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Response of two sorghum varieties to salt stress of newly reclaimed soil in Upper Egypt

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Abstract

This study was conducted on a private farm located at Southeast of Sohag Governorate, during two successive seasons of 2017/2018 and 2018/2019. Experiment were carried out to examine the capability of two varieties different kinds, Relatively Salt-tolerant, sorghum variety (Gia113) and. relatively Salt-sensitive, sorghum variety (Dorado) as a summer crop in the studied soil under stress condition. application different amelioration techniques with organic amendments,(mixture1and mixture 2) as well as Bio-organic treatments (soil, foliar spray and soil + foliar application) Results showed that increased fresh, dry weight and water content of both shoot and root, as well as increased plant length of shoot. Results also showed that different amelioration techniques with organic amendment under two varieties differed in salt tolerant, at 60th) as expected, associated with a marked improvement in the Na content and Na uptake status for both shoots and roots. Comparing the studied three methods of bioorganic amelioration (s, f and s + f) showed that application (s + f) significant effect application together, compared with the other with respect to varietal responses to salinity, reported that tolerant plants were associated with greater net transport of Na+ from roots to shoots.

Keywords:
Amelioration, stress conditions, organic amendment, bioorganic, sorghum, Salt- tolerant, Salt- sensitive.

INTRODUCTION

According to the successive increase in population the higher needs for agricultural products require maximum yields form the whole area including those salt-affected soils. The problem of salinity assumes special importance in ARE both for the old cultivated area as well as for the newly reclaimed lands. This may be mainly attributed to the continuous rise in the ground water table following irrigation in the absence of adequate drainage, using the relatively low-quality waters for irrigation being other possibility (Dinardo-miranda *et al.,* 2008). Salinity has a great role in the definition of the absorption features of plants roots which should be reflected on the behavior of any particular crop with respect to physiological and metabolic activities. Under saline condition stunted growth, nutrient imbalance and deep bluish-green foliage of followed by low crop production are common observations (Dinardo-miranda *et al.*, 2008).

Grain sorghum (*Sorghum bicolor L. Moench*) is one of the most important cereals in the world as well as in Egypt. The main producers of grain sorghum in the world are USA, India, Mexico, China, Nigeria, Argentina and Sudan. In 2014 season, the cultivated area of grain sorghum in Egypt was 148,456 ha, producing about 804,000 tons with an average productivity of 5.42 ton ha-1 FAO, (2014). Most of grain sorghum cultivated area in Egypt is concentrated in Assiut and Sohag governorates (Upper Egypt) instead of maize, where the atmospheric temperature during the growing season is high since grain sorghum is tolerant to high-temperature stress Al-Naggar, *et al.,* (2018). Salinity and drought stress. Egypt ranks first among all grain sorghum producers in the world for average productivity per unit area, followed by China and Argentina FAO, (2014) grain sorghum is mainly consumed for making bread in Upper Egypt, for feeding livestock and poultry and for green fodder and silage. Sorghum grain has high nutritive value, with 70-80% carbohydrate, 11-13% protein, 2-5% fat, 1-3%fiber, and 1-2% ash. Protein in sorghum grain is gluten-free and, thus, it is a specialty food for people who suffer from celiac disease (in tolerant to food with gluten), including diabetic patients.

MATERIALS AND METHODS

Experimental design

The experimental design was a split- split plot design with three replicates. The main plots were randomly assigned with the different crop varieties, whereas the amelioration techniques treatments for both soil and plant were randomly distributed in sub and sup – sup plots.

Main plots varieties treatments

V1- Relatively Salt-tolerant, wheat variety (Gia113) as a winter crop.

V2 - Relatively Salt-sensitive, wheat variety (Dorado)

Sub plots (Organic amendment treatments)

MX0- Control (without addition organic amendment).

MX1-Soil application with a mixture1 (filter mud + Vinasse) (3: 1) at a rate of 2 ton fed-1).

MX2- Soil application with a mixture1 (filter mud + Vinasse) (3: 1) at a rate of 5 ton fed-1).

The three soil organic amendment treatments were added to the soil before two months of cultivation.

Sub- Sub (Bioorganic compound treatments)

Control-Without the soil application or foliar application to plants with a Bio-organic compound.

Soil application with a Bio-organic compound at the rate of 5L fed^{-1}. In addition with drip irrigation at the last of 10 minutes from the irrigation periods.

Foliar application with a Bio-organic compound of the rate of 5L300L^{-1} fed^{-1} after 30, 45 and 60 days of sowing for both two wheat and sorghum plants.

S+F - Soil and foliar spray treatment plants with a Bio-organic compound as a previously mentioned with S and F treatments.

Field experiments

The soil was prepared for cultivation of both the Sorghum (*Sorghum vulguare*), at a rate of 5 kg fed^{-1}i.e, cultivars Giza113 which showed a relative resistance and Dorado), which showed a relative sensitivity were sown at 10th June 2018 and 1st June, 2019, and harvested on 1st October 2018 and on 1st October 2019.All the cultural operations for wheat and sorghum crops, like field preparation, fertilization, irrigation; weeding, plant protection etc. were carried out as recommended by the Ministry well water Agriculture.

