Egypt. J. Soil Sci. **48** No.3, pp. 399- 414 (2008)

Effect of Salinity and Supplementary Phosphorus and Potassium on Growth, Yield, Nutrition Development and Anatomical Structure of Sorghum Plants

M.M. Hussein*, A.A. Abd El-Kader, K.A. Kady*** and R.A. Youssef ****

Water Relations and Irrigation Department, **Soils and Water Use Department , National Research Center, Giza and * Faculty of Home Economics, Helwan University, Helwan, Egypt.*

A POT experiment was conducted in the Greenhouse of National Research Center, Dokki, Giza, Egypt during the summer season of 2005 to evaluate the effect of different salt concentrations (Tap water as control, 2500 ppm and 5000 ppm from diluted sea water) and potassium and phosphorus foliar application (0,50 and 100 ppm spraying of Potassium dihydrogen phosphate) on the growth, yield, chemical composition and anatomical features of sorghum plants. There is a negative relationship between salinity and growth characters. Continuous depression was detected in plant height, number of green leaves , fresh weight of shoot and the increase in salt concentration in the root media. However, the decrement in fresh weight of shoot seemed to be equal with the two levels of salinity. Nitrogen and phosphorus concentration decreased with both levels of salt stress but the differences between the 1^{st} and 2^{nd} levels was less than to be considerable. The increase in salt concentration in water of irrigation adversely affected the content of N and P content in shoots of sorghum plants.

Except number of green leaves, growth traits increased by foliar fertilization and increment raised as the dose of fertilizer increased. The values in fresh and dry weights of shoots could be amounted by the two folds of the control and the plant height regularly increased by the increase in foliar fertilization. Concentration of N and P was increased by foliar fertilizer and the increment by the 2^{nd} dose of fertilizer exceeded those from the 1^{st} dose. Significant and pronounced increases in N and P content were found by application of fertilizer through leaves. This was hold fairly true under irrigation by salt solutions or tap water.

The differences in number of green leaves were not significant. The positive effect of P and K foliar fertilizer was markedly shown under different salt level. Spraying of foliar fertilizer considerably lowered the depressive effect of salinity on the content of P and N. This was true under the two levels of salinity.

Irrigation regimes include saline irrigation water, caused a reduction in the diameter of cross stem section and leaf blade. The decreases were due to the decrease in length and width of the vascular bundles and diameter of xylem vessels as well as thickness of mesophyl of leaf blade. Potassium foliar application alleviated the harmful effect of saline water on the internal structure of stem and leaf.

Keyword: Salinity, P and K Foliar fertilizer, Anatomical features, Sorghum.

It is a well known fact that world recourses of fresh water is getting exhausted because agriculture and industry have become more intensive; the population and numbers of new settlements have increased; and the living standard has improved and also the demand of water for agriculture will increase in contrast with increasing scarcity. Therefore, the use of low water quality, such as ground water, drainage water and even sea water diluted with fresh water, the best irrigation management and use of appropriate agronomic techniques are necessary. The irrigation management may vary according to whether the objective is to maximize production or to minimize the adverse effects on soil. The suitability or unsuitability of irrigation water should be evaluated on the basis of local conditions in conjunction with the prevailing climate, soil and plant growth. Dissolved salts have general and specific effects on plants that directly influence crop growth and yield. (El-Sharawy *et al.*,1997; Tededschi & Menenti, 2002 and Saleh *et al.*, 2002). Soil salinity has been considered a limiting factor to crop production in arid and semi arid regions of the world (Gheyi, 2000 and Munns, 2002).

Sorghum is becoming an increasingly important forage crop in many regions of the world (Zerbini & Thomas, 2003). Grain Sorghum is one of the most important cereal crops in Egypt. It ranks third among summer cereal crops after rice and maize in term of acreage and total production. Grain Sorghum tolerates many diverse environments such as heat, drought, salinity, poor soils and many other stress conditions compared to maize crop. (El-Kady, 2006). Sorghum salt sensitivity has been related to reduction in the concentrations of ions such as K^+ and Ca^{2+} and/or leaf accumulation of toxic ions, especially Na^+ and Cl^- (Berstein *et al.*, 1995; Igartua *et al.*, 1995; Lacerda *et al.*, 2003a and Claudivan *et al.*, 2005). Potassium phosphate fertilizers can use as a specially fertilizers in intensified agriculture in green houses as well as in open fields. It can be used either in direct application or as intermediate for compound NPK mixture to empire the desired ratio of N:P:K. Also it could used specially in high PK depletion periods as in the time of fruiting (Ankorion,1995). Good intake, translocation and improving leaf P and K status in some crops were detected (Neumann & El-Etzion, 1993; Ankorion, 1995 and Willams & Kafkafi, 1995).

