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Effect of Soil and Water Salinity on Barley Grains Germination under Some Amendments

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Abstract: The importance of reclaiming salt affected soils, scarcely of water resources and reuse of salty water issues were raised in last decades. Barley is a salt-tolerant crop species with considerable economic importance in salinity-affected arid and semiarid regions of the world. Barley (*Hordeum vulgare* L. Giza 58) was screened for salt tolerance during seed germination in the Water Relations and Field Irrigation Dept, National Research Centre, Egypt, to study the effect of salt affected soils differ in texture, water salinity of 0.5 (control), 3.2, 5.8, 8.7 and 11.7 d Sm^{-1} and soil amendments such as Organic Matter (OM) and gypsum at 10; 20 m^3 fed^{-1} and 1.5; 2.5 t fed^{-1}, respectively. From obtained results it could conclude that: Applying OM at 1st application rate has improved soil EC to be decrease to extent is required to improve both germination % and germination rate of barley grains, while gypsum significantly increased soil EC under all water salinity levels. Seed germination significantly decreased by increasing water salinity level up to 3.2 dS m^{-1}. Germination was significantly diminished at the highest level of salt (11.7 dS m^{-1}) with significant variation among water salinity level under control soils. Also data indicated that increasing water salinity significantly reduced percentage and rate of barley germination under gypsum at both rates used. Significantly decrease in germination % with increasing water salinity with a considerable variation among amendments used from side and within itself. Generally, increasing salt stress significantly decreased germination rate in barley. The present study indicated that salt stress must be removed from soil surface for successful seedling establishment by OM and gypsum at rate 10 m^3 and 1.5 t fed^{-1}, especially in clay loam soil textures.

Key words: Barley · water salinity · soil textures · soil EC · germination % · germination rate

INTRODUCTION

World will face a great challenge, in next decades such as shortage in fresh water and hence food production, so more attention would take place to use low quality of both water and soil. Also soil salinity is a major factor limiting for plant development, reduces crop yield and considered one of the major obstacles to increasing crop productivity. Some of the most severe problems in soil salinity occur in arid and semiarid regions of the world. Besides these regions, salinity also affects agriculture in many areas affected by low-quality of irrigation water [1].

One such practice is the incorporation of $CaSO_4$-$2H_2O$ (gypsum) into the soil. Gypsum application improves soil structure in heavy-textured soil, so that water infiltration and the ability of roots to penetrate the soil are enhanced [2]. Othman *et al.* [3] stated that seed germination significantly decreased by increasing salinity level. Other research showed a yield increase of 15% in wheat (*Triticum vulgare* Vill.) and sorghum (*Sorghum vulgare* Pers.) with gypsum addition especially in fine texture soils [4].

Organic matter improves soil properties by enhancing redistribution of soil pores [5], which results in improved water holding capacity and aeration. Similarly, the beneficial effects of OM have been attributed to release root exudates such as organic acids which regulate soil pH and decreases the harmful effect of increasing salt concentration of soil and to improved soil physical properties and nutrient availability [6]. Horticultural crop yields and quality have also been improved with OM application [7].

Barley is widely grown in the arid and semiarid regions of the Mediterranean for forage purposes and as a grain crop [8]. It is rated as a moderately tolerant forage crop and a highly tolerant grain crop [9]. Barley is most sensitive to salinity at germination and young seedling

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stage and exhibits increased tolerance with age [10]. They stated that salt stress for barley at seedling stage has been mainly attributed to ionic effects rather than to osmotic effects. This is different from the germination stage, where osmotic effect is the primary stress component [11]. Salinity tolerance at germination and seedling stages determines the stand density in the field under saline conditions. Most cereals including wheat and barley [9] are reported to be more salt-tolerant at germination than at seedling stage.

Generally, barley grown near soil surface where the salts accumulated and at this point of soil, the concentration of salt change over time by continuous evapotranspiaration gradually rising salt levels or rainfall leaching salts from the soil surface supplying water to grains [12]. Variation in salt levels may restricted seed germination and in some cases resulting in the death of seeds [13, 14].

The objective of present research was to determine the effect of gypsum and organic matter (as a soil amendments) application on soil EC and both percentage and rate of germination of barley grown under some salt affected soils differ in texture.

MATERIALS AND METHODS

Barley (*Hordeum vulgare* L.) Giza 58 was chosen. Grains were washed several times with deionized water, 10 grains were germinated on plastic pots (with drainage holes to drain excessive water and also to prevent grains to rot.) were packed with 200 g air-dried soil (8 and 4 cm width and height) uniformly compressed. The studied amendments mixed well with in three replicates and saturated (every week) by water salinity at different levels two weeks before experiment. The plants were grown in a greenhouse at National Research Centre in Nov. 2006. Germination period lasted 15 days and soil moisture content was maintained at field capacity by weighting twice a week. During germination test, the total number of germinated grains was counted and calculated using the equation:

Final germination % = number of germinated grains/total number of grains planted X 100

Germination rate was calculate as follows:

Germination rate = $(n_1 + n_2d_2 + .. + n_nd_n)/n_t$ .....