Table (1) Some physio-chemical properties of the experimental soil (before plant).

Soil properties and units	Value
Sand (%)	72.67
Silt (%)	21.03
Clay (%)	6.30
Texture class	Sandy Loam
pH (1:2.5)	7.86
EC (dS. m^{-1})	6.8
SP (%)	32.5
OM (%)	0.44

Table (2) Chemical composition of filter mud, Vinasse and Bio-organic compound used as amelioration of both soil and plant.

Characteristics	Filter mud	Vinasse	Bio-organic compound
Density (Mg m^{-3})	0.74	1.14	0.63
pH (1:2.5)	7.17	4.8	4.7
EC (dSm^{-1})	4.3	7.0	1.25
Total elements (%)			
Nitrogen %	2.35	0.20	0.98
Phosphorus %	4.55	0.21	0.45
Potassium %	0.68	0.71	1.36
Calcium %	2.08	0.65	4.51
Manganese %	0.06	0.60	0.17
Iron %	0. 75	0.0006	0.007
Copper %	0.10	0.0073	0.96
Zinc %	0.11	0.0024	0.17
Some bacterial strains i.e.	-	-	(PGPR)

Table (3) Composition and chemical properties of the mixtures of soil amendments used.

Mixtures of amendments	Mixtures composition percent		Chemical properties		
	F.M.C	V	pH	EC dS m^{1}	$CaCO_3$ %
(MX)	3	1	7.11	2.11	14.3

F. M.C: filter mud, V: Vinasse,

Yield Components

Measurements of growth and yield as well as its composition: At 60th day of sorghum day 5 plants were taken randomly respectively, then the plants registered shoot length in cm, shoot fresh and dray weight gplant-1, root fresh and dray weight gplant-1, and water content (gplant-1) in both shoot and root. Then the data were recoded.

K and Na contents in the studied plants

At 60th day, of sorghum day from sowing, shoot and root fresh or dry weights were measured using digital balance. Half of the plant samples were air dried and finally kept in oven at 70 ºC till constant dry weights were obtained, while the other half plant material was digested by using root and shoot samples (0.1g DW) with sulfuric acid and hydrogen peroxide mixture (2 ml) according to the Wolf method (Wolf, 1982), to measure Na^+ and K^+ concentrations using a flame photometer Corning M-410, Ciba Corning Diagnostics Scientific Instruments Corp., Halstead, Essex, UK).

3- Potassium and sodium content was determined by using flame photometer (Jackson 1967).

RESULTS AND DISCUSSION

Behavior of sorghum varieties to amelioration techniques

Vegetative growth of the studied plants

An approach for evaluating the growth of sorghum plants as affected by different amelioration techniques with organic amendment,(mixture1and mixture 2) as well as Bio-organic treatments (soil, foliar spray and soil+ foliar application) under two varieties differed in relatively salt tolerant, at 60th of cultivation were performed through the determination of fresh weights, dry weights and water content as well as shoot length in the studied soils under stress condition in the first and the second season.

Data in table (4) generally, showed that with organic amendment treatments i.e., mixture 1 and mixture 2 under bioorganic amelioration techniques (soil, foliar spray and soil+ foliar application) have been increased fresh, dry weighs and or water content for both shoot and root, while increased plant length of shoot for all the studied varieties compared with control treatments, the highest values were recorded with MX2 (f + s) treatments in the both verities in which in V1 was (527.8, 200.7, 327.1, 140.9, 61.4, 79.5,179.7) g plant and (388.7,174.1, 214.6, 110.3,48.6

,61.7,120.7) g plant in V2. While the lowest values were obtained with control in verities (165.4, 71.3, 94.1, 33.0, 15.1, 17.9, 92.7) for V1, (136.8, 49.5, 97.3, 30.7,13.8, 16.9, 63.5) for V2), respectively. These results in line with those of Oo, *et al.,* (2015) investigated the effectiveness of compos as soil amendments on reducing soluble salts from salt affected soils and enhancing maize yield. Their Results showed that the height of plant and dry matter yield of maize was maximized due to applying compost as compared with the control. Unqueira, *et al.,* (2009) The use of vinasse in fertigation systems has advantages because it can contribute substantial amounts of water and mineral nutrients, support soil quality and crop productivity.

Comparing the studied three methods of bioorganic amelioration (s, f and s + f) showed that application (s + f) significant effect application together, compared with the other. Similar results were obtained by Negrao, *et al.* (2017). An evident reduction in plant growth parameters through reducing the plant height, number of leaves, shoots which considered high responsive to salinity. Addition of organic acids with irrigation water led to a significant increase in all plant growth parameters. This reflects the importance the role of organic acids for increasing plant growth and ameliorating the adverse effects of salt stress. The above results agree with those obtained by Jarosova, *et al.* (2014). Also, on the other hand Shaban and Omar (2009) revealed that the values of soil salinity EC (dSm^{-1}) decreased significantly by bio fertilizer because probably Azospirillum spp. produce several phytohormones such as indoleactic acid and cytokinins, which promote plant growth and reduce the salinity stress.