As function of soil management there are using soil leaching; water quality; chemical amendments and nutrients balance through fertilization to the soil or foliar application to counteract the drought or salinity negative effects (Nour *et al.*, 1989; Hussein *et al.*, 1990; Sherif *et al.*, 1998 and Thalooth *et al.*, 2006) .

This experiment carried out during the summer season of 2005 to evaluate the effect of different salt concentrations by diluted seawater and foliar application with phosphorus and potassium on the growth, yield, chemical composition and anatomical features of sorghum plants.

Material and Methods

A pot experiment was conducted in the greenhouse of National Research Centre during the summer season of 2005 to evaluate the effect of spraying Potassium di-hydrogen phosphate [KH_2PO_4] and different concentration of salts through irrigation by diluted seawater on growth, yield and content of different nutrient elements to sorghum plants *(Sorghum bicolor* L. cv. Dorado) .Some chemical, physical properties and nutrients concentration of the experimental soil are presented in Table 1a & b. The irrigation water with different salt concentration was prepared by using the sea water as a source of salinity. The analysis of sea water are shown in Table 1c. The treatments were as follows:

I)- Salt concentration: tap water, 2500 and 5000 ppm by diluting sea water (33 000 ppm salts). II)-Phosphorus and Potassium as potassium di-hydrogen phosphate sprayed at 0, 50 and 100 ppm as PK.

TABLE 1. Some physical and chemical properties of studied soil A, B and sea water (C).

A . Soil mechanical analysis.

Sand		Silt 20-2 μ%	Clay < 2 μ%	Soil Texture
Course >200 μ %	Fine 200-20μ %			
7.20	14.25	30.22	48.33	clay

B . Soil chemical analysis.

pH 1:2.5	EC dSm^{-1} 1:5	$CaCO_3$ %	CEC C mole Kg^{-1}	OM %	Soluble cations and Anions meq/100 g soil							
					Na^+	K^+	Ca^{2+}	Mg^{2+}	CO^{-3}	HCO^{-3}	Cl^{-1}	SO^{-2}
7.15	1.3	2.53	33.5	1.3	1.82	0.23	2.38	1.27	0.0	0.91	1.9	1.89

Available macro and micro-nutrients (ppm)						
N	P	K	Zn	Fe	Mn	Cu
47	7.5	264.0	3.1	4.8	7.3	5.2

C. Chemical analysis of sea water.

pH	EC (dSm^{-1})	Cations (meq/L)				Anions (meq/L)			
		Na^+	K^+	Ca^{2+}	Mg^{2+}	CO^{-3}	HCO^{-3}	Cl^{-1}	SO^{-2}
8.62	33.0	393.5	20.4	26.2	118.3	0.53	9.6	253.2	295.1

The experiment included 3 levels of salinity in combination with three PK foliar fertilization (Fo PK) *i.e.,* 9 treatments in 6 replicates. Metallic ten pots 35 cm in diameter and 50 cm. in depth were used. Every pot contained 30 kg of air dried clay soil. The inner surface of the pots was coated with three layers of bitumen to prevent direct contact between the soil and metal. In this system, 2 kg of gravel (particles about 2-3 cm in diameter), so the movement of water from the base upward. Seeds of grain sorghum (*Sorghum bicolor* L.) *Dorado* were sown in July 20, 2005.

Plants were thinned twice, the 1st 15 days after sowing and the 2nd two weeks latter to leave three plants / pot. Calcium super phosphate (16 % P_2O_5) and potassium sulfate (48.5 % K_2O) in the rate of 3.0 and 1.50 g/pot were added before sowing. Ammonium sulfate (20.5 % N) in the rate of 6.86 g/ pot was added in two equal portions, the 1st after two weeks and the 2nd two weeks latter. Irrigation with diluted red sea water in different concentrations were started 30 days after sowing (one irrigation by salt water and the next was by fresh water alternatively). Representative plant samples of three replicates of each treatment were randomly taken at harvesting stage of sowing. The following measurements were determined during the season. Soils and plant samples were collected . Plant samples were cleaned, dried in oven at 70°C and ground in a stainless steel mill. Chemical analysis was carried out according to the methods which described by Cottenie *et al.* (1982). The obtained results were subjected to the split plot statistical analysis according to Snedecor & Cochran (1980).

Anatomical study

Samples for anatomical study were taken from selected treatments during the at the age 8 weeks from the 7th internodes from the main stem with its fully expanded leaf . Samples were killed and fixed in F.A.A. solution (10 ml formalin + 5 ml glacial acetic acid + 35 ml distilled water + 50 ml ethyl alcohol 95%) for two days. Samples were hydrated and cleared in butyl alcohol series (Willey , 1971) and embedded in paraffin wax of 56-58°C m.p. Cross sections 20μ in thickness were cut using a rotary microtome, adhesive with Haupt's adhesive and stained with crystal violet-erythrosine combination (Sass, 1961), cleared in carbolxylene and mounted in Canada balsam and microscopically examined . Measurements data were taken using calibrated eyepiece micrometer, averages of 10 readings were calculated.

