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POTASSIUM REMOVAL FROM SALINE-SODIC SOILS BY GREEN HOUSE AND LABORATORY PROCEDURES

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In a pot study, the potassium status in two saline-sodic soils (sandy loam and sandy clay loam) was assessed by green house and chemical extractants like water, NH_4OAc, MgOAc, $CaCl_2$ and HNO_3. Potassium was applied @ 0, 25, 50, 75 and 100 mg kg^{-1} soil to maize crop which was harvested after 45 days. There was no effect of K application on germination and growth parameters of the maize crop. The correlations between the K extracted by different extractants and its uptake by maize plants were equally good under saline-sodic conditions. So any of these extractants may be used to evaluate K-status for maize fodder in saline-sodic soils.

INTRODUCTION

Some work has been done on the K behaviour in normal soils but little information is available on its behaviour in salt-affected soils in Pakistan. Soil salinity and sodicity are the problems for good plant production especially in arid and semi-arid zones. Higher salinity levels lead to sodium toxicity and potassium deficiency, resulting in significantly reduced grain and straw yield (Muhammad, 1986). Generally, there are no responses of different crops to K addition in alkaline soils but effects on potato growth have been quoted by Shukla and Singh (1980).

Studies regarding correlation between K uptake and the amount extracted by different extractants have been conducted using normal soils. In normal soils, 0.025 N $CaCl_2$ has been proposed as the best extractants by Mehdi *et al.* (1989) but 1 N NH_4OAc is normally accepted extractant for plant available K determinations. Keeping this in view this study was undertaken to determine the best extractant for extraction of K in saline-sodic soils.

MATERIALS AND METHODS

A pot experiment was conducted on two different textured (sandy loam and sandy clay loam) saline-sodic soils collected from Soil Salinity Research Institute Farm, Pindi Bhattian (Table 1). The samples were air dried, ground, passed through 2 mm sieve and were added to the pots @ 10 kg pot^{-1}. Potassium was applied @ 0, 25, 50, 75 and 100 mg kg^{-1} soil as K_2SO_4. The soils were equiliberated for 15 days for K fixation and samples were taken from each pot, and was determined with water, 1 N NH_4OAc, 0.5 N mgOAc, 0.025 N $CaCl_2$ and 1 N HNO_3. Maize crop was sown to which N and P_2O_5 were applied @ 75, 50 and 50 mg kg^{-1}, as basal dose in the form of urea and SSP, respectively. After 45 days at booting stage, the crop was harvested and the plant samples were analysed for K concentration. Then simple correlation coefficients were determined between K taken up by plants and K extracted by various extractants (Chaudhry, 1985). All the analyses were done according to the methods of U.S. Salinity Lab. Staff (1954) while N in soil and

Table 1. Physical and chemical characteristics of soils

Characteristics	Unit	Values	
		S_1	S_2
Sand	%	74	67
Silt	%	14	16
Clay	%	12	17
Textural class		Sandy loam	Sandy clay loam
pHs	-	8.2	8.0
ECe	dS m^{-1}	6.6	6.0
Ca + Mg	me l^{-1}	18	14
Na	"	58	52
K	"	4.8	5.2
CO3	"	Nil	Nil
HCO3	"	14	15
Cl	"	30	27
SO4	"	35	30.1
Total nitrogen	%	0.07	0.08
Available P	ppm	4.2	5.0
Extractable K	ppm	63.33	290.0

plant was determined by Jackson (1962), available P in soil by Watanabe and Olsen (1965), textural class by Moodie *et al.* (1959). The data were analysed statistically using completely randomised design (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The effect of K application on germination, fresh and dry weight of maize plants in two different textured (sandy loam and sandy clay loam) saline-sodic soils was non-significant except fresh weight in sandy clay loam soil where it was found maximum at 75 mg K kg^{-1} application (Table 2). The very little response of maize in these soils might be due to the originally higher availability of K. Whereas sandy clay loam soil due to higher amount of clay showed response to fresh weight of maize. Similar results have been reported by Anonymous (1987).

