crops in saline environments. Soil permeability problems may be prevented or corrected by using soil or water amendments.

Synthetic zeolite produced from coal ash is a beneficial soil amendment because it enhanced the absorption and retention of plant nutrients and water and supplemented micronutrients (Burriesci *et al*., 1984). Since calcium ion plays vital nutritional and physiological role in plants, the restricted plant growth due to effects of specific ion or Na^+/Ca^{+2} imbalances may be ameliorated using Ca-type zeoilte. Reviewing the literatures showed that other types of soil amendments such as apatite, and compost are being considered to reduce salt accumulation in the root zoon. Barley is an important salt tolerant cereal crop grown under various climatic, soil and water conditions. Thus, it is more amenable to irrigation with saline water than most crops. However, excessively saline water may hinder its growth and yield. We are not aware of studies into the use of such soil amendments to mitigate the impacts of low-quality (saline) water on the productivity of agricultural crops.

The objectives of this study, therefore, were thus to investigate the effects of zeolite, compost and new material called "unisal" on the growth and elemental composition of barley plant grown on calcareous soil and irrigated with saline water, and on the accumulation of salts in soil.

MATERIALS AND METHODS

Used Soil:

Calcareous soil sample was collected from the upper layer (0- 15) at El-Zhoor village (Banger El-Sokar region). The soil was analyzed using the methods described by Page *et al*. (1982). Some physical and chemical properties of the soil are presented in Table 1.

Used amendments:

Three amendments were used in this study namely compost, zeolite and unisal. The compost sample, which in such a way is representative of the compost produced in Egypt, was analyzed according to Page *et al*. (1982). The chemical properties of the used compost are

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presented in Table 2. The second amendment (zeolite) was obtained from a deposit located in Germany with particle size <45 µm and its characteristics and features was given by Sigma- Aldrich company (Table 3).

The third amendment (unisal) is a solution used for soil and water salinity treatment. It is produced by Union Agricultural Development Company in Egypt**.** The chemical composition of unisal is given by the company and is presented in Table 4.

Irrigation saline water:

Four different saline irrigation waters (2.5, 5.0, 7.5 and 10.0 dS/m) were prepared by dilution sea water dilution of using distilled water. The characteristic of these waters are shown in Table (5).

Pot experiment

A pot experiment was conducted at the greenhouse at Faculty of agriculture (Saba Bash), Alexandria University, Egypt, during 2010 growing season. Plastic pot of 30 cm depth and 13 cm inside diameter with holes in its bottom, was filled with 1.0 kg of the soil mixed with the selected amendments, leaving the upper 5 cm without soil. The selected amendments (Zeolite, Compost and Unisal) were mixed with the soil at the rates of 0, 4, 8 and 12 % by w/w before cultivation.

Seeds of barley (*Hordeum sp*) variety, (Giza 126), as the test crop and being salt tolerant, were sown (6 grains/ pot) and irrigated with tap water. After a week, the barley seedlings were thined to four plants and irrigated with the saline waters (2.5, 5.0 and 7.5 dS/m) using tap water (0.44 dS/m) as a control. The pot experiment was designed as a three factors experiment, amendment type (A), amendment rate (R) and irrigation water salinity (S).

Table 1. The main physical and chemical characteristics of the experimental soil

Particle size distribution			Texture class	pH	EC, dS/m	$CaCO_3$, %
Sand %	Silt %	Clay %		(1:2.5 soil :water)	(1:1 soil;water)	
51.62	55.50	22.88	Sandy loam	8.10	1.66	32.00
Water soluble cations, meq/L				Water soluble anions, meq/L		
Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
7.20	0.20	9.90	0.42	6.30	3.80	3.02

Table 2. The chemical properties of the used compost

pH (1:2 soil :water)		EC, dS/m (1:1 soil;water)		O.M. %	Total P, %	Total N, %
7.02		4.10		52.80	0.44	0.92
Water soluble cations, meq/L				Water soluble anions, meq/L		
Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
18.20	9.80	6.50	2.30	10.20	13.00	13.60

Table 3.The chemical and phase composition of the used zeolite

Chemical composition,%							
SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	IW[a]
58.05	11.94	4.36	0.77	5.94	1.50	1.20	12/09

Phase composition, %			
Clinoptilolite	Mordenite	Montmorillonite	Others[b]
35.00	15.00	30.00	20.00

[a] IW: ignition waste.