Results and Discussion

Effect of salinity

Growth and yield parameters

Data presented in Table 2 show the effect of different saline concentration rates (0, 2500 and 5000 ppm of diluted sea water) on some growth parameters of sorghum. Data reveal that dry weight of plant, plant height, Leaf area and leaves number per plant of sorghum irrigated by saline water were significantly decreased as compared with those irrigated by tap water. The highest values of the previous parameters were obtained from plants irrigated with tap water followed by 2500 and 5000 ppm in decreasing order. Many authors sported the adverse effects of salinity on plant growth and productivity among of them: Ahmed *et al.* (2000); Badr & El-Shafie (2003) and Lacerda *et al.* (2005). The obtained results indicate that salinity has more hazardous effect on the studied parameters of sorghum plants. This effect might be due to salinity which generally inhibits the growth of plants, through reduced water absorption, reduced metabolic activities due to Na^+ and Cl^- toxicity and nutrient deficiency caused by ionic interference (Mengel & Kirkby, 1982).

TABLE 2. Some growth parameters and yield of sorghum as affected by salinity from diluted sea water and P and K foliar application.

Treatments		Plant hight (cm)	No of green leaves	Av. one leaf area (cm)	Shoot weight g/plant		Grain yield g/ plant
Salinity ppm	Fo PK ppm				fresh	dry	
0	0	115.0	7.0	171.6	90.4	36.5	22.2
	50	123.0	7.7	188.3	107.6	43.5	30.7
	100	134.6	8.7	203.6	121.4	48.8	32.7
Mean		124.2	7.8	187.8	106.5	42.9	28.5
2500	0	91.2	5.7	135.3	66.1	26.6	16.3
	50	103.3	6.7	170.6	101.7	41.0	27.4
	100	129.3	7.3	175.7	115.1	46.5	29.2
Mean		107.9	6.6	160.5	94.3	38.0	24.3
5000	0	85.0	5.7	122.0	54.0	21.8	13.8
	50	93.6	5.7	149.0	87.2	35.6	22.3
	100	112.9	6.7	166.3	105.4	42.5	24.0
Mean		97.0	6.0	145.8	82.2	33.3	20.0
Mean Salinity		124.2	7.8	187.8	106.5	42.9	28.5
		107.9	6.6	160.5	94.3	38.0	24.3
		97.0	6.0	145.8	82.2	33.3	20.0
Mean Fo Pk		97.1	6.1	143.0	70.2	28.3	17.4
		106.7	6.7	169.3	98.8	40.0	26.8
		125.7	7.6	181.9	114.0	45.9	28.6
LSD at 0.05							
Salinity		2.07	0.56	5.36	3.77	4.87	1.45
Fo PK		1.36	0.31	2.91	8.76	5.77	2.05
interaction		3.38	NS	4.75	NS	NS	NS

This means that salt stress inhibits plant growth by water deficiency and ion toxicity among other factors (de Lacerda *et al.,* 2003). The supply of mineral ions to the leaf growing region may decline. Lower transpiration rate, coupled with reduced ion uptake by the roots, or reduced xylem loading, may cause poor supply via the xylem. So it is possible that an inadequate supply of ions to the expanding region may restrict cell division and/or expansion when plants are grown at high levels of NaCl (Berstein *et al.,* 1995). In expanding leaves, salinity has disturbed concentrations of K (Jeschke, 1984) and P (Martinez & Lauchli, 1991). Moreover, the inhibitory effect of salinity on the growth and plant production could be attributed to the osmotic effect of salinity (Munns, 2002). They pointed out that, salt within plant reduce growth by causing premature senescence of old leaves and hence a reduced supply of assimilates to the growing regions. Godfrey *et al.* (2004) reported that the two sorghum varieties appear to sequester Na^+ predominantly in roots, stems, leaf sheaths and older leaf blades sparing the growing tissues as a salt tolerance mechanism. Nevertheless, greatly reduced concentrations of Ca^{2+}, K^+ and Mg^{2+} in leaves under salinity could cause cation deficiency which reduces plant growth.

Macronutrients in both leaves and grans

Data in Tables 3 and 4 show that Na concentration in sorghum plant irrigated by different saline water significantly increased as compared with control plants irrigated by non saline water.

