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EFFECT OF GYPSUM, FARM YARD MANURE, GREEN MANURE AND SSP FERTILIZAR ON SOME PHYSICAL PROPERTIES OF SALINE-SODIC SOILS

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A laboratory experiment with five saline-sodic soils having different SAR values was performed to determine the effects of different amendments on hydraulic conductivity, water permeability and degree of dispersion of these soils. Gypsum was applied at rates of 50, 75 and 100 % of gypsum requirement. Farm yard manure (FYM) and green manure (GM) of Sesbania leaves were applied at rates of 15 and 25 t acre^{-1} while single superphosphate (SSP) fertilizer was added at the rate of 80 kg acre^{-1}. The soil samples mixed with gypsum and SSP were incubated for one month while the samples treated with FYM and GM were incubated for 75 days. Increasing rate of SAR generally caused a corresponding reduction in hydraulic conductivity and intrinsic permeability but increased the degree of dispersion. All treatments produced significant effect on the values of these parameters. Application of gypsum resulted in an increase in hydraulic conductivity, intrinsic permeability and in a decrease in the degree of dispersion. This effect was generally directly proportional to the rate of gypsum applied. Chemical amendments were more effective than FYM and GM, and, among amendments, gypsum proved better than SSP fertilizer in improving physical conditions of saline-sodic soils.

INTRODUCTION

The adverse effects of exchangeable sodium on soil hydraulic conductivity are well established while clay dispersion has been concluded to be a major cause of sodicity related reduction in soil hydraulic conductivity (Felhendler et al., 1974; Frenkel et al., 1978). The dispersion of clay and its subsequent lodgement in soil pores is responsible for reduction in soil hydraulic conductivity when the soil is slightly sodic or the percolating water is low in electrolyte concentration (Shainberg et al., 1981). The laboratory studies by Sharma (1971), Chawala and Abrol (1980) and Oster and Frenkel (1980) have shown that mixing gypsum into the sodic soils hastens reclamation and provides higher solution concentration for the improvment of soil hydraulic conductivity. Increasing rates of P_2O_5 might increase the hydraulic conductivity, and decreases bulk density as well as water dispersible silt + clay (Mian, 1974; Sharma et al., 1981). Farm yard manure and green manure additions to the soil may change the soil physical characteristics. This might be due to decrease in bulk density and increase in total porosity or due to change in the aggregate size distribution. Somani (1981), Chauhan et al., (1983) and Freitas et al. (1984) observed decrease in dispersion ratio and increase in hydraulic conductivity by organic matter. Much of work on saline-sodic soil in Pakistan explores the reclamation efficiency of different amendments. However, scanty literature is available about the effect of these amendments on physical properties of saline-sodic soils. This paper examines the information gained on this subject

MATERIALS AND METHODS

This laboratory study was conducted in the Department of Soil Science, University of Agriculture, Faisalabad. Five saline-sodic soils (Table 1) having different SAR values were taken from the Saline Agriculture Research Project, Sadhoki, Lahore. To these soil samples, gypsum was applied at rates of 50, 75 and 100% of actual gypsum requirement. Farm yard manure and green manure of Sesbania leaves were applied at rates of 15 and 25 tons $acre^{-1}$. Single superphosphate was applied at rate of 80 kg $acre^{-1}$. The samples mixed with gypsum and single superphosphate were incubated at room temperature (25 ± 5°C)

Table 1. *Physical and chemical characteristics of soils used.*

Determination	S_1	S_2	S_3	S_4	S_5
Textural class	Loamy clay				
Saturation %age	44	48	42	47	46
EC_e (dS m^{-1})	7.00	12.36	10.26	9.86	10.78
pH of saturated soil paste	8.28	8.11	8.65	8.53	8.75
SAR (mmol $l^{-1})^{1/2}$	25	35	45	50	60
Gypsum requirement (t $acre^{-1}$) 0-15 cm depth	6.5	7.2	7.9	9.6	12.0