[b] Others : Calcite, feldspate and quartez.

Table 4. The chemical composition of unisal solution

Chemical parameter	W/V %
Polyethylene glycol	9.0
Calcium	7.5
Gelotharik acid	7.0
Nitrogen	5.0
Citric acid	1.0
Total organic matter	**17.0**

Table 5. The characteristic of the saline waters

Parameter	Water salinity, dS/m			
	2.5	**5.0**	**7.5**	**10.0**
pH	8.0	8.17	8.27	8.58
Soluble cation, meq/L				
Ca^{+2}	1.26	2.31	3.10	3.69
Mg^{+2}	2.1	3.8	5.17	6.5
Na^{+}	21.3	42.5	63.4	90.0
K^{+}	0.77	1.8	2.2	2.4
Soluble anion, meq/L				
HCO_3^{-}	10.8	16.8	22.2	27.5
Cl^{-}	11.0	30.9	34.0	36.9
SO_4^{-2}	4.1	5.6	19.2	39.3

The treatments were replicated 3 times in a completely randomized block design. The soil of each pot was fertilized with 120 mg N Kg^{-1} soil as NH_4NO_3, 150 mg K Kg^{-1} soil as K_2SO_4 and 30 mg P_2O_5 Kg^{-1} soil as $Ca(H_2PO_4)_2$. The plant were irrigated every day to keep the soil at 70% of its field capacity by regular weighting of pots. After 8 weeks of growth, the over – soil plant parts were cut and the fresh weights were determined. The dry biomass was estimated after drying the shoots in an oven at 65°C for 48h. Samples of the oven- dried biomass were ground for analysis. Samples of the oven- dried plant materials (0.5 g) were wet-digested with H_2SO_4 - H_2O_2 digest (Lowther, 1980) and the following determinations were carried out in the digested solution: Na^+, K^+, Ca^{+2}, Mg^{+2}, Cl^- and SO_4^{-2} according to Jackson (1967).

Soil samples were also collected from each pot after harvest and extracted with distilled water to determine EC, in the filtrate solution according to Jackson (1967).

The obtained were statistically analyzed according to the technique of analysis of variance (ANOVA) and the least significant difference (L.S.D) method, to test the differences between the treatment means, as described by Gomez and Gomez (1984).

RERSULTS AND DISCUSSION

Growth of barley plants

Table (6), showed that both the fresh and dry weights barley shoot were decreased significantly with increasing the irrigation water salinity. The data showed that the fresh and oven-dried weights were decreased significantly from 7.35 and 1.21 g/pot with the control treatment (water salinity of 0.44 dS/m) to 5.87 and 0.99 g/pot (water salinity of 7.5 dS/m), respectively. It is known that the water quality of 4.0 dS/m is marginal for barley production (Ayres and Westcot 1985). Salinity stress retards plant growth through its influence on several plant physiological processes e.g., osmotic adjustment, nutrient uptake, photosynthesis, organic soluble accumulation, alteration in respiration rates and soil water potential (Pessarakli, 1994). The adverse effect of salinity on plant growth has been reported by various researchers (Radwan *et al*., 1993; Abou Hussien *et al*., 1994; Song and Fujiyama, 1996 and Ahmed *et al*., 2008). Generally, salts in the soil and water under increase the plant absorption force of water and this additional force is referred to as the osmotic effect or osmotic potentials. The same trend was obtained by Abo-Khadrah *et al*. (1999).

Table (6) also indicated significant increase in the fresh and dry weight of barley shoot as affected by the addition of the amendment materials (zeolite, unisal and compost). The highest values of fresh and oven-dried weights were obtained by compost and zeolite, while the lowest values were produced by unisal. The fresh or dry matter yield values of barley plants produced with the different amendment types followed the order, compost > zeolite > unisal.