The obtained results of Na^+ concentration in sorghum are in good agreement with those obtained by Barett-Lennard (2003) and Shi & Sheng (2005). Hussein & Magied (2000) found that increasing salt concentration increased P, K and Mn while N, Fe and Zn content increased slightly by 2000 ppm salt in water of irrigation. Lacerdia *et al.* (2005) revealed that salinity increased the Na^+ or cell Na^+/K^+ and Na^+/Ca^{2+} ratios in wheat leaves. Ahmed (2000) on some sorghum cultivar, demonstrated that N, Ca and Na showed higher mean values on cultivars grown in saline clay soil, however, P, K and Mg concentrations exhibited the opposite trend. Badr & El-Shafie (2002) pointed out that salinity increased Mg^{2+} Na^+ and Ca^{2+} in wheat plants. This means that salinity induced disturbance in the nutrients status in plant leaves. Concerning this phenominion, Marschner (1986) and Zekri & Persons (1992) noted that the damage caused by salinity has been attributed mainly to the excessive accumulation of Cl^- and Na^+ in leaves and plants causing a nutritional disorder through the reducing of Ca^{2+}, Mg^{2+} and K^+. Generally, data show that K^+ concentration in sorghum irrigated by saline water significantly decreased when compared with K^+ content in sorghum irrigated by non-saline water. Confirm these results, Grattan & Grieve (1999) who reported that high levels of external Na not only interfere with K^+ acquisition by the roots, but also may disrupt the integrity of root membranes and alter selectivity.

Moreover, Na^+ and K^+ changes also reflected the effect of salt-alkali mixed stress on the metabolism of Na^+ and K^+ and indicate that the physiological responses of plant to salt-alkali mixed stress were more complex than that of salt stress alone. Confirm the previous results Weinberg (1987) and Lacerda *et al.* (2003) who reported that Na^+ increased and K^+ decreased in plants stressed by salt and they added that high levels of Na^+ inhibited the K^+ concentration in sorghum plants and as a results of this it caused an increase in the Na^+/K^+ ratio.

Data in Table 4 reveal that, regardless the effect of $K_2H_2PO_4$, irrigated sorghum plants by 2500 ppm in diluted seawater led to decrease N,P,K and Ca and when irrigated by 500 ppm solution increased the reduction of these elements compared to that irrigated by fresh water. On reverse, these two concentration of salts increased Na+ content than that in control plants. Aich *et al.* (1998) and Hathout (1996) reported that salinity above 8000 ppm significantly decreased N content in wheat grains. Moursy & Gaballah (2001) found that the highest Na content recorded in shoots and the lowest in wheat grains under salinity. P in mg/g decreased in different wheat plants included grains. Furthermore, in spite of that the bulk of the studies indicate the N uptake or accumulation in the shoot may be reduced under saline conditions, however some studies found the opposite or no-effect (Feigin, 1985).

TABLE 3. Macronutrients uptake of sorghum leaves as affected by salinity from diluted sea water and P K foliar application.

Treatments		Macronutrients (%)				
Salinity ppm	Fo P K ppm	N	P	K	Na	Ca
0	0	1.16	0.33	2.43	0.81	1.15
	50	1.56	0.39	2.53	0.74	1.21
	100	2.11	0.45	2.57	0.65	1.26
Mean		1.61	0.39	2.51	0.73	1.21
2500	0	1.08	0.25	2.14	0.93	1.15
	50	1.27	0.29	2.18	0.86	1.10
	100	1.52	0.32	2.39	0.85	1.09
Mean		1.24	0.27	2.23	0.88	1.11
5000	0	1.05	0.09	1.57	1.00	1.03
	50	1.20	0.14	1.86	0.98	1.00
	100	1.32	0.19	1.92	0.93	0.81
Mean		1.19	0.13	1.78	0.97	0.94
Mean Salinity		1.61	0.39	2.51	0.73	1.21
		1.24	0.27	2.23	0.88	1.11
		1.19	0.13	1.78	0.97	0.94
Mean Fo PK		1.10	0.22	2.05	0.91	1.11
		1.34	0.27	2.19	0.86	1.10
		1.65	0.32	2.29	0.81	1.05
LSD at 0.05						
Salinity		0.093	0.023	0.021	0.039	0.014
Potassium		0.097	0.029	0.024	0.032	0.011
interaction		0.159	NS	0.029	NS	0.016

TABLE 4. Macronutrients contents of sorghum grains as affected by salinity from diluted seawater and P and K foliar application.