Where; n_1d_1= number of germinated grain in the 1st day, n_nd_n =number of germinated grain in the day n and n_t = total number of grains used in germination.

Salinity waters were collected from different salinized wells to represent different salinity levels used with a final EC in the range of 0.5-11.7 dS m^{-1} was reached. Germination response to salinity levels was monitored visually at 24 hr intervals for duration of the germination test. A grain was considered to have germinated if the radical exceeded 2 mm length. Water treatments were five salinity levels (0.5, 3.2, 5.8, 8.7 and 12.0 dS m^{-1}), two soil amendments (organic matter 10, 20 m^3 fed^{-1} and gypsum 1.5, 2.5 t fed^{-1} application rate) and five soil textures (clay, sand, loamy sand and clay loam). Both soil and water physical and chemical characteristics were shown in Table 1 and Table 2 and were determined after [15]. Organic matter characterizes such as pH, EC

Table 1: Some physical and chemical characteristics of the studied soils

	Physical characteristics				Chemical characteristics				
Soil texture	Loamy sand	Sand	Clay loam	Clay	Ions	Loamy sand	Sand	Clay loam	Clay
pH	8.05	8.15	8.01	7.85	Soluble cations (meq l^{-1})				
EC dSm^{-1}	5.00	11.00	5.00	6.00	Ca^{++}	12.00	32.50	26.00	29.50
CaCO3%	1.50	3.12	17.86	1.79	Mg^{++}	3.50	11.00	11.50	13.50
C sand	36.80	46.60	12.30	4.60	Na^{+}	26.70	37.78	9.12	19.00
F sand	44.50	41.20	27.70	15.60	K^{+}	0.26	0.31	3.37	1.41
Silt	14.20	9.20	23.50	36.20					
Clay	4.50	3.00	36.50	43.60	Soluble anions (meq l^{-1})				
Sat %	23.70	19.30	48.60	53.20					
FC %	13.10	9.80	28.40	37.50	$CO^{=}_3$	0.00	0.00	0.00	0.00
DP %	10.60	9.50	20.20	15.70	HCO^{-}_3	1.75	1.58	2.10	2.80
ESP %	33.73	35.73	45.32	34.37	Cl^{-}	23.75	72.75	5.00	19.75
CEC	7.47	9.60	10.90	37.33	$SO^{=}_4$	16.96	7.26	42.89	40.86

pH: 1:2.5, EC: 1:5, DP %: Drainable pores %, CEC: cations exchangeable capacity meq/100g soil, ESP: exchangeable sodium percenr

Table 2: Chemical characteristics of the studied saline water

			Soluble cations (meq l^{-1})				Soluble anions (meq l^{-1})				
No.	pH	EC dS m^{-1}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	SO^{-}_4	SAR
1	7.6	0.5	1.8	1.4	1.5	0.2	0	1.5	1.9	1.5	1.2
2	7.8	3.2	8.5	5.1	18.1	0.3	0	2.8	16.2	13	6.9
3	7.8	5.8	14.1	7.5	36.5	0.3	0	3.4	41.6	13.4	11.1
4	7.8	8.7	16.2	8.5	63.2	0.3	0	3.6	68.2	16.4	18.0
5	8.1	11.7	19.8	10.6	86.3	0.4	0	3.7	88.3	25.1	22.1

(in 1:10 material:water), C/N ratio were 6.37, 0.23 dS m^{-1} and 1:18.5, respectively Sodium adsorption ratio (SAR) was calculated from the following equation:

$$SAR = Na^{+}/((Ca^{++}+Mg^{++})/2)^{0.5}$$

Where: Na^{+}, Ca^{++} and Mg^{++} in meq l^{+}

Data were statistically analyzed using analyses of variance (ANOVA) using the SAS [16] program. Probabilities of significance among treatments by using LSD (5%) to compare treatments means were used.

RESULTS AND DISCUSSION

Soil and water analysis: Some physical and chemical characteristics of the studied soils are shown in Table 1. The investigated soils were loamy sand, sand, clay loam and clay in texture. Values of the soil pH were close to alkalinity and soil EC varied between 5.0 (loamy sand and clay loam) and 11.0 dS m^{-1} (sand soil). The maximum and minimum values of $CaCO_3$ % were observed in clay loam (17.89%) and loamy sand (1.5%).

According to the soil ability to retain water, the investigated soils could be arranged in the descending order as follows: clay>clay loam>loamy sand>sand. While the drainable pores, which represent the drainage state in the soil, took the opposite trend where the highest and lowest values were 45 and 30% (from total porosity) under the loamy sand and clay soil, respectively. Data on hand, reveal that clay soil has a highly CEC (37.33 meq/100 g soil) while loamy sand was the lowest one (7.47 meq/100 g soil). This result could be described by dominancy of sand fraction.