A straight line equations were established to express the relationship between the dry weight (X) of barley shoot and the rate of each amendment (Y) over the salinity levels of water salinity as follows:

$Y_{compost} = 0.0231x + 1.025$ $R^2 = 0.99$

$Y_{zeolite} = 0.0243x + 0.992$ $R^2 = 0.97$

$Y_{unisal} = 0.0108x + 1.003$ $R^2 = 0.9$

Application of the slope method to a equations showed the efficiency of the three amendments is equivalent to: 1.00: 1.10: 0.50 for compost, zeolite and unisal respectively. It is clear, therefore, that the efficiency of zeolite was slightly higher than compost but the compost and zeolite efficiencies were much higher than unisal.

Compost is used in agriculture as a fertilizer or to improve the physical properties of the soil. Chaney (1992) stated that the physical and chemical properties of soil can be improved by using compost, which may

Table 6. Mean effect of water salinity, amendment type and amendment rate on the fresh and dry weight of barley shoot

Treatment	Fresh weight (g/pot)	Dried-oven weight (g/pot)
Water salinity (S), dS/m		
0.44 (control)	7.35	1.21
2.5	8.71	1.25
5.0	6.35	1.01
7.5	5.87	0.99
$LSD_{0.05}$	0.10	0.02
Amendment type (A)		
Compost	7.28	1.15
Unisal	6.83	1.06
Zeolite	7.11	1.12
$LSD_{0.05}$	0.01	0.01
Rate of amendment (R), %		
0	6.51	1.01
4	6.82	1.07
8	7.32	1.14
12	7.65	1.32
$LSD_{0.05}$	0.102	0.02
Interaction		
S x R	**	**
S x A	**	**
A x R	**	**
S x A x R	**	**

***** Significant at 5%
****** Significant at 1%

ultimately increase crop yields. Increasing the growth of barley as a result of compost application may be also due to decreasing the adverse effect of salts in soil or irrigation water. El- Shakweer *et al*. (1998) stated that application of organic matter to saline soil can have different effects such as speeding up of NaCl leaching, decrease of the exchangeable sodium percentage and electrical conductivity and increase of water infiltration. Moreover, compost provides plant nutrients and enabling their increased uptake by plants (Lea- Master *et al*., 1998).

The response of barley to zeolite is possibly associated with water, salt and nutrient dynamics. The improvement in growth may also be related to the essential nutrients contained in zeolite. Ayan *et al*. (2005) reported that cation exchange ability, water retention and plant nutrient were increased following zeolite application.

Janzen and Chang (1987) and Rengasamy (1987) reported that zeolite provides an alternative Ca^{+2} cation to the soil-plant system reducing the ratio of Na^{+}/Ca^{+2}. The provision of Ca^{+2} from zeolite in the root media would prevent an accumulation of toxic levels of Na^{+} in plants. The greater need for Ca^{+2} by ionic interactions and precipitation are partially responsible for the reduced yield under saline or sodic conditions. The conditioning of saline soil with zeoilte could mitigate the stress effects of salts on plants.

The beneficial effects of unisal material may be due its content of calcium which prevents the effects of alkalinity and salinity. Beside Ca^{+2}, applying polyethylene glycol (PEG) to the root medium has been often used to submit higher plants to control negative water potentials (Perez- Alfocea *et al* 1993). Also, its content of organic matter (17%) may decrease total soluble salts in the soil solution in the thizosphere which could improve the growth of plants.

Table (6) revealed also that the rate of the applied amendment resulted in a highly significant effect on fresh and dry weights of barley. Thus, application of each amendment increased significantly fresh and dry weights. Increasing amendment rate to 4, 8 and 12% increased the fresh weight of plant from 6.51 to 7.65 g/pot and the dry weight from 1.01 to 1.32 g/pot, respectively. It is clear, therefore, that the yield of fresh and dry matter positively correlated with amendment rate at each water salinity level for the three amendments. The values of "**r**" for the dry weight were the highest for compost at 2.5 and 7.5 dS/m water salinity (Table 7).