Treatments		Macronutrients (%)				
Salinity ppm	Fo PK ppm	N	P	K	Na	Ca
0	0	1.33	0.42	1.66	0.63	0.75
	50	1.44	0.46	1.95	0.56	0.85
	100	1.63	0.55	2.13	0.51	0.93
Mean		1.47	0.48	1.91	0.57	0.84
2500	0	1.13	0.36	1.38	0.67	0.63
	50	1.25	0.37	1.49	0.55	0.68
	100	1.34	0.38	1.53	0.57	0.75
Mean		1.24	0.37	1.47	0.60	0.69
5000	0	0.84	0.19	1.16	0.85	0.53
	50	1.22	0.24	1.27	0.66	0.55
	100	1.29	0.29	1.34	0.61	0.59
Mean		1.12	0.24	1.25	0.71	0.56
Mean Salinity		1.47	0.48	1.91	0.57	0.84
		1.24	0.37	1.47	0.60	0.69
		1.12	0.24	1.25	0.71	0.56
Mean Fo PK		1.10	0.32	1.40	0.72	0.64
		1.30	0.36	1.57	0.59	0.69
		1.42	0.41	1.67	0.56	0.76
LSD at 0.05						
Salinity		0.025	0.010	0.040	0.023	0.035
Potassium		0.057	0.020	0.046	0.021	0.022
interaction		0.092	0.029	0.050	0.029	0.037

Data in Tables 3 and 4 show that the interaction between salinity and phosphorus (P) content of plants is equally as complex as that between salinity and N, *i.e.,* the P conc. in sorghum leaves and grains took the same trend of N conc. In most cases, salinity decreases the concentration of P in plant tissue (Sharpley *et al.,* 1992) but the results of same studies indicate salinity either increased or had no-effect on P uptake. Phosphate availability is reduced in saline soils not only because of ionic strength effect that reduce the activity of phosphate but also because phosphate concentrations in soil solution are tightly controlled by sorption processes and by the low-solubility of Ca-P minerals. Therefore, it is understandable that phosphate concentrations in field-grown agronomic crops decreased as salinity ($NaCl+CaCl_2$) increased (Sharpley *et al.,* 1992) Godfrey *et al.* (2004) reported that the negative effect of NaCl on the allocation of K, Ca^{2+} and Mg^{2+} to the leaf tissues may contribute to their deficiency and the accompanying metabolic perturbations.

Effect of foliar fertilization

The concentration of N and P was increased by foliar fertilizer and the increment by the 2^{nd} dose of fertilizer exceeded those from the 1^{st} dose. However, K concentration slightly affected but the values of Ca concentration seemed to be without effect. Na+ concentration was reversely responded (Table 3). Significant and pronounced increases in N and P content and decreases in Na+ content (Table 4) were found by application of fertilizer through leaves. This was hold fairly true under irrigation by salt solutions or tap water. Similar trends were obtained by Willams & Kafkafi (1995).

Effect of interaction

The positive effect of PK foliar fertilizer was markedly shown under different salt level. Spraying of foliar fertilizer considerably lowered the depressive effect of salinity on the content of P and N. This was true under the two levels of salinity (Table 3 and 4). The obtained results in agreement with Kaya *et al.* (2001) who pointed out that Sodium (Na) concentration in plant tissues increased for both species, especially in lettuce, in the elevated NaCl level. High salinity lowered the concentrations of P and K in leaves, but supplementary potassium (K) and phosphorus (P) enhanced concentrations of these two elements in the leaves. The results suggest that supplementary P and K can reduce the adverse effects of high salinity on plant growth and physiological development.

Effects on soil properties

After the harvest of sorghum representative soil samples were analyzed. The results in Table 5 indicated that slightly alkaline in soil pH, increase in soil EC, low content of N and P and high levels of Na^+ inhibited the K^+ concentration and as a result of this, it caused an increase in Na^+/K^+ ratio. This may be causes a disturbance in the ion balance in plant by an increase in the Na^+ uptake, which improved by foliar application. In order to since soluble salts accumulate in soils must be leached below the crop root zone to maintain productivity.

TABLE 5. Some chemical properties of studied soil after harvest sorghum.

Treatments		pH (1:2.5)	EC (dSm^{-1})	Macronutrients (mg/kg soil)			
Salinity ppm	Fo pk ppm			N	P	K	Na
0	0	7.25	1.36	41	14	300	250
	50	7.32	1.41	45	16	325	230
	100	7.41	1.47	47	18	350	210
2500	0	7.36	2.68	35	11	280	380
	50	7.45	2.59	38	13	310	365
	100	7.55	2.43	38	14	315	360
5000	0	7.60	4.71	36	10	220	450
	50	7.68	4.56	39	12	280	410
	100	7.75	4.39	42	12	290	395

Anatomical traits

Stem anatomy

The results revealed adverse effect of the tested salinity levels (2500; 5000 ppm) on all anatomical stem traits as shown in Table 6 and Fig. 1 .