It was also observed that application organic amelioration techniques particularly 5 ton fed^{-1} from the mixture2 (FMC: Vinasse) 3:1 was more effective than that the other one, while, the treatments of (soil + foliar) application integrated with 5 ton fed^{-1} soil application from organic amendment were more effective compared with control and other treatments, especially in the second season . These results in line with by Utami, *et al.*, (2012).Who revealed that the growth of Maize plants increased with increasing the rate of filter mud addition, receiving the largest amounts of filter mud comparable to those receiving chemical fertilizers treatment (control). Data, Also, Revealed that the salt – tolerant plants (Gia113) were more by the different amelioration techniques in studied soil under salinity stress conditions. mainly due to avoid Na toxicity of salinity particularly what concerning effects on metabolic processes, as well as ionic imbalance which reflected on water balance causing "physiological drought " Alqahtani, *et al.,* (2019). Differences exist between plant species in their tolerance of salinity can be related to the salt content in the soil and water which causes an initial decline in growth (yield), and also to the rate of yield decline that occurs with increasing salinity. Gorham, *et al.,* (1990) and Hussain, *et al.,* (2003) in wheat, one of the major mechanisms conferring salt tolerance is sodium exclusion from the leaves. On the other hand, Variations in responses of the studied Varieties are in agreement with those found Acosta-Motos, *et al.,* (2017) who showed that dry matter yield of relatively salt – resistant plants was less affected by salinity than relatively salt-sensitive ones .such responses were reported by Zörb, *et al.,* (2019) to be mainly due to genetic and biochemical makeup of the species as salt tolerance ability is ultimately attributed to genetic and biochemical characteristics. Most species, including crops, activate tolerance mechanisms only after exposure to salt stress. Activation of the tolerance program drives plants to acclimatize under the saline condition and involves altered physiological responses, redirection of metabolism, reinforcement of defense and repair, and changes in developmental programs to adapt morphological and anatomical characteristics Zörb, *et al.,* (2019), Acosta-Motos, *et al.,* (2017).

Status and Translocation of both Na^+ and K^+ in the studied plants

1- Sodium

Presence of salinity in growth media is well known to have effects on sodium status in plants. Data in tables (5 and 6) generally showed that different amelioration techniques with organic amendment, mixture (1) and mixture (2) as well as Bio-organic treatments (soil, foliar spray and soil+ foliar application) under two varieties differed in respectively salt tolerant, at 60^{th} day) as expected, associated with a marked improvement in the Na content and Na uptake status for both shoots and roots, the lowest values were found with MX2 (f + s) treatments in the both verities in which in V1 was (3.54, 2.10) % and (2.64, 2.40) % in V2. While the highest values were observed with control in both verities (4.91, 3.19) for V1, (3.06, 2.85) for V2) . While Na uptake the highest values were found with MX2 (f + s) treatments in the both verities in which in V1 was (7.10, 1.29) % (4.60, 1.17) % in V2. While the lowest values were observed with control in both verities (3.50, 0.48) for V1, (1.36, 0.41) for V2) respectively, being with less response mainly due to some sort of antagonistic effect between k,Ca and Na uptake Alqahtani ,et al., (2019). (These results are in agreement with those reported by most species, including crops, activate tolerance mechanisms only after exposure to salt stress. Activation of the tolerance program drives plants to acclimatize under the saline condition and involves altered physiological responses, redirection of metabolism, reinforcement of defense and repair, and changes in developmental programs to adapt morphological and anatomical characteristics (Zörb, *et al.*, (2019) and Acosta-Motos, *et al.*, (2017)).

It may be worth to mention that more response was generally obtained for sodium status in shoots receiving in studied soil , particularly Na, compared to that encountered with roots, responses of (Sids1) (relatively salt–resistant variety) being more obvious. Variations in the obtained responses may be attributed to the high rate of Na-translocation from roots to shoots, as clear from calculations presented in Table (5 and 6). This may be confirmed by comparing translocation efficiency obtained for the Mx2 (soil+ Foliar) application treatments with that obtained from other ones; This mains that, one of the major mechanisms conferring salt tolerance is sodium exclusion from the leaves of wheat plants. These results agree with those of Gorham, *et al.*, (1990) and Hussain, *et al.*, (2003) who suggested an efficient mechanism for sodium mobility towards the shoots of grown plants particularly at progressed stage of growth. Munns and Tester (2008) added that osmotic adjustment of halophytic *chenopdiaceae* was achieved mainly by accumulation of high levels of Na+ in the shoots. Also, reported that both active and passive transport operating via both apoplast and symplast systems should be acting as to finally have an efficient Na+ translocation to shoots, thus pushing plant tissues to relatively tolerate salt stress.