The interaction effect between salinity of irrigation water and amendment type (SxA) on fresh and dry weights of barley was highly significant (Table 6). The maximum fresh and dry weights were obtained with 2.5 dS/m salinity of irrigation water using compost, zeolite and unisal and the maximum values were observed with compost followed by zeolite (Table 6). These data showed that with increasing water salinity to 5.0 and 7.5 dS/m, the fresh and dry weights decreased. It is also noticed that zeolite was superior than both compost and unisal at 5.0 dS/m water salinity. On the other hand, the compost was the superior at 7.5 dS/m water salinity.

Table (6) showed also significant interaction effect between irrigation water salinity and rate of amendment (SxR) on fresh and dry weights of barley. The highest values of fresh and dry weights (8.90 and 1.33 g/pot, respectively) were produced at 2.5 dS/m irrigation water salinity and 12% amendment rate, while the lowest values were produced at 7.5 dS/m irrigation water salinity without amendment application.

Significant interaction effect between amendment type and rate (AxR) for fresh and dry weights and the second-order interaction between salinity of irrigation water, amendment type and amendment rate (SxAxR) were also observed (Table 6). The highest value of fresh weight (9.41 g/pot) was produced with compost at 2.5 dS/m irrigation water salinity and 12% compost, while the highest value of dry weight (1.34 g/pot) was produced at 2.5 dS/m irrigation water salinity and 12% with zeolite.

Elemental composition

The results in Table (8) represented the mean elemental content of barley plants as affected by the type and rate of amendment and levels of irrigation water salinity. The data showed that Na^{+} and Mg^{+2}, Cl^{-} and SO_4^{-2}contents of barley plant were significantly increased as salinity increased from 0.44 to 7.5 dS/m. It is also clear that K^{+} and Ca^{+2} content were decreased as salinity increased from 0.44 to 7.5 dS/m.

The decrease in the concentration of K^{+} in plants may be related to attendant increase in the uptake of Na^{+}. This result is in agreement with that of others (Mass and Hoffman., 1977 and Nasseem, 1986). It is clear that the concentration of Na^{+} ion in the shoot was the higher than the other elemental concentrations. The Na^{+} ion concentration was related to its higher level in water of irrigation.

The results also showed that, there is highly significance in increases Na^{+}, K^{+}, Ca^{+2}, Mg^{+2} and Cl^{-} and SO_4^{-2} concentrations in barley plant with amendment type. The highest values of Na^{+} and Cl^{-} were produced with unisal, while the highest values of K^{+}, Mg^{+2} and SO_4^{-}were produced with compost. The highest values of Ca^{+2} were produced with zeolite. Similar results were obtained by Ahmed *et al*., (2008) who found that zeolite application at 5 % increased calcium concentration in salt stressed plants.

The results also showed, that the rate of amendment material produced a highly significant effect on the concentration of Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Cl^{-} and SO_4^{-2}. The highest values of Na^{+}, Cl^{-} and SO_4^{-2} were produced without amendment application, while the highest values of K^{+}, Ca^{+2} and Mg^{+2} were produced at 12% rate of amendment.

The interaction between salinity of irrigation water and amendment type (SxA) had highly significant effect on Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Cl^{-} and SO_4^{-2} contents in barley plant. The highest values of Na^{+} and Cl^{-} were obtained with 7.5 dS/m irrigation water salinity using unisal, but the highest value of K^{+} was obtained with 2.5 dS/m irrigation water salinity using compost. The highest value of Ca^{+2} was obtained with 5.0 dS/m irrigation water salinity using zeolite, while the highest value of Mg^{+2} was produced with 0.44 dS/m (the control) irrigation water salinity using compost.

James (1990) repored that nutrient availability and uptake in saline environments are related to: i) the activity of nutrient ions in the solution, which depends on pH and salt composition, ii) the concentration and ratios of accompanying elementals that influence the uptake and transport of this nutrtion by roots, and iii) numerous environmental factors. In plant; K^{+}, Mg^{+2} and Ca^{+2} ions play similar role, i.e., they act as a buffer system of plant cells, and hence they can be substituted for each other (Rabie and Kumazawa, 1988). Classen and Wilcox (1974) reported that the uptake of K^{+} ion by plants at high salinity levels was reduced by increasing availability of Ca^{+2}, Mg^{+2} and Na^{+} ions from added salts. Salt addition to the soil plant system may add or remove essential elements. The higher amount of Na^{+} in the root zone could decrease the uptake of other cations such as Ca^{+2}, Mg^{+2} and K^{+} by the plant root due to cation-balance (Pessarakli, 1994).