Table 2 shows the chemical analysis of the used water in the germination experiment. pH and EC values varied 7.60-8.15 and 0.5-11.7 dS m^{-1}. One can notice that increasing water salinity was associated by increasing Na^{+} and Cl^{-}, which means that the sodium chloride was the dominant salt in water. Also increasing sodium cation was in parallel with increasing SAR values which is the main terms in its calculated equation.

According to FAO [17] Sodium Absorption Ratio (SAR) values were classified into non-saline (0.7), moderately saline (2-10) and highly saline, so plant will suffer from salinity stress induce by using this water. Both EC and SAR of water used play an important role on soil water intake rate. Data on hand noticed that there is no restriction of the used water on soil permeability (water intake rate).

Soil EC: Figure 1 illustrates the interaction effect between two used amendments (OM and gypsum) on both water salinity levels, soil textures and also the interaction effect between water salinity levels and soil textures on soil EC (dS m^{-1}). Data on hand reveal that application of both organic matter and gypsum under studied rates has a pronounced effect on soil EC except OM at 1st rate, which decreased soil EC dramatically. Applying the 2nd rate of OM increase soil EC by about 1, 20, 46, 91 and 81% by using water salinity levels 0.5, 3.2, 5.8, 8.7 and 11.7 dS m^{-1} as compared with control ones [17].

According to the effect of gypsum at two studied rates (1.5 and 2.5 t fed^{-1}) clearly increases soil EC by 41, 67; 52, 80; 62, 117; 75, 124 and 100, 124% as compared with untreated soil after using water salinity levels 0.5, 3.2, 5.8, 8.7 and 11.7 dS m^{-1}, respectively. This increase in soil EC may be due to not only to water salinity levels but also gypsum effect.

From the above mentioned, it could conclude that applying OM at 1st application rate has improved soil EC to be decrease to extent suitable for improving both germination % and rate of barley grains.

Regardless water salinity levels, application of OM and gypsum increased soil EC under different investigated soil textures except 10 m^3 fed^{-1} OM which decreased with sand, loamy sand and clay loam by about -6, -20 and -57%, respectively and 2nd rate (20 m^3 fed^{-1}) with loamy sand by -5% (Fig. 1). Also