Comparing the studied varieties' under organic and bioorganic ameliorations showed that a stimulatory effect of 5 ton fed^{-1} from the mixture2 (FMC: Vinasse) 3:1 application together with soil + foliar application of bioorganic treatment , compared with the other treatment With respect to varietal responses to salinity, reported that tolerant plants were associated with greater net transport of Na^+ from roots to shoots, mainly due to osmotic adjustment Finally, it may be worth to mention Alqahtani, *et al.*, (2019) reported that plants of maize cultivars which had lower Na^+ concentrations were found to be more salt sensitive and had significantly lower amounts of dry matter production than those of cultivars having higher Na+ concentrations. The authors added that it is possible that maize cultivars with higher Na^+ in the shoots may sequent the Na in specific tissues or / cell compartments more efficiently than maize cultivars with lower Na content, and thus avoid Na^+.

2- Potassium

As known, potassium is an essential plant nutrient which plays special roles in membrane transport processes along with establishment for the cell ionic and osmotic equilibrium particularly under saline conditions, K-status was thought to be evaluated and shown in tables (5 and 6) data indicated general depressive responses for salinity particularly for roots, especially in control with at amelioration techniques treatments, the highest values were recoded with MX2 (f + s) treatments in the both verities in which in V1 was (2.76,1.90) % (2.35,1.50) % in V2. While the lowest values were observed with control in both verities (1.81, 1.31) for V1. (1.72, 0.85) for V2. While Na uptake the highest values were found with MX2 (f + s) treatments in the both verities in which in V1 was (5.54, 1.17) % and (4.90, 0.73) % in V2. While the lowest values were observed with control in both verities (1.29, 0.20) for V1. (90, 0.12) for V2, respectively. This result agrees with Reda, *et al.*, (2011).

Comparing K-status for different amelioration techniques with organic treatments , data showed that 5 ton fed-1 from the mixture2 (FMC: Vinasse) 3:1 was more effective than that of the other one.

This may be confirmed with those results reported by Asik, *et al.,* (2009) who showed that soil and Foliar application with organic amendments increased uptake of k. While, Dinardo-mirnda, *et al.,* (2008) reported that the main benefit of filter mud is a source of organic matter and nutrient elements, especially k and ca. Also, Resend, *et al.,* (2006) revealed that vinasse is a source of nutrients K and Ca and organic matter. This may be attributed to antagonistic phenomenon which is known to frequently take place between Na ions and both K and Ca ones Reda, *et al.,* (2011).

It was also observed that soil application with organic amendment, (mixture 2) as well as bio-organic treatments (soil + foliar application) under two varieties differed in respectively salt tolerant, at 60th day being more effective, particularly in the scorned season. Raafat and Tharwat (2011) reported that the combination of FYM and Foliar application increased K.

3- Plant Translocation

Data tables (5 and 6) data also showed that indicated responses for k concentration were more obvious in roots of relatively salt sensitive plants (Dorado) but shoots of relatively salt tolerant plants (Giza 113) and whose uptake was however inferior, while, opposite trend was noticed with Na-status This may reflect differences obtained in translocation between the two varieties under consideration. The highest values translocation Na and k for shoot were recoded with MX2 (f + s) treatments in the both verities in which in V1 was (84.6, 82.6) % and (79.8, 84.9) % in V2. While the lowest values were observed with control in both verities (87.9, 86.7) % for V1. (77.1, 88.2) % for V2) respectively, which agrees with results obtained by Reda, *et al.,* (2011) who reported that higher k translocation by salt - sensitive of barley plants may result in an increase of the influx of k ions to the guard cells which, in turn, may affect the rapid change of osmotic potential in these cells thus contributing to the maintenance of stomata opening and consequently increases in transpiration rate accompanied with injury to plants exposed to salinity. The plants response to the salinity effects that may harm the plant due to the presence of salts in the growth environment or in the water can be classified into two main categories.; a rapid response to the increase in external osmotic pressure and a slow response due to the accumulation of Na+ in leaves that was confirmed by Munns and Tester (2008). It may be worth to mention that more response was generally obtained for sodium status in shoot receiving.

In the studied soil conditions, particularly Na, compared to that encountered with roots, responses of relatively salt–tolerant variety (Giza 113) being more obvious. Variations in the obtained responses may be attributed to the high rate of Na-translocation from roots to shoots, as clear from calculations presented in the data. This may be confirmed by comparing translocation efficiency obtained for the (soil+Foliar) application treatments with that obtained from other ones; This agrees with results in wheat, one of the major mechanisms conferring salt tolerance is sodium exclusion from the leaves Hussain, *et al.,* (2003).

4-Na^+/ K^+ Ratio

An approach for evaluating the nutrient balance within plant tissues was thought to be performed through calculating the of Na^+/K^+ ratio in both shoots and roots for both relatively salt -tolerant and relatively salt-resistant plants. Calculated values shown in tables (5 and 6) indicated that the concerned ratio was less than at control under the different amelioration techniques treatments, such values being decreased to be less than1 at higher doses of organic amendments (5 ton fed^{-1}) integrated with bioorganic treatment (soil + foliar) application indicating that Na was less absorbed. The lowest values the first session were recoded with MX2 (f + s) treatments in the both verities in which in V1 was (1.32, 1.11) ratio and (1.12, 1.60) ratio in V2. While the highest values were obtained with control in verities (2.70, 2.43) ratio for V1, (2.02, 3.52) ratio for V2). While the lowest values the second session were recoded with MX2 (f + s) treatments in the both verities in which in V1 was (1.13, 0.90) ratio and (0.96, 1.31) ratio in V2. While the highest values were observed with control in both verities (2.34, 1.98) for V1 (1.74, 2.79) ratio for V2) respectively.