Data indicated a reduction in stem section diameter these reduction were due to decreases in parenchymatous tissues length and width of the vascular bundles, average of diameter of xylem vessels. Also potassium foliar application alleviated the harmful effect of saline water on the internal structure of sorghum stem, barley and wheat, who suggested that the harmful effect of salinity may be due to suppressed division and enlargement of cells and the salinity caused narrowing for the vessels of conducting tissue and reducing for the cell size of both xylem and phloem .Similar results were obtained by El-leboudi & El-Semak (1997) on wheat plant. Akram *et al.* (2002) revealed that tomato stem characteristics (area of epidermal cell, largest metaxylem and cortex) were adversely affected by increasing salinity. Also salinity reduced area of cortex, stele and pith in roots. Junghans *et al.* (2006) found that both poplar species showed decreases in vessels lumina associated with increases in wall strength in response to salt stress.

TABLE 6. Effect of salinity and P and K foliar application on the internal structure of sorghum stem .

Treatments		Botanical properties (μ)				
Salinity ppm	Fo P K ppm	Stem diameter (μ)	Stem wall thikness (μ)	Dimension of vascular bundle		Xylem vessel diameter (μ)
				Length (μ)	Width (μ)	
0	0	4370	28.5	106.6	95.8	26.75
	50	4940	31.1	108.3	100.3	28.32
	100	5890	33.3	110.2	103.2	29.25
2500	0	3665	21.2	94.5	90.2	19.35
	50	3984	23.6	99.0	90.5	20.30
	100	4180	25.2	100.2	93.21	21.20
5000	0	3042	17.5	90.3	85.0	18.25
	50	3440	18.3	94.3	90.0	19.60
	100	3910	20.2	96.6	92.3	20.40

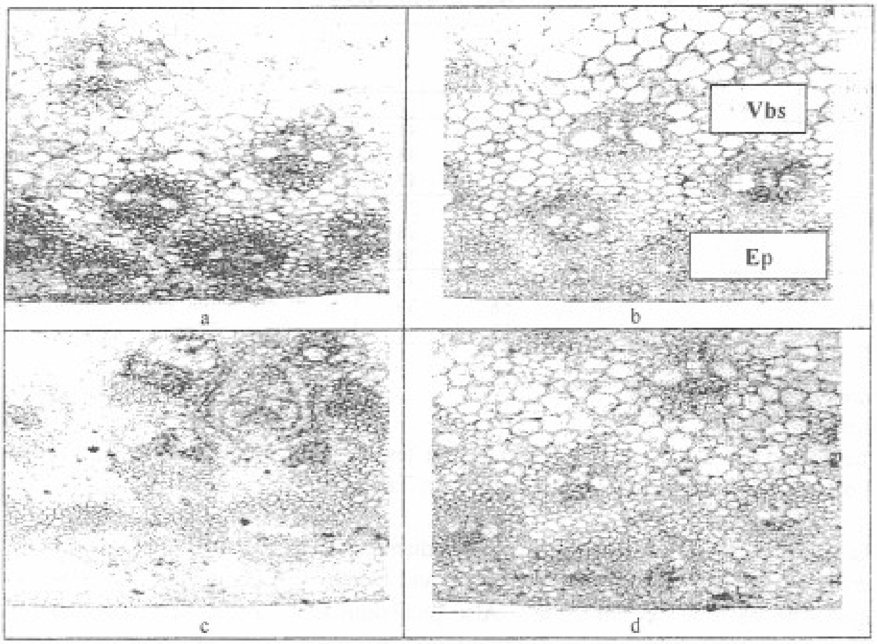

Fig. 1. Transactions of sorghum stem as affected by salinity from diluted sea water and P and K foliar application. [a] control; [b] treated with 100 ppm Fo PK; [c] treated with 5000 ppm salinity; [d] treated with 5000 ppm salinity + 100 ppm FoP K .(X = 100, Ep: Epidermal- Vbs : Vascular bundle).

Leaf anatomy

The results revealed adverse effect of salinity levels (2500; 5000 ppm) on all anatomical leaf traits as shown in Table 7 and Fig. 2. Data indicated a decreases in lamina thickness, upper and lower epidermis, length and with of bulli form cell, mesophyll thickness, small and larg vascular bundle dimension and xylem vessel dimension. Potassium foliar application alleviated the harmful effect of saline water on the internal structure of sorghum leaf. Baum *et al.* (1999) noticed that within the growth zone, salt affected leaves of sorghum and narrow protozylem and metazylem cells than control. Hu *et al.* (2001) reported that the cellular cross section area of wheat leaf at 120 mM NaCL was reduced by 32 % at 5mm, compared to 36 % arranged from region between 5 and 30 mm from the leaf base, indicating that the reduction in this criterion by salinity occurred mainly at the leaf base when the leaf initiated. Hameed *et al.* (2002) revealed that the thickness of wheat leaf cuticle, epiderms, hypoderms and number of stomata generally increased under water stress which the number of hairs and stomatal length decreased in wheat by salt stress. Akram *et al.* (2000) on tomato, found that salinity increased the number of stomata while reduced the area of stomata and interveinal distance.