The uptake of K by crops depends to a considerable extent on the level of N nutrition. Generally, the better crop is supplied with N the greater the yield increase due to K. On the other hand applied N is only fully utilised for crop production when K supply is adequate. In the present study, N, P and K concentrations in maize (table 3) remained unaffected except N concentration in sandy

Table 2. Effect of K on germination, fresh weight and dry weight of maize plants

K rate (mg kg^{-1} soil)	Germination		Fresh weight (g/pot)		Dry weight (g/pot)	
	Sandy loam	Sandy clay loam	Sandy loam	Sandy clay loam	Sandy loam	Sandy clay loam
0	8.7	9.3	91.36	63.43 b	17.33	12.60
25	9.0	8.7	98.13	72.67 b	17.86	14.23
50	9.0	8.0	92.30	73.27 b	18.30	14.43
75	9.0	9.7	101.80	96.13 a	20.06	18.73
100	9.3	8.0	113.40	97.33 a	20.96	18.16

Table 3. Effect of K on NPK concentration and NPK uptake by maize plants

K rate (mg kg^{-1})	Concentration						Uptake					
	N		P		K		N		P		K	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
0	1.56 c	3.21	0.05	0.05	0.95	0.90 c	469	405	8.86 c	6.73 c	165 b	113 b
25	1.82 bc	3.26	0.06	0.07	0.97	0.97 bc	420	465	11.27 bc	10.42 bc	174 b	138 b
50	1.92 b	3.37	0.09	0.09	1.06	1.04 b	353	426	16.51 ab	13.42 ab	194 ab	150 b
75	2.70 a	3.16	0.09	0.08	1.10	1.27 a	367	596	17.29 a	15.58 a	220 a	236 a
100	2.71 a	3.07	0.08	0.08	1.10	1.28 a	329	560	16.90 a	14.53 ab	230 a	234 a
SE	-	-	-	-	-	-	-	-	-	-	-	-

Table 4. Potassium extraction by various extractants (mg kg^{-1} soil)

K rate (mg kg-1)	Water		1N NH_4 OAc		0.5N Mg OAc		0.025N $CaCl_2$		1N HNO_3	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S2
0	0.486 c	1.701 e	63.33 e	29.33 e	36.67 d	144.67 e	27.33 e	140.00 d	285.33 e	873.33 d
25	0.774 c	2.027 bc	90.66 d	326.00 d	46.67 c	193.33 d	64.00 d	148.67 d	333.33 d	933.33 c
50	0.990 b	2.432 b	108.67 c	365.33 c	53.33 c	208.00 c	76.67 c	226.00 c	360.67 c	966.67 b
75	1.251 a	3.232 a	141.00 b	417.33 b	66.00 b	228.00 b	124.00 b	245.33 b	406.67 b	1020.00 a
100	1.467 a	3.552 a	151.00 a	442.67 a	91.33 a	248.00 a	146.00 a	286.67 a	430.00 a	1046.67 a
SE	-	-	-	-	-	-	-	-	-	-

Table 5. Correlation and regression between K uptake by maize plants and K extracted by various chemical extractants in two different textured soils

Sandy loam soil		Sandy clay loam soil	
(r = 0.98)	Y = 196.36 + 0.014 X	(r = 0.98)	Y = 174.19 + 1.018 X
(r = 0.98)	Y = 55.39 + 1.27 X	(r = 0.96)	Y = -335.52 + 1.28 X
(r = 0.94)	Y = 154.58 + 0.71 X	(r = 0.98)	Y = 10.32 + 0.80 X
(r = 0.98)	Y = 50.18 + 1.669 X	(r = 0.89)	Y = -95.37 + 1.28 X
(r = 0.98)	Y = -539.1 + 2.03 X	(r = 0.95)	Y = -1275.82 + 1.49 X

* Significant at 5% level of probability.
Y = K uptake.
X = K extracted by extractant(s).

loam and that of K in sandy clay loam (Table). With the increasing concentration of K, N concentration decreased perhaps due to growth dilution effect particularly in soils containing more clay (Terman *et al.*, 1975). The K concentration in plants increased with an increase in its level in soil. However, P and K uptake by maize plants was significantly affected by k application, i.e. increasing K increased the P and K uptake whereas N remained unaffected.

The K extracted by all the chemical extractants (H_2O, NH_4OAc, MgOAc, $CaCl_2$ and HNO_3) significantly increased with the increasing K application rate (Table 4). However, HNO_3 extracted most of the non-exchangeable K in the soil, whereas NHO_4Ac extracted exchangeable K and interlayer K and MgOAc and $CaCl_2$ extracted only exchangeable K and H_2O only solution K (Mehdi *et al.*, 1989). The K extracted by all these methods was positively and significantly correlated with K uptake by maize plants in both the soils. The results reported by Mehdi *et al.* (1989) are in contrasts to these findings. They found $CaCl_2$ and MgOAc as the best extractants but in normal soils. With the help of these regression equations (Table 5) one can calculate K uptake (y) by the crop if a soil contains extractable K (x) extracted by these extractants. In other words, these equations may help to evaluate the K status of soils for better maize crop production in salt affected soils. These equations will also help in recommending K application rates in these soils. We are going to verify these results by using more salt affected soils for different crops.

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