Comparing the two studied varieties, the ratio of Na^+/K^+ was always higher in shoots of relatively salt tolerant verities (Giza 113) but generally lower in relatively salt sensitive verities (Dorado) while the opposite trend was noticed in shoots.

Table (4) Effect of different amelioration techniques on fresh, dry weights and water content of both shoots and roots, as well as shoot length at 60th day of sorghum plant after the both seasons under stress condition respectively.

Different amelioration techniques			Sorghum (Season1)							Sorghum (Season2)						
varieties treatments	Organic amendment treatments	Bioorganic compound treatments	Shoot				Root			Shoot				Root		
			F.W ($gplant^{-1}$)	D.W ($gplant^{-1}$)	Water Content ($gplant^{-1}$)	shoot length (cm)	F.W ($gplant^{-1}$)	D.W ($gplant^{-1}$)	Water Content ($gplant^{-1}$)	F.W ($gplant^{-1}$)	D.W ($gplant^{-1}$)	Water Content ($gplant^{-1}$)	shoot length (cm)	F.W ($gplant^{-1}$)	D.W ($gplant^{-1}$)	Water Content ($gplant^{-1}$)
V1	Without	Without	165.4	71.3	94.1	92.7	33.0	15.1	17.9	175.4	76.3	99.1	99.2	41.0	19.1	21.9
		F	265.5	101.7	163.8	128.6	60.9	24.8	36.1	284.5	110.7	173.8	135.0	82.9	35.8	47.1
		S	232.2	85.3	146.9	121.8	48.9	20.9	28.0	252.2	95.3	156.9	128.1	70.9	31.9	39.0
		F+S	301.8	123.4	188.4	141.1	72.8	27.9	44.9	331.8	133.4	198.4	147.3	94.8	38.9	55.9
	MX1	Without	234.3	115.6	118.7	109.7	59.3	21.3	38.0	254.3	125.6	128.7	116.2	81.3	32.3	49.0
		F	369.5	179.4	190.1	144.7	83.5	34.2	49.3	388.5	189.4	199.1	151.0	105.5	45.2	60.3
		S	319.3	154.9	164.4	135.9	71.4	27.9	43.5	339.3	164.9	174.4	142.4	93.4	38.9	54.5
		F+S	404.0	192.7	211.3	153.6	100.2	44.0	56.2	434.0	212.7	221.3	160.0	122.2	55.0	67.2
	MX2	Without	307.6	137.3	170.3	121.1	88.5	31.4	57.1	327.6	147.3	180.3	127.6	110.5	42.4	68.1
		F	486.8	198.6	288.2	164.0	128.2	58.1	70.1	505.8	208.6	297.2	170.1	150.2	69.1	81.1
		S	414.8	173.1	241.7	154.6	110.5	47.3	63.2	434.8	183.1	251.7	161.0	132.5	58.3	74.2
		F+S	527.8	200.7	327.1	179.7	140.9	61.4	79.5	546.8	210.7	336.1	186.2	151.9	72.4	89.5
V2	Without	Without	136.8	49.5	97.3	63.5	30.7	13.8	16.9	146.8	54.5	102.3	71.0	37.7	17.3	20.4
		F	169.7	74.3	115.4	88.1	50.3	18.3	32.0	190.7	79.3	125.4	95.5	70.3	28.3	42.0
		S	147.7	66.5	101.2	78.2	44.2	15.6	28.6	168.7	77.5	101.2	85.4	64.2	25.6	38.6
		F+S	199.4	89.5	129.7	96.5	55.8	20.9	34.9	220.4	115.7	139.7	104.0	75.8	30.9	44.9
	MX1	Without	178.0	98.5	99.5	75.0	41.6	19.4	22.2	199.0	109.5	109.5	82.3	61.6	29.4	32.2
		F	212.4	121.1	121.3	96.5	61.1	29.8	31.3	233.4	169.1	131.3	104.0	81.1	39.8	41.3
		S	192.5	112.7	109.8	87.8	53.0	20.3	32.7	213.5	113.7	119.8	95.0	73.0	30.3	42.7
		F+S	264.7	135.3	143.4	106.6	81.0	34.9	46.1	284.7	141.3	153.4	114.1	101.0	44.9	56.1
	MX2	Without	248.7	130.4	130.3	91.9	74.4	31.0	43.4	269.7	139.4	140.3	99.0	94.4	41.0	53.4
		F	348.5	178.8	179.7	112.0	102.7	43.7	59.0	368.5	178.8	189.7	119.4	122.7	53.7	69.0
		S	270.8	151.5	154.3	96.2	85.5	34.2	51.3	290.8	156.5	164.3	103.7	105.5	44.2	61.3
		F+S	388.7	174.1	214.6	120.7	110.3	48.6	61.7	409.7	184.1	225.6	128.0	130.3	58.6	71.7
LSD at 5%																
A			12.0	NS	NS	8.99	6.71	2.51	NS	14.8	14.2	8.28	NS	7.59	NS	2.35
B			7.81	NS	NS	5.58	4.28	2.79	7.36	11.6	10.1	6.13	7.84	6.59	2.83	4.25
AB			11.1	NS	NS	NS	6.05	NS	NS	16.3	14.2	8.67	NS	NS	NS	NS
C			12.9	63.8	NS	4.94	5.52	2.65	4.67	14.7	9.96	12.5	5.85	5.84	2.73	2.81
AC			18.2	NS	NS	6.99	NS	3.74	NS	20.7	14.08	17.6	8.27	NS	NS	NS
BC			22.3	NS	NS	NS	NS	4.58	NS	25.4	NS	NS	NS	NS	NS	4.87
ABC			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table (5) Effect of different amelioration techniques on Na+ and K+ content and K+/Na percent at 60th day after the both seasons of sorghum under stress condition respectively.