Table 2. *Effect of gypsum, FYM, GM and SSP fertilizer on hydraulic conductivity* ($cm\ hr^{-1}$) *of saline-sodic soils.*

(Average of three repeats)

Treatment	*S_1	S_2	S_3	S_4	S_5	
	SAR = 25	SAR = 35	SAR = 45	SAR = 50	SAR = 60	Mean
T_1 = Control	0.056 no	0.045 s	0.036 u	0.031 vw	0.026 x	0.039 I
T_2 = Gypsum @ 50%	0.092 h	0.075 ij	0.053 op	0.056 no	0.054 op	0.066 C
T_3 = Gypsum @ 75 %	0.031 b	0.102 f	0.095 g	0.092 h	0.074 j	0.099 B
T_4 = Gypsum @ 100 %	0.172 a	0.128 c	0.125 d	0.129 bc	0.115 e	0.134 A
T_5 = FYM @ 15 t $acre^{-1}$	0.066 l	0.058 n	0.049 r	0.044 s	0.036 u	0.051 F
T_6 = FYM @ 25 t $acre^{-1}$	0.070 k	0.064 lm	0.052 pqr	0.049 r	0.041 t	0.055 E
T_7 = GM @ 15 t $acre^{-1}$	0.059 n	0.049 qr	0.040 t	0.035 u	0.029 in	0.042 H
T_8 = GM @ 25 t $acre^{-1}$	0.063 m	0.054 op	0.045 s	0.040 t	0.034 uv	0.047 G
T_9 = SSP @ 80 kg $acre^{-1}$	0.077 i	0.070 k	0.053 p	0.052 pq	0.046 s	0.060 D
Mean	0.087 A	0.072 B	0.061 C	0.059 D	0.051 E	

*S = Soil type

Mean sharing the same letter(s) do not differ significantly.

Table 3. *Effect of gypsum, FYM, GM and SSP fertilizer on permeability* $(\mu m)^2$ *of saline-sodic soils.*

(Average of three repeats)

Treatment	*S_1 SAR = 25	S_2 SAR = 35	S_3 SAR = 45	S_4 SAR = 50	S_5 SAR = 60	Mean
T_1 = Control	1.272 mno	1.015 sv	0.825 v	0.711 wx	0.590 y	0.883 I
T_2 = Gypsum @ 50 %	2.083 g	1.696 h	1.211 nop	1.279 mn	1.234 nop	1.501 C
T_3 = Gypsum @ 75 %	2.984 b	2.325 e	2.212 f	2.098 g	1.674 hi	2.258 B
T_4 = Gypsum @ 100 %	3.916 a	2.893 c	2.885 c	2.931 bc	2.621 d	3.049 A
T_5 = FYM @ 15 t $acre^{-1}$	1.499 k	1.317 m	1.120 qr	0.991 st	0.825 v	1.151 F
T_6 = FYM @ 25 t $acre^{-1}$	1.598 ij	1.431 kl	1.181 pqr	1.113 r	0.924 tu	1.249 E
T_7 = GM @ 15 t $acre^{-1}$	1.340 m	1.121 qr	0.908 u	0.795 v	0.658 xy	0.964 H
T_8 = GM @ 25 t $acre^{-1}$	1.422 l	1.226 nop	1.022 s	0.908 u	0.750 vw	1.066 G
T_9 = SSP @ 80 kg $acre^{-1}$	1.174 h	1.598 j	1.196 opq	1.179 pqr	1.037 s	1.350 D
Mean	1.984 A	1.625 B	1.396 C	1.334 D	1.146 E	

*S = Soil type

$1(cm^2) = 10^{-8}(\mu m)^2$

Mean sharing the same letter(s) do not differ significantly.