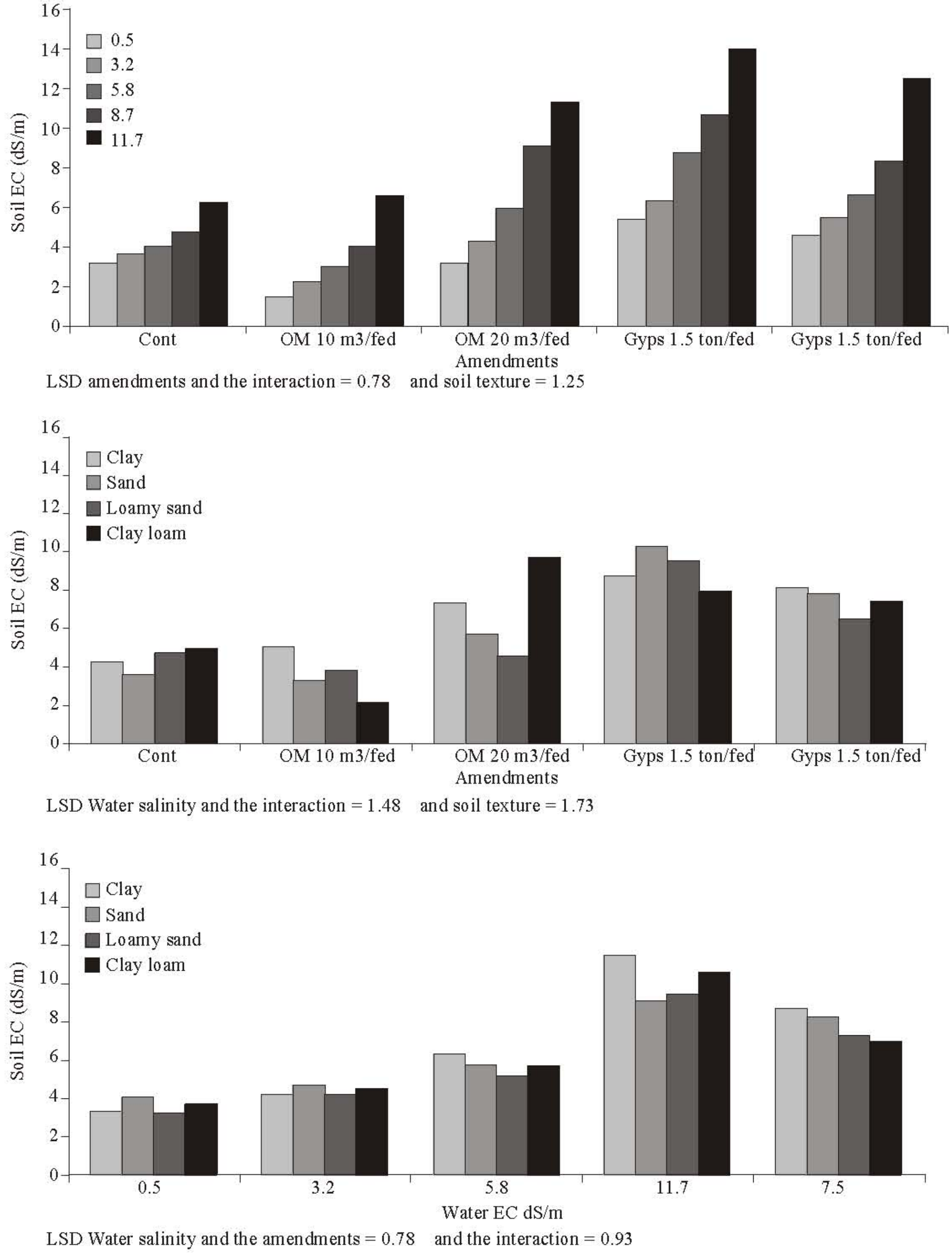
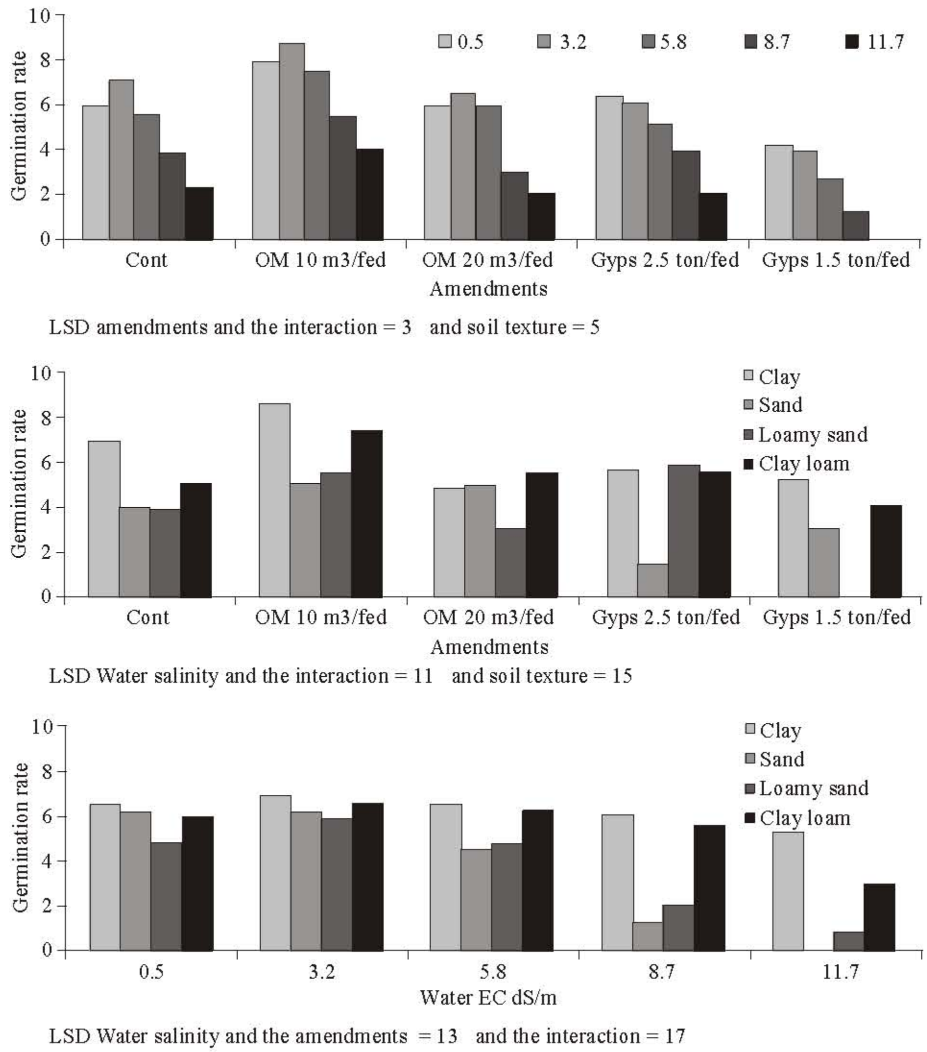


Fig. 1: Effect of soil amendment, water salinity and soil textures on soil EC

data notice that application of gypsum at rate of 1.5 and 2.5 t fed^{-1} significantly increased soil EC with different studied soil textures. The maximum and minimum soil EC values as affected by gypsum application were 3.54 and 4.72 dS m^{-1} which represents an increase 190 and 38% in sand and loamy sand soil textures, respectively. From the obtained data, one can notice that the 1^{st} rate of OM ($10 m^3$) was more effective in



LSD amendments and the interaction = 3 and soil texture = 5

LSD Water salinity and the interaction = 11 and soil texture = 15

LSD Water salinity and the amendments = 13 and the interaction = 17

Fig. 2: Effect of soil amendment, water salinity and soil textures on germination %

reducing soil EC especially under clay loam followed by loamy sand soil textures. This finding may be due to organic matter effects on water dissolved salts and water movement in soil.