Different amelioration techniques			Sorghum (Season1)						Sorghum (Season2)					
			Shoot			Root			Shoot			Root		
varieties treatments	Organic amendment treatments	Bioorganic compound treatments	Na^+ (%)	K^+ (%)	Na^+/K^+	Na^+ (%)	K^+ (%)	Na^+/K^+	Na^+ (%)	K^+ (%)	Na^+/K^+	Na^+ (%)	K^+ (%)	Na^+/K^+
V1	Without	Without	4.91	1.81	2.70	3.19	1.31	2.43	4.71	2.01	2.34	2.99	1.51	1.98
		F	4.81	2.16	2.23	2.99	1.35	2.21	4.61	2.36	1.95	2.79	1.55	1.80
		S	4.55	2.26	2.01	2.69	1.39	1.93	4.35	2.47	1.76	2.49	1.59	1.57
		F+S	4.51	2.07	2.17	2.79	1.47	1.90	4.31	2.27	1.90	2.59	1.67	1.55
	MX1	Without	3.93	1.91	2.06	2.90	1.36	2.13	3.73	2.12	1.76	2.70	1.56	1.73
		F	3.84	2.30	1.67	2.83	1.33	1.83	3.64	2.50	1.46	2.63	1.53	1.72
		S	3.50	2.41	1.55	2.55	1.76	1.45	3.30	2.61	1.26	2.35	1.96	1.20
		F+S	3.48	2.45	1.50	2.65	1.89	1.40	3.28	2.65	1.24	2.45	2.09	1.17
	MX2	Without	3.94	2.11	1.75	2.48	1.68	1.48	3.64	2.21	1.65	2.18	1.78	1.22
		F	3.80	2.45	1.55	2.38	1.85	1.27	3.50	2.55	1.37	2.08	1.95	1.07
		S	3.63	2.59	1.40	2.26	1.82	1.24	3.33	2.69	1.24	1.96	1.92	1.02
		F+S	3.54	2.76	1.32	2.10	1.90	1.11	3.24	2.86	1.13	1.80	2.00	0.90
V2	Without	Without	3.46	1.72	2.02	2.94	0.85	3.52	3.16	1.82	1.74	2.65	0.95	2.79
		F	3.36	1.80	1.87	2.86	0.91	3.76	3.06	1.90	1.61	2.56	1.01	2.53
		S	3.24	1.82	1.78	2.79	0.99	2.85	2.94	1.92	1.53	2.49	1.09	2.28
		F+S	3.20	1.88	1.70	2.81	1.37	2.95	2.90	1.98	1.46	2.51	1.47	1.71
	MX1	Without	3.06	1.89	1.62	2.85	0.98	2.90	2.76	1.99	1.39	2.55	1.08	2.36
		F	2.89	1.93	1.50	2.78	1.07	2.61	2.59	2.03	1.28	2.48	1.17	2.12
		S	2.76	1.96	1.41	2.39	1.04	2.30	2.46	2.06	1.19	2.09	1.14	1.83
		F+S	2.75	1.96	1.40	2.40	1.11	2.17	2.45	2.06	1.19	2.10	1.21	1.74
	MX2	Without	2.87	1.98	1.45	2.61	1.18	2.21	2.57	2.08	1.24	2.31	1.28	1.80
		F	2.79	2.13	1.30	2.56	1.30	1.27	2.49	2.23	1.12	2.26	1.40	1.61
		S	2.59	2.16	1.20	2.48	1.47	1.69	2.29	2.26	1.01	2.18	1.56	1.40
		F+S	2.64	2.35	1.12	2.40	1.50	1.60	2.34	2.45	0.96	2.10	1.60	1.31
LSD at 5%														
A			0.30	0.13	0.09	NS	0.09	0.49	NS	0.63	0.24	NS	0.06	0.14
B			0.24	NS	0.14	0.22	0.15	0.19	0.20	NS	0.13	0.25	0.09	0.09
AB			NS	NS	NS	NS	NS	0.27	NS	NS	NS	NS	NS	NS
C			0.25	NS	0.23	NS	0.15	0.27	NS	NS	0.18	0.13	0.15	0.15
AC			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BC			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ABC			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table (6)) Effect of different amelioration techniques on Na+ and K+ uptake and translocation at 60th day after the both seasons of sorghum under stress condition respectively.