Conclusion

In present study, salt stress caused significant decreases in the studied growth parameters as well as macro nutrients in both leaves and grains. The negative effect of saline water on plant was due to osmotic potential by salt in the soil solution which reduced cell water required from soil solution, and/or to the toxicity of Na^+ and Cl^- accumulated ions. Moreover, high NaCl induced depression in mineral uptake and translocation which led to great nutrient deficiencies in the leaves tissues included P and K. Foliar spray of KH_2PO_4 alleviated the adverse effects of high salinity on plants and improved all parameters mentioned above.

Saline irrigation water, caused a reduction the diameter of cross stem section and leaf blade. The decreases were due to the decrease in parenchymatous tissues length and width of the vascular bundles, and diameter of xylem vessels as well as thickness of mesophyll of leaf blade. Potassium foliar application alleviated the harmful effect of saline water on the internal structure of stem and leaf.

It could be said that in the strategy for coping with salinity could, therefore, be to attempt to supplement P and/or K where the growth medium is known to be or may become saline at some time during the crop growth cycle and foliar spray of P and K fertilizer may be needed specially at fruiting periods which characterized by high depletion of these two elements.

TABLE 7. Effect of salinity and P K foliar application on the internal structure of sorghum leaf.

Botanical properties (µ)	Saline water treatments								
	0 ppm			2500 ppm			5000 ppm		
	Potassium foliar application treatments								
	0 ppm	50 ppm	100 ppm	0 ppm	50 ppm	100 ppm	0 ppm	50 ppm	100 ppm
Lamina thichness	135	142.6	150.8	122.3	128.2	132.2	97.2	103.2	107.3
Upper epidermal thickness	26.5	32.2	34.5	21.4	23.5	26.0	18.5	19.82	22.23
lower epidermal thickness	22.5	27.0	29.3	20.0	21.3	22.5	17.1	18.3	19.20
Bulliform cell length	49.5	51.3	53	40.5	42.8	46.5	28.9	31.5	33.8
Bulliform cell width	34.2	38.2	42.8	23.4	28.5	30.5	22.5	29.5	25.7
Mesophyll thickness	90	102.2	103.2	81	90	98	72	77.8	85.9
Small Vb's dimension	58.5x 59	58.5x 49.5	60x60	54x45	54x49	58x53	50.2x 49	51.1x 49	52.3x 50
large Vb's dimension	108.5x 98.9	110x 102.5	112.3x 103.2	96.5x 89	98.7x 91.2	99.5x 92.3	91.5x 85	92.3x 88.9	96.4x 90.3
Xylem vessel in large Vb's d	28.8x 29.3	22x22	23.5x 22.1	17x17	18.2x 17	20.1x 19	18x18	19x19	26x19
Number of vascular bundle	132	135	137	118	119	125	117	118	123