According to the effect of water salinity, results showed that increasing water salinity was associated with increasing soil EC under different studied soil textures. The highest and lowest soil EC values were recorded at clay after water salinity 11.7 dS m^{-1} (11.49 dS m^{-1}) and at 0.5 dS m^{-1} (3.24 dS m^{-1}). The obtained results show that there was dramatically increase in geometric sequence of soil

EC with increasing water salinity levels in all the investigated soil textures (Fig. 1). This result could be attributed to highly CEC and also to lowest drainable pores of clay soil than in sand one.

According to the interaction effect between type of soil amendments and water salinity levels, results indicate that increase water salinity from 0.5 to 11.7 dS m^{-1} associated with increasing soil salinity under control treatment. While OM decreased soil salinity by about -28 and -9% after using water salinity 0.5 and 3.2 dS m^{-1} relative to the untreated ones. Highly significant increase in soil EC was observed after gypsum application under all water salinity levels. The highest and lowest soil EC were attained at 0.5 and 11.7 dSm^{-1} and the increase were 54 and 112% as compared with untreated ones. While amendments application increased soil EC after all used water salinity levels. The highest and the lowest soil EC were obtained after water salinity 0.5 (3.61) and 11.7 dS m^{-1} (11.11) by 14 and 78% as compared with the untreated soils, respectively.

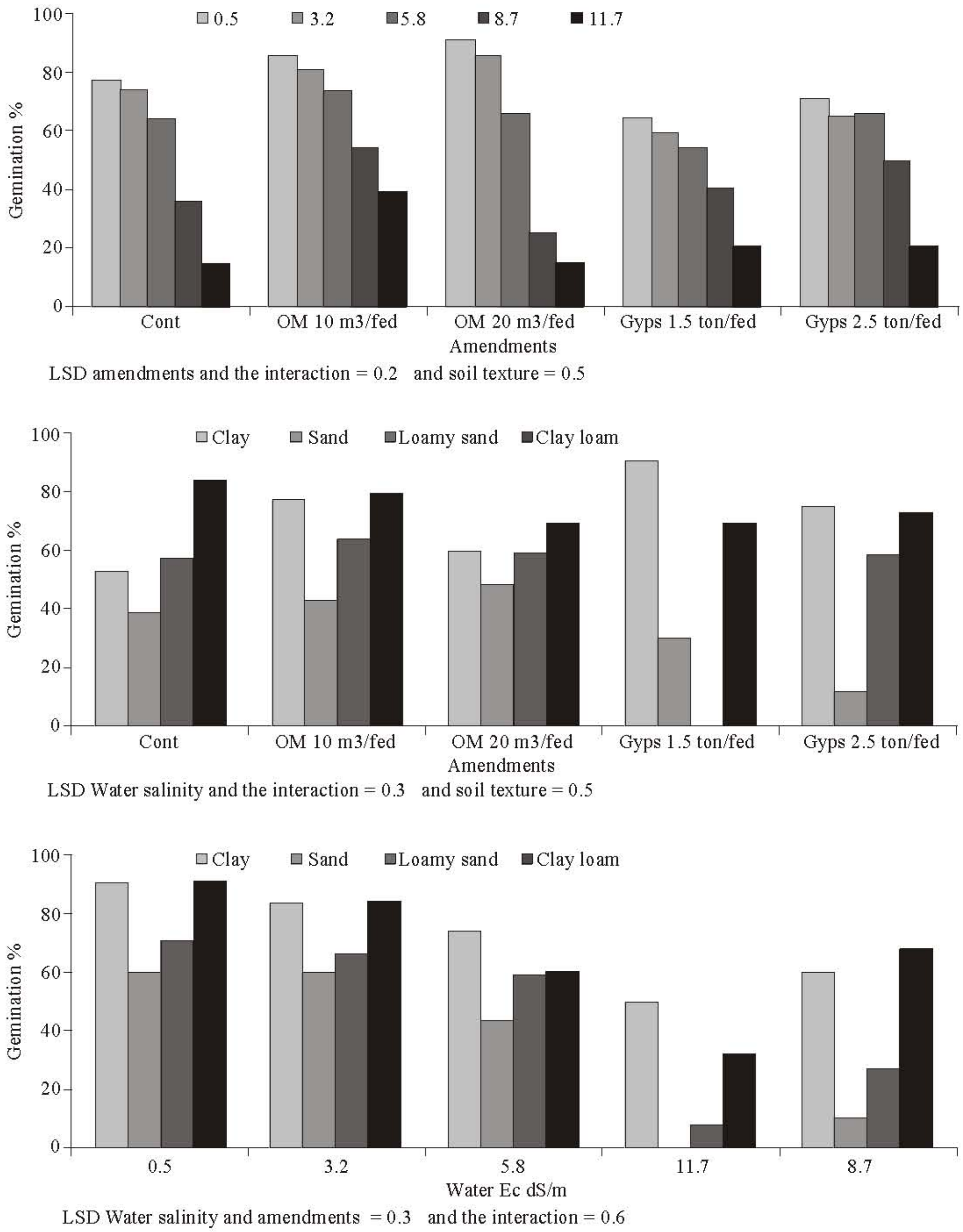


Fig. 3: Effect of soil amendment, water salinity and soil textures on germination rate