Different amelioration techniques			Sorghum (Season1)						Sorghum (Season2)					
varieties treatments	Organic amendment treatments	Bioorganic compound treatments	Shoot		Translocation		Root		Shoot		Translocation		Root	
			Na^+ ($mgplant^{-1}$)	K^+ ($mgplant^{-1}$)	Na^+%	K^+ %	Na^+ ($mgplant^{-1}$)	K^+ ($mgplant^{-1}$)	Na^+ ($gplant^{-1}$)	K^+ ($gplant^{-1}$)	T.L Na^+%	T.L K^+ %	Na ($gplant^{-1}$)	K^+ ($gplant^{-1}$)
V1	Without	Without	3.50	1.29	87.9	86.7	0.48	0.20	3.59	1.53	86.3	84.2	0.57	0.29
		F	4.89	2.20	86.8	86.8	0.74	0.33	5.10	2.61	83.6	82.5	1.00	0.55
		S	3.88	1.93	87.3	86.9	0.56	0.29	4.15	2.35	83.9	82.3	0.79	0.51
		F+S	5.57	2.55	87.7	86.2	0.78	0.41	5.75	3.03	85.1	82.3	1.01	0.65
	MX1	Without	4.54	2.21	88.0	88.4	0.62	0.29	4.68	2.66	84.3	84.1	0.87	0.50
		F	6.89	4.13	87.7	90.1	0.97	0.45	6.89	4.74	85.3	87.3	1.19	0.69
		S	5.42	3.73	88.4	88.4	0.71	0.49	5.44	4.30	85.6	85.0	0.91	0.76
		F+S	6.71	4.72	85.2	85.0	1.17	0.83	6.98	5.64	83.8	83.1	1.35	1.15
	MX2	Without	5.41	2.90	87.4	84.6	0.78	0.53	5.36	3.26	85.3	81.2	0.92	0.75
		F	7.55	4.87	84.5	81.9	1.38	1.07	7.30	5.32	83.6	79.8	1.44	1.35
		S	6.28	4.48	85.5	83.9	1.07	0.86	6.10	4.93	84.2	81.5	1.14	1.12
		F+S	7.10	5.54	84.6	82.6	1.29	1.17	6.83	6.03	84.0	80.6	1.30	1.45
V2	Without	Without	1.37	0.90	77.1	88.2	0.41	0.12	1.41	0.99	75.4	86.1	0.46	0.16
		F	1.82	1.41	77.7	87.2	0.52	0.17	2.00	1.51	73.4	83.9	0.72	0.29
		S	1.51	1.8	77.6	96.5	0.44	0.15	1.69	1.49	72.6	84.2	0.64	0.28
		F+S	2.23	1.78	79.2	87.0	0.59	0.29	2.34	2.29	75.1	83.6	0.78	0.45
	MX1	Without	2.40	1.96	81.3	91.1	0.55	0.19	2.47	2.18	76.7	87.2	0.75	0.32
		F	2.63	2.46	76.1	88.5	0.83	0.32	2.64	3.43	72.8	88.0	0.99	0.47
		S	2.28	2.32	82.5	91.7	0.49	0.21	2.31	2.34	78.4	87.0	0.63	0.35
		F+S	3.34	2.79	79.9	88.7	0.84	0.39	3.22	2.91	77.3	84.4	0.94	0.54
	MX2	Without	3.40	2.71	80.8	88.0	0.81	0.37	3.33	2.90	77.8	84.8	0.95	0.52
		F	4.71	3.99	80.8	87.5	1.12	0.57	4.45	3.99	78.6	84.2	1.21	0.75
		S	3.02	3.42	78.1	87.2	0.85	0.50	2.90	3.54	75.0	83.7	0.96	0.69
		F+S	4.60	4.9	79.8	84.9	1.17	0.73	4.31	4.51	77.8	82.8	1.23	0.94
LSD at 5%														
A			0.01	0.75	0.83	NS	0.001	0.001	NS	0.22	NS	0.21	0.001	0.001
B			0.43	0.24	NS	NS	0.05	0.01	0.12	0.30	NS	1.25	0.05	0.05
AB			NS	0.34	NS	2.91	NS	0.01	0.16	0.42	1.70	1.77	0.07	0.07
C			0.80	0.40	NS	NS	0.10	0.01	0.21	0.44	NS	NS	0.09	0.09
AC			NS	0.57	NS	NS	NS	0.02	0.30	0.62	NS	NS	NS	0.12
BC			NS	NS	NS	6.40	NS	0.03	NS	NS	NS	NS	NS	NS
ABC			NS	NS	NS	NS	NS	0.04	NS	NS	NS	NS	NS	NS

CONCLUSION

It is recommended to use studded amelioration techniques, which is effective, especially with spraying with the bio-organic compound on the vegetative system of the plant and injecting it with irrigation water. Amelioration techniques works on the decrease of sodium in the soil through the accumulation of high concentrations of sodium within the shoots and roots of plants grown in sorghum. It is highly recommended to use a treatment of soil with a mixture of (1:3) FM + vinasse at a rate of 5 tons fed^{-1} with bio-spray and injection with irrigation water. It is recommended to use salinity-resistant varieties (Giza 113) Sorghum in salt-affected lands under conditions of salt stress.