Table 4. *Effect of gypsum, FYM, GM and SSP fertilizer on degree of dispersion (%) of saline-sodic soils*

(Average of three repeats)

Treatment	*S_1 SAR = 25	S_2 SAR = 35	S_3 SAR = 45	S_4 SAR = 50	S_5 SAR = 60	Mean
T_1 = Control	57.70 q	66.36 j	71.19 e	72.83 d	77.35 a	69.09 A
T_2 = Gypsum @ 50 %	53.87 b	62.54 m	63.66 m	69.11 gh	71.42 f	63.92 F
T_3 = Gypsum @ 75 %	46.43 y	56.35 st	56.67 rs	63.46 m	65.61 k	57.71 G
T_4 = Gypsum @ 100 %	41.61 z	51.13 x	52.33 w	57.15 qr	60.81 p	52.61 H
T_5 = FYM @ 15 t $acre^{-1}$	55.79 tu	64.49 l	68.29 i	69.60 gh	74.00 c	66.43 C
T_6 = FYM @ 25 t $acre^{-1}$	54.37 v	63.23 m	66.23 jk	69.17 gh	72.65 d	65.13 D
T_7 = GM @ 15 t $acre^{-1}$	56.64 rs	65.77 jk	69.21 gh	70.43 f	75.71 b	67.55 B
T_8 = GM @ 25 t $acre^{-1}$	55.60 u	64.34 l	68.92 h	69.69 g	74.46 c	66.60 C
T_9 = SSP @ 80 kg $acre^{-1}$	54.33 v	61.85 o	65.50 k	69.25 gh	71.62 e	64.53 E
Mean	52.93 E	61.78 D	64.68 C	67.85 B	71.40 A	

*S = Soil type

Mean sharing the same letter(s) do not differ significantly.

for one month while the samples treated with FYM and green manure were incubated for 75 days to get complete decomposition as well as reaction with soil. After the incubation period, these soils were taken out and hydraulic conductivity, water permeability and degree of dispersion were determined according to the methods mentioned by USDA Salinity Laboratory Staff (1954). The experimental design was a randomized complete with three replications. The analysis of variance was run on the data and individual comparison among treatment means were made by Duncan's multiple range test, according to methods presented by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The data regarding the effect of different treatments and sodicity levels (SAR values) on hydraulic conductivity and water permeability are presented in Tables 2 and 3. The hydraulic conductivity measurements of saline-sodic soil provide an indication of the ability of the soil to transmit water while the soil water permeability is the ease with which liquids can pass through a bulk mass of soil or a layer of soil. The results from experiments indicate that increase in sodicity of soil significantly decreased the hydraulic conductivity and water permeability of soil. Maximum hydraulic conductivity and water permeability were recorded at S_1 (SAR = 25) followed by S_2, S_3, S_4 and S_5. The data also revealed that the treatment effects were highly significant. The highest value of mean hydraulic conductivity and water permeability was caused by T_4 (gypsum @100 % GR) followed by T_3, T_2, T_9, T_5, T_8, T_7 and T_1 (control). Green manure @ 15 tons acre^{-1} increased the hydraulic conductivity and permeability less than all other treatments while SSP fertilizer produced results similar to those obtained with gypsum @ 50 % GR. These results agree well to those reported by Sharma (1971), Mian (1974), Chawala and Abrol (1980), Oster and Frenkel (1980) and Shainberg et al. (1981).

Degree of dispersion data for the five saline-sodic soils are shown in Table 4. Soil dispersion means the breaking down of compound particles, such as soil aggregates, into the individual particles. The translocation of dispersed particles through the soil profile reduces the effective pore diameter which in turn reduces the permeability of soil for water. Moreover, physical condition of dispersed soil is undesirable from plant growth point of view. The differences among the degree of dispersion values for different soils and treatments are highly significant. The degree of dispersion increased with the increase in soil SAR. Treatment means showed that gypsum @ 100 % GR resulted in minimum degree of dispersion. In the case of all the saline-sodic soils, all the treatments significantly decreased the degree of dispersion than control. These results agree well with the findings of Sharma et al. (1981), Somani (1981), Chauhan et al. (1983) and Freitas et al. (1984) for different treatments. A negative correlation between hydraulic conductivity and degree of dispersion is observed in all the treated saline-sodic soils. Clay dispersion has been concluded to be a major cause of sodicity related reduction in soil hydraulic conductivity (Frenkel et al., 1978).

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