Germination %: Figure 2 represents the interaction between soil amendments application from side and water salinity levels from the other one. Results notice that increasing water salinity has a pronounced effect on reducing germination % under investigated amendments. The highest and lowest values of germination % were 77 and 15% under control treatment under using water salinity 0.5 and 11.7 dS m^{-1}, respectively. This finding agreed with those obtained by [18] who found that increasing salinity concentrations in germination often cause osmotic and/or specific toxicity which may reduce or retard germination percentage.

According to the organic matter effect on germination %, results reveal that increasing rate of OM

Table 3: The interaction effect between amendment with water salinity and soil texture on soil EC, germination % and rate

Water salinity (dS m^{-1})	Soil EC (dS m^{-1})				Germination %				Germination rate			
	Cont	OM	Gyp	Amd	Cont	OM	Gyp	Amd	Cont	OM	Gyp	Amd
0.5	3.18	2.33	4.90	3.62	77	88	67	78	5.90	6.95	5.30	6.13
3.0	3.58	3.26	5.96	4.61	74	84	62	73	7.10	7.60	5.05	6.33
6.0	4.05	4.47	7.73	6.10	64	70	60	65	9.60	6.70	3.90	5.30
9.0	4.75	6.54	9.47	8.01	36	40	45	43	3.90	4.20	2.60	3.40
12.0	6.24	8.99	13.23	11.11	15	27	21	24	2.30	3.05	1.00	2.03
Mean	4.36	5.118	8.258		53.2	61.8	51		5.76	5.7	3.57	
Soil texture	Soil EC (dS m^{-1})				Germination %				Germination rate			
Clay	4.32	6.11	8.37	7.24	53	69	83	76	6.90	6.85	5.55	6.20
Sand	3.54	4.52	9.04	6.78	39	46	21	33.5	4.00	5.05	2.25	3.65
Loamy sand	4.72	4.14	7.95	6.05	57	62	29	45.5	3.90	4.30	3.00	3.65
Clay loam	4.87	5.86	7.66	6.76	84	75	71	73	5.10	6.55	4.85	5.70
Mean	3.49	4.13	6.60		47	50	41		3.98	4.55	3.13	

Cont control, OM = organic matter, Gyp= gypsum, Amd= amendments

applied increases germination % by about 10, 18; 9, 16 and 14, 3% under 1st and 2nd rate after using water salinity 0.5, 3.2 and 5.8 dS m^{-1} as compared with control ones, respectively. While under water salinity 8.7 and 11.7 dS m^{-1}, there were an increase followed by decrease in germination % of barley grains after increasing OM from 1st to 2nd rate by about 50, 31 and 160, 0% as compared with control one, respectively.

According to the interaction effect of gypsum application with water salinity levels, results noticed that increasing gypsum rate from 1.5 to 2.5 t fed^{-1} decreased germination % of barley grains under water salinity 0.5 and 3.2 dS m^{-1} by about -8, -17% and -12, -20% as compared with control one (untreated soils), respectively. While under water salinity 5.8, 8.7 and 11.7 dS m^{-1}, there were an increase in germination % of barley grains after applying gypsum at rate of 1.5 and 2.5 t fed^{-1} and the change in the increase was 3, -16, 36, 11 and 40, 33% as compared with control ones, respectively, except after gypsum at rate of 2.5 t fed^{-1} under water salinity 6.0 dS m^{-1} decreased by -16% as compared with control one.

Figure 2 illustrates the interaction effect of used amendment and different soil textures on germination % of barley grains. Results indicated that increasing rate of both OM and gypsum increase germination % in all investigated soil textures except clay loam soil, which decreased. One can notice also, that gypsum at rate of 2.5 t fed^{-1} inhibits germination % of barley grains under loamy sand soil texture. Younis *et al.* [19] reported that low moisture content under salt stress caused cessation of metabolism or inhibition of certain steps in metabolic even low levels of salt.

According to rate of organic matter, increasing OM from 10 to 20 m^3 fed^{-1} increased germination % by 47, 13; 10, 23 and 12, 4% under clay, sand and loamy sand soil textures, respectively as compared with control one. Also it is clear that increasing organic matter decreased germination % of barley under all the investigated soil textures except sand one which increased by about 12 % relative to the untreated one.