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استجابة صنفين من الذرة الرفيعة للإجهاد الملحي للتربة المستصلحة حديثًا في صعيد مصر

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اجريت هذه الدراسة في مزرعة خاصة تقع جنوب شرق محافظة سوهاج خلال موسمين متتالين من 2018/2017 و 2019/2018. واستخدمت معالجات (معالجة التربة بمخلوط (1:3) طينة المرشحات + الفيناس بمعدل 2 طن / فدان ((MX1)و(معالجة التربة بمخلوط (1:3) طينة المرشحات + الفيناس بمعدل 5 طن / فدان (MX2) (ومعالجة النبات باستخدام مركب عضوي حيوي ارضي منفردا S) (ورشا علي المجموع الخضري للنبات منفردا (F) واستخدامها معا (S+F) ذلك تحت استخدام صنفين من الذرة الرفيعة احادهما مقاوم نسبيا للأملاح والاخر حساس نسبيا. زاد كل من الوزن الطازج والجاف للمجموع الجذري الخضري وكذلك المحتوي المائي لكل من المجموع الجذري والخضري عند 60 يومًا من الزراعة وزاد طول النبات للأصناف المدروسة مقارنة بالكنترول وكانت اعلي زياده عند استخدام معالجة التربة والنبات بمخلوط2 ((MX2 مع رش المركب العضوي الحيوي وذلك في كلا الموسمين وكانت الموسم الثاني اعلي من الموسم الاول. أوضحت الدراسة أن النباتات المقاومة للملوحة (جيزة113) قد زاد كل من الوزن الطازج والجاف للمجموع الجذري والخضري وكذلك المحتوي المائي كانت أكثر بمقارنة الأصناف الحساسة للملوحة (دورادو) باستخدام تقنيات التحسين المختلفة في التربة المدروسة تحت ظروف الإجهاد الملحي. أوضحت الدراسة أن النباتات المقاومة للملوحة (جيزة113) قد حدث تحسن ملحوظ في محتوى Na وحالة امتصاص Na لكل من المجموع الخضري والجذري كان المجموع الخضري أعلى تراكم من الجذري في محتواه من الصوديوم بمقارنة الاصناف الحساسة للملوحة وأظهر الدراسة أن تقنيات التحسين المختلفة مع المركب العضوي (MX1) و (MX2وكذلك المعالجات الحيوية العضوية للتربة والنبات (التربة SوالرشF والتربة + الرش (S+Fتحت الاصناف المدروسة في مقاومة الملح عند 60 يومًا) عند مقارنة الطرق الثلاث المدروسة للتحسين الحيوي العضوي وجدا أن تأثيرًا استخدام مقدار 5 طن فدان من الخليط 2 (MX2) مع إضافه المركب الحيوي العضوي للتربة ورشا للنباتS+F ، مقارنة بالطريقة الأخرى وحدها يقوم النبات بنقل صافٍ أكبر لـ Na من الجذور إلى المجموع الخضري وكانت أعلي في الموسم الثاني عن الاول. أوضحت الدراسة أن النباتات الحساسة للملوحة (دورادو) قد حدث تحسن ملحوظ في محتوى Kوحالة امتصاص Kلكل من المجموع الجذري و الخضري كان المجموع الخضري اكبر من الجذري في محتواه من البوتاسيوم بمقارنة الأصناف المقاومة للملوحة جيزة113) قد وجد أن محتوي المجموع الجذري اكبر من المجموع الخضري في محتواه من البوتاسيوم باستخدام تقنيات التحسين المختلفة في التربة المدروسة تحت ظروف الإجهاد الملحي. وجد أن النباتات المقاومة نسبيًا للملوحة (جيزة113) قد حدث انتقال اكبر ل Na لكل من المجموع الجذري الي المجموع الخضري. وكان محتوي الجذور من الصوديوم اقل بمقارنة الاصناف الحساسة نسبيًا للملوحة (دوراد) وقد وجد أن محتوي المجموع الجذري أكبر من المجموع الخضري في محتواه من الصوديوم باستخدام تقنيات التحسين المختلفة في التربة المدروسة تحت ظروف الإجهاد الملحي. بمقارنة الصنفين المدروسين ، كانت نسبة Na / k دائمًا أعلى في المجموع الخضري للصنف المقاوم نسبيًا للملوحة (جيزة113) ولكنها كانت أقل بشكل عام في الصنف الحساس نسبيًا للملوحة (دوراد).