At each EC level of irrigation water, concentrations of Na^{+} and Cl^{-} ions in plant tissue peaked at the compost, unisal or zeolite level of 0% but those of K, Ca and Mg ions were peaked at 12% of each amendment. Cramer *et al*. (1985) ascribed the low concentration of Ca^{+2} to: i) less uptake by plants compared to N, P or K^{+}, ii) its presence in the amendments in less bioavailable form, and iii) competition for absorption or activities in the soils from other cations contained in see water. Such physiochemical changes in system may deregulate plant nutrition under saline conditions. Although, the use of saline water for irrigation is not widely practiced, soil amendment like compost or zeolite seems to be a promising management tool under such conditions.

The interaction between salinity of irrigation water and rate of amendment (SxR) had highly significant effect on Na^+, K^+, Ca^{+2}, Mg^{+2} and Cl^- contents (Table 8). The highest values of Na^+ and Cl^- were obtained with 7.5 dS/m irrigation water salinity at amendment level of 0%, while the highest value of K^+ was produced at 0.44 dS/m(the control) irrigation water salinity at 8% rate of amendment. The highest value of Ca^{+2} was produced at 0.44 dS/m irrigation water salinity (the control) and 12% rate of amendment, but the highest value of Mg^{+2} was obtained at 7.5 dS/m irrigation water salinity and 12% rate of amendment.

The interaction between amendment type and rate of amendment (AxR) had no significant effect on Na^+ content, but it has a highly significant effect on the K^+, Ca^{+2}, Mg^{+2} and Cl^- contents in barley plant (Table 8). The second- order interaction between irrigation water salinity, amendment type and rate of amendment (SxAxR) had no significant effect on Na^+ concentrations in barley plants, but it has a highly significant effect on the K^+, Ca^{+2}, Mg^{+2} and Cl^- concentrations in barley plants.

Table 7. Simple correlation coefficient "r" between amendment rate and fresh or dry matter yield at each soil salinity for the three amendments

Water salinity dS/m	Fresh weight			Oven-dried weight		
	compost	zeolite	unisal	compost	zeolite	unisal
0.44 (control)	0.96 *	0.98 *	0.93	0.88	0.94	0.98 *
2.5	0.91	0.89	0.98 *	0.99 **	0.93	0.93
5.0	0.93	0.98 *	0.93	0.97 *	0.97 *	0.93
7.5	0.88	0.86	0.89	0.99 **	0.85	0.97 *

* Significant at 5%
** Significant at 1%

Table 8. Mean effect of water salinity, amendment type and rate on the concentrations of Na^+, K^+, Ca^{+2}, Mg^{+2}, Cl^- and SO_4^{-2} in barley shoot

Treatment	Na	K	Ca	Mg	Cl	SO_4
			g/kg, D.W.			
			Water salinity (S), dS/m			
0.44 (control)	14.41	14.43	3.24	2.03	8.04	12.85
2.5	18.61	14.06	2.98	2.02	8.99	14.73
5.0	20.05	13.00	2.75	2.17	11.63	20.93
7.5	32.53	12.06	2.67	2.15	14.07	21.69
$LSD_{0.05}$	0.74	0.076	0.014	0.010	0.128	0.120
			Amendment type (A)			
Compost	18.31	13.90	2.61	2.67	10.58	18.27
Unisal	19.67	12.70	2.70	1.72	11.24	17.81
Zeolite	19.47	13.46	3.43	1.89	10.23	16.57
LSD	0.637	0.066	0.012	0.009	0.111	0.104
			Amendment rate (R), %			
0	20.60	11.60	1.83	1.37	11.71	19.70
4	20.03	13.00	2.60	1.83	11.21	17.76
8	18.73	14.15	3.27	2.38	10.45	16.87
12	17.24	14.81	3.95	2.79	9.46	15.87
$LSD_{0.05}$	0.735	0.076	0.014	0.010	0.128	0.120
			Interaction			
S x R	**	**	**	**	**	**
S x A	**	**	**	**	**	**
A x R	NS	**	**	**	**	**
S x A x R	NS	**	**	**	**	**