Regardless the effect of soil amendments, the interaction effect of water salinity levels and soil textures on germination % of barley was shown in Fig. 2. Results indicated that increasing water salinity was involved with decreasing in germination % under all investigated soil textures. The maximum values of germination % was attained under water salinity 0.5 dS m^{-1} under all the studied soil textures, while the minimum ones were obtained after using water salinity levels 11.7 dS m^{-1}. Also, the minimum decrease in germination % was observed after using water salinity 3.2 dSm^{-1} and the decrease were 8, 2, 6 and 8% under soil textures clay, loamy sand and clay loam as compared with water salinity 0.5 dS m^{-1}, respectively.

According to the amendments type effect on germination of barley (Table 3), results showed that the application of OM has a promotive effect on germination % under all water salinity levels. The maximum and minimum germination % values were obtained after using water salinity 5.7 and 11.7 dS m^{-1} and the increase were about 9 and 80% relative to the control ones (untreated). While gypsum inhibit germination % and changed by about -12, -16 and -6% after water salinity 0.5, 3.2 and 5.7 dS m^{-1}, but increases in germination % were observed after using water salinity 7.8 and 11.7 dS m^{-1} by about 25 and 40% as compared with untreated ones.

According to the effect of amendments type and water salinity levels on germination of barley grains, results show that the highest and lowest values of germination % were obtained in clay loam and sand by about 84 and 39% as compared with control one, respectively (Table 3). While OM application increased germination % in clay (30%), sand (18%) and loamy sand (9%) and decreased in clay loam soil textures by about -11% relative to untreated ones. In case of gypsum application, decreasing in germination % was observed by about -86, -97 and -18% in sand, loamy sand and clay loam, while an increase was attained in clay soil texture by about 57% as compared with untreated ones, respectively. This result could be attributed to the highly CEC of clay soil which absorbed Ca^{++} and quickly regulate SAR value of soil solution to be more suitable for barley germination [17].

Relative to the amendment types, there were slightly change in germination % under water salinity levels 0.5, 3.2 and 5.8 dS m^{-1} , while a great improvement was observed under water salinity level 8.7 and 11.7 dSm^{-1} by about 17 and 60%, respectively. This result reflects the important role of amendment in increasing germination % in highly salinity condition and hence, could be utilize soil and water under the same condition in increasing cereal production.

Our results are in a good agreement with those obtained by Othman [20] who reported that seed germination can be initiated by water imbibitions and any shortage in water supply will let seed under stress. Shainberg *et al.* [21] reported that salt stress negatively affected seed germination; either osmotically through reduced water absorption or ionically through the accumulation of Na and Cl causing an imbalance in nutrient uptake and toxicity effect.

Germination rate: The effect of different soil amendments (OM and gypsum) on germination rate of barley grains after using different water salinity levels was shown in Fig. 3. Results reveal that increase water salinity levels decreased germination rate under different studied amendments (OM and/or gypsum), except after water salinity level 3.2 dS m^{-1}, which increased germination of barley grains by about 10 and 14% as compared with 0.5 dS m^{-1} water salinity level under 1st and 2nd of OM application, respectively.

Data on hand noticed that OM at rate of 10 m^3 fed^{-1} was the best organic amendment used in increasing germination rate of barley grains under water salinity levels used and the increase was 34, 23, 34, 41 and 78% after using water salinity levels 0.5, 3.2, 5.8, 8.7 and 11.7 dS m^{-1}, respectively. While slightly increase in germination rate of barley grains was observed after using of OM at rate of 20 m^3 fed^{-1} under 0.5 and 5.8 dS m^{-1} water salinity and the increase was 2 and 8% as compared to control ones, respectively. Also, results indicated that gypsum rate at 2.5 t fed^{-1} inhibit germination rate. Results notice that any increase in water salinity levels was associated by dramatically decrease in germination rate of barley grains under using both gypsum rate.

Regardless the water salinity levels, the highest and lowest values of germination rates were recorded under control treatment in clay (6.9 dS m^{-1}) and loamy sand (3.9 dS m^{-1}). Data in Fig. 3 shows that the 1st OM rate has encourage germination of barley grains in different investigated soil textures. The increase in germination values after application OM at 1st rate (10 m^3 fed^{-1}) was 28, 28, 41 and 47% relative to the untreated ones, under clay, sand, loamy sand and clay loam soil. While significant increase in germination rate was attained after application OM at 2nd rate (20 m^3 fed^{-1}) on sand and clay loam soil textures by about 25 and 10%, respectively as compared with control ones.

According to the soil chemical amendment used, data on hand show that gypsum at rate of 1.5 t fed^{-1} was more effective on germination rate of barley grains than the other one (2.5 t fed^{-1}). Gypsum at rate of 1.5 t fed^{-1} has an influenced effect on germination rate in different investigated soil textures except clay and sand soils. It could describe the role of calcium in clay soil to its water content and its ability to increase the amount of calcium dissolved, which affect directly on SAR value to be more suitable for germination from side and frome the other one to decrease the harmful effect of Na^+ in soil solution. The increase in germination rate of barley grains was about 54 and 10% on loamy sand and clay loam soil textures, respectively.