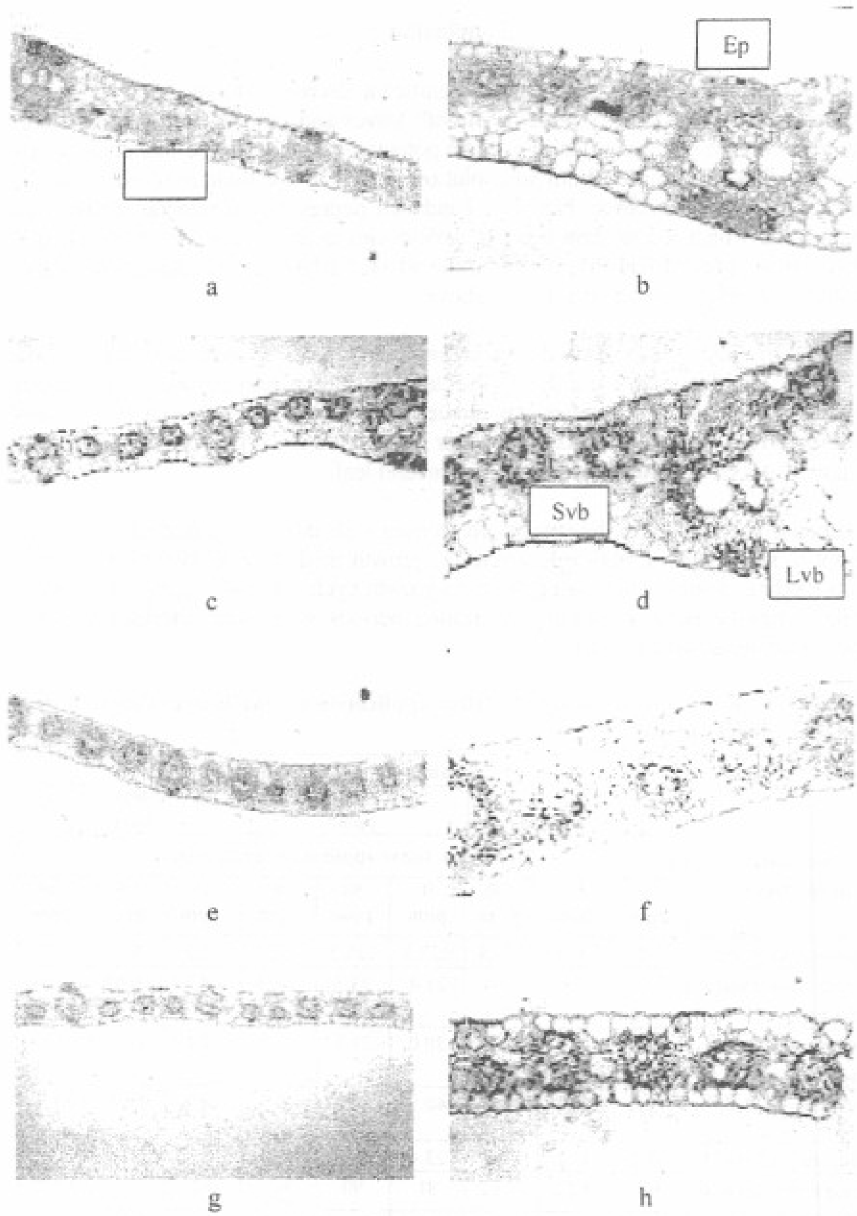

Fig. 2. Transactions of sorghum leaf blade as affected by salinity from diluted sea water and potassium foliar application . [a, b] control; [c,d] treated with 100 ppm Fo P K; [e,f] treated with 5000 ppm salinity; [g, h] treated with 5000 ppm salinity + 100 ppm Fo P K (. X- 100. EP: Epidermal- Bf: Bulliform cell- Lvb: Large Vascular bundle= Svb: Small Vascular bundle).

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(*Received* 8/2008;
accepted 9/2008)

تأثير الملوحة و الفوسفور و البوتاسيوم الاضافى على النمو والمحصول وتطورالتغذية و الصفات التشريحية فى نبات السورجم

محمد مرسى محمد حسين*، عبدالقادر عبدالفتاح عبدالقادر ، خالد عبدالغفار القاضى*** و رفعت عبدالقوى ابو يوسف****

*قسم العلاقات المائية والرى – ** قسم الأراضى واستغلال المياه – المركز القومى للبحوث – الجيزة*** وكلية الإقتصاد المنزلى – جامعة حلوان – حلوان– مصر.

اجريت تجربة بصوبة المركز القومى للبحوث بغرض تقييم نبات الذرة الرفيعة صنف دورادو و المنزرع فى ارض طمية فى موسم ٢٠٠٥ مع الرى بمياة البحر المخفف بتركيزات ملوحة مختلفة وهى٢٥٠٠و ٥٠٠٠ جزء فى المليون مع استخدام ماء الصنبور كمعاملة مقارنة ورش النباتات بالبوتاسيوم داى هيدروجين فوسفات (صفر و ٥٠ و ١٠٠جزء فى المليون).

و كانت النتائج المتحصل عليها كالتالى:

١. التركيزات العالية من الملوحة قللت تركيز كل العناصر تحت الدراسة.
٢. نقص تركيز كلا من النتروجين و الفوسفور و البوتاسيوم وزيادة الصوديوم بزيادة تركيز الملوحة الى ٥٠٠٠جزء فى المليون فى الاوراق.
٣. محتوى حبوب الذرة الرفيعه من النتروجين و الفوسفور و الكالسيوم نقص بزيادة تركيز الملوحة .
٤. زيادة نقص محتوى حبوب الذرة من الصوديوم وزيادة محتواها من البوتاسيوم برش الفوسفور والبوتاسيوم مما ادى الى تقليل الضرر الناتج عن الملوحة وكذلك جميع الخواص المدروسة.
٥. ادى استخدام الماء المالح الى حدوث نقص فى الصفات التشريحية تتمثل فى قطر القطاع و ابعاد الحزم الوعائية وسمك طبقة القشرة وقطر اوعية الخشب فى السيقان . بينما ادى الى نقص واضح فى سمك الورقة والنسيج المتوسط وعدد وابعاد الخلايا اللافة و كذلك ابعاد الحزم الوعائية الصغيرة و قطر الاوعية الكبيرة فى الورقة.
٦. أدى استخدام الرش بالفوسفور والبوتاسيوم الى تخفيف التأثير السلبى للماء المالح على الانسجة سواء فى الساق او الاوراق وكان اكثر وضوحا معاملة ١٠٠ جزء فى المليون سواء عند ٢٥٠٠ او ٥٠٠٠ جزء فى المليون.