***** Significant at 5%
****** Significant at 1%

Table 9. Mean effect of water salinity, amendment type and amendment rate on soil salinity after plant harvest

Treatment	EC dS/m
Water salinity (S) dS/m	
0.44 (control)	3.14
2.5	5.33
5.0	7.47
7.5	12.25
$LSD_{0.05}$	0.032
Amendment type (A)	
Compost	7.00
Unisal	7.55
Zeolite	6.61
$LSD_{0.05}$	0.028
Amendment rate (R) %	
0	9.08
4	6.84
8	6.39
12	5.90
$LSD_{0.05}$	0.032
Interaction	
S x R	**
S x A	**
A x R	**
S x A x R	**

*Significant at 5%

****** Significant at 1%

CONCLUSION

The obtained results demonstrate that the three amendments (compost, zeolite and unisal) were effective in reducing the concentration of salts in soil solution and its bioavailability. This approach might have great merit for reducing the salt concentration in soil solution especially with application of the compost and zeolite. Controlling the soil or water salinity by the addition of compost alone, however, will have a temporal effect because when the compost degrades, the compost loses its effect on controlling the salinity problem in soil or irrigation water. At the same time, addition of zeolite alone will not improve the biological quality of the soil or support plant growth. The combination of the compost and zeoltite could optimize to provide a long-term effects in decreasing the effect of salt stress effect and also improve biological quality of the soil. The benefit of zeolite application which is unlike other soil amendments is not the break down over time but remains in the soil to help improvement of nutrient and water retention permanently. The combined use of compost with zeolite is promising for improving plant performance. However, because of the large differences in the physcochemical and biological characters between composts and soils, the compost suggested to be used for a specific soil should be tested with the soil before applying in the field.

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الملخص العربي

تاثير الزيوليت والكمبوست واليونى سال على النمو والتركيب الكيميائي لنبات الشعير المروى بمياه مالحة

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ملوحة التربة عامل رئيسى يحد من انتاج المحاصيل ولكن المعاملة بالزيوليت الصناعى او الكمبوست او اليونى سال قد يخفف من آثار الملوحة الضار على النباتات. كان الهدف من الدراسة هو تحديد آثاروالكمبوست والزيوليت واليونى سال على نمو الشعير المروى بمياه البحر المخففة. تمت زراعة الشعير فى تربة جيرية معاملة بالزيوليت والكمبوست واليونى سال بنسبة 0, 4, 8 , 12% ومروية بمياه البحر المخففة بمستويات ملوحة 0.44 (مياه الصنبور) , 2.5, 5.0, 7.5 ديسسمنز/ متر. وقد خفض الرى بالمياه المالحة عند مستويات 5.0, 7.5 ديسسمنز/متر من الوزن الرطب والجاف لنبات الشعير, الا انه تمت ملاحظة زيادة جوهرية فى الكتلة الحيوية النباتية للشعير مع المعاملات الثلاثة تحت ضغط الملح والتى تبعت الترتيب: الكمبوست > الزيوليت > اليونى سال, كما زاد الزيوليت والكمبوست واليونى سال ايضا من امتصاص البوتاسيوم والكالسيوم و المغنسيوم وقلل من الصوديوم والكلوريد والكبريتات فى براعم الشعير. وقد اظهر تحليل التربة بعد الحصاد قيم التوصيل الكهربى العالية فى التربة بفعل المياه المالحة ولكن التركيزات كانت اقل فى الترب المعالجة بالمعاملات المختبرة خصوصا الزيوليت. واشارت النتائج الاجمالية الى ان معاملة التربة بالزيوليت او الكمبوست يمكن ان تحسن من ضغط الملوحة بشكل مؤثر وتحسن من التوازن الغذائى فى التربة الجيرية.