According to the effect of water salinity levels on germination rate under the studied soil textures, the highest and lowest values of germination rate were 6.6 (clay) and 4.9 (loamy sand) under 0.5 dS m^{-1} water salinity. One can notice the increase water salinity level from 0.5 to 11.7 dS m^{-1} increased germination rates of barley grains until 5.8 dS m^{-1} then great decrease was observed. Increase water salinity from 0.5 to 3.2 dS m^{-1} associated with increasing in germination rate of barley grains by about 8, 0, 10, 18 and 10% in clay, sand, loamy sand and clay loam as compared with control one (0.5 dS m^{-1}), respectively. While under 5.8 dS m^{-1} water salinity under clay loam soil texture was only increased germination rate of barley grains by about 7%. This means that salt stress increased the intake of toxic ions which may altered certain enzymatic or hormonal activities of the seeds during germination [22].

According to the effect of amendments type and water salinity levels on germination rate of barley grains, results in Table 3 show that the lowest germination rate was attained after using water salinity 11.7 dS m^{-1} (2.3) and the highest one was obtained after using 3.2 dS m^{-1} (7.10) water salinity. One can notice that OM has a pronounced effect on germination rate and increased it by about 18, 7, 20, 8 and 33% as compared with untreated ones. While there were sharply decrease in germination rate of barley grains after applying gypsum under all water salinity levels used. This may be due to the salinity induced by gypsum application especially the 2nd rate (2.5 t fed^{-1}) which affects directly on grains absorbent to water.

Regardless water salinity level, Table 3 illustrates the effect of amendments type and soil textures on germination rate. One can notice that the highest and the lowest germination rate were obtained under clay (6.9) and loamy sand (3.9) soil textures. Application of OM improved germination rate in all investigated soils except clay one which showed slightly decrease and could be neglected (-1%) relative to untreated one. The maximum and minimum increase in germination rate were observed under clay loam (6.55) and loamy sand (4.30) which represent 28 and 10%, respectively as compared with control ones.

Application of gypsum to the studied soil texture decreased germination rate. The highest and lowest germination rate was observed at clay (5.55) and sand (2.25). Slightly decrease in germination rate was observed in clay and clay loam soil textures by about -10 and -5% as compared with control ones.

Regardless the amendments type, there was a decrease in germination rate with increasing water salinity except at 3.2 dS m^{-1} was increased in unamended soil textures. Application of amendment increased germination rate under 0.5 dS m^{-1} water salinity, while slightly decrease was observed with increasing water salinity from 5.7 to 7.8 dS m^{-1} by 5 and 13% as compared with untreated ones.

The relation between amendments and soil textures was clearly observed in increasing soil EC after application of amendments in all the studied soil texture. But in case of germination %, application of amendments improves germination % only in clay soil and decreasing in other studied soils. While germination rate was improved after application amendments only in clay loam soil texture. These results are in agreement with Basalah [23] who found that high levels of soil salinity can significantly inhibit seed germination. Salt induced inhibition of seed germination could be attributed to osmotic stress or to specific ion toxicity [24].

Biological technique and use of organic matter such as farmyard manure and composts have long been known to facilitate the reclamation of saline soils. The beneficial effect of organic matter incorporation is described to the decomposition of organic matter resulting in the evolution of carbon dioxide and organic acids, lowering of soil pH and Ca^{++} release by solubilization of $CaCO_3$ and other soil minerals, thereby increasing the electrical conductivity and replacement of exchangeable sodium by actions like calcium and magnesium and thus lowering the ESP [25]

According to the statistical analysis, highly positive correlation was observed between gypsum and OM as soil amendments from side and soil EC and r values were 0.924** and 0.877**, respectively, while the 1st rate of OM was lowest r value. In the stand point of germination %, highly negative correlation was attained with OM at the 2nd rate (0.873**) followed by the 1st arte (0.721**), whereas, OM in general view show highly negative correlation with germination % (-0.847**). As well as gypsum absolute and/or two used rates show negative significant correlation -0.553**, -0.580 and -0.402**, respectively. Germination rate show the same trend with slightly moderately, where OM (regardless the application rates) show highly positive significant correlation (0.831**) and with the 2nd rate (0.791**) was more effective than the 1st one (0.647**). These results support our obtained data.

CONCLUSIONS

This study illustrates that the effect of water salinity levels and both organic matter and gypsum as soil amendments on soil EC, % and rate of germination of barley grains sown in salt affected soil differ in texture. As well under soil salinity and water salinity levels conditions it could be maintained in order to limit odors. Also we can use not only low water quality and salt affected soil to increase the cultivated area from side but also increase cereals production from other side.

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