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Ameliorative Effect of Soil Amendments and Relevant Field Practices in Saline-Sodic Soil

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Abstract: The field experiment was carried out to evaluate the efficiency of 50 and 100% Gypsum Requirement (GR), molasses 35 $t.ha^{-1}$ and 20 $t.ha^{-1}$, presumed 40 $t.ha^{-1}$ and 20 $t.ha^{-1}$, Farm Yard Manure 50 $t.ha^{-1}$ and 30 $t.ha^{-1}$, continuous flooding and drying to ameliorate saline-sodic soils. All the treatments were replicated three times in the Randomized Complete Block Design. The initial pre project soil chemical analysis assessed the area saline-sodic in nature. Salt crust scraping, deep plowing leveling and water management practices were given prime emphasis in amelioration process. There was significant reduction of pH, ECe, SAR and ESP under each treatment, but, 100% GR followed by 50% GR recoded maximum reduction of pH, EC, SAR and ESP values respectively. As the sampling depth increased the reduction in the soil chemical values also decreased. Among the soil depths, upper most sampling depth (0-15 cm) was found rapid towards ameliorative process. The relevant field practices were also found effective where continuous flooding was ranked first in reduction of pH, ECe, SAR and ESP. The amendments showed maximum efficiency in the soil where upper crust of salts was scraped and drainage system of field was maintained.

Key Words: Salinity-Amelioration-Amendments-Field Practices

Introduction

Living things depends upon land and water as biological sustenance. To meet the challenge of increasing the agriculture production of the country, it is not only essential to increase the production per unit area but also to utilize unproductive lands for agriculture. In Pakistan out of 14 million ha of land, 8.5 million ha are salt affected Shafique *et al.* (1983). Nearly 60% of these are saline-sodic in nature Hassan *et al.* (1975). In Sindh salt affected area is 85% in upper Indus Basin Zaidi *et al.* (1968) or salt affected area of Sindh is equal to the cultivated area. In irrigated areas, soil salinity is almost a universal problem and soil salinity would go increasing with the passage of time with application of irrigation. Thus, soil salinity is a wide spread problem in canal irrigated tracts of Pakistan; about 23% of salt affected soils fall within canal command area (NCA,1987). The accumulation of salts on the lands of Sindh, Pakistan is the most common problem. This complicates the water management practices and reduces the land value in the irrigated areas; resulting to unsatisfactory and uneconomical yield or failure of crop in these regions due to adverse effects or preventing owing to the effect of excess exchangeable sodium directly on plant growth or through its effect on physical and physiochemical properties of soils. Inadequate drainage is another factor intimately associated with the development of soil salinity. Some times soil salinity develops in spite of good quality irrigation water and good irrigation practices Michael, (1978). Since the high concentration of salts acts adversely on the physical, chemical and biological properties of the soil. The accumulation of salts usually takes place during germination upto harvesting period in the crop root zone and was reported in less or non economic productivity of crop. It is due to improper drainage, soil, cultural practices, and unsuitable cropping sequences. The physical properties of soil may be improved or deteriorate despite the presence of salts depending upon the nature and amount of salts, soil amendments, and the initial physical and chemical conditions of the soil. The main physical properties influencing the air-water relationships in irrigated agriculture are markedly influenced by the nature and amount of exchangeable cations and swelling characteristics of the soil Kovada, (1960). Cultural and drainage practices were also considered to be effective in the amelioration of the problem soils. These soils if brought under cultivation can contributed a tidy sum to total agriculture production of the country.

Results and Discussion

Identification : The pre-project soil chemical analysis showed pH = 9.55, ECe = 14.05, SAR = 25.3 and ESP = 26.15 which assess the area as saline sodic in nature. Saline sodic soils identified by U.S. Salinity Laboratory (1954) and Michael (1978) reveals that these soils has Sodium Absorption Ratio (SAR) greater than 15, Electrical conductivity (ECe) more than 4 m.mhos/cm at 25 °C, pH more than 8.5 and has Exchangeable Saturation Percentage (ESP) value greater than 15.

pH: Application of various treatments decreased pH of the soil where as control plot without any treatment recorded slight increase in pH value. The result reveals that as the rate of applied amendments increased; the pH tend to decrease. Among the treatments GR 100% (100%, gypsum requirement) enhanced significantly to reduce soil pH value (16.1% decrease) followed by GR 50% (14.7 % decrease) at 0-15 cm sampling depth. The preferential pH value had slight reducing effect in those plots which received Farm Yard Manure, alternate flooding and drying (Table-2).

The pre-experiment pH value of the soil was almost constant at each sampling depth.

Each treatment application showed efficiency of reducing pH at upper most sampling depth (0-15 cm). The efficiency of the treatments was not satisfactory at onward depths beyond 0-15 cm. Among the amendments with interaction to sampling depths, 100% GR and 50% GR recorded minimum pH value at 0-15 cm sampling depth. However the control plots without

Table 1: Pre-project soil chemical analysis

Depth (cm)	EC x 10^3	pH	CO_3	HCO_3	Cl	SO_4	Ca +-Mg	Na	SAR	ESP
0 - 15	14.7	9.5	Nil	2.9	19.4	94.7	24.0	123	35.5	33.8
15-30	15.9	9.7	Nil	2.1	15.9	75.0	51.0	108	21.3	23.1
30-60	13.5	9.5	Nil	1.8	9.9	87.3	36.0	99	23.3	24.8
60-90	12.1	9.5	Nil	1.9	7.2	64.9	34.0	87	21.1	22.9
Mean	14.05	9.55	-	2.17	13.10	80.47	36.25	104.25	25.30	26.15

Table 2: Percent decrease in soil pH at different depths as affected by various treatments

Treatments	% Decrease Soil Sampling Depths (cm)			
	0-115	15-30	30-60	60-90
100% GR	16.1	17.8	16.1	13.6
50% GR	14.7	17.5	13.3	10.5
M 35 $t.ha^{-1}$	13.6	15.1	11.8	11.2
M 20 $t.ha^{-1}$	13.3	14.1	11.2	10.5
PM 40 $t.ha^{-1}$	12.3	14.4	9.1	8.4
PM 20 $t.ha^{-1}$	10.5	10.3	7.0	6.0
FYM 50 $t.ha^{-1}$	5.5	6.9	4.2	3.8
FYM 30 $t.ha^{-1}$	5.2	5.1	4.2	4.9
Flood 4-5 cm	10.5	11.0	7.6	5.5
AF & D	3.8	4.4	3.1	4.1
Control	-1.0	1.7	-1.0	-0.7

Table 3: Percent decrease in soil ECe at different depths as affected by various treatments

Treatment	% Decrease Soil Sampling Depths (cm)			
	0-15	15-30	30-60	60-90
100% GR	62.3	61.8	49.4	32.2
50% GR	47.1	48.4	40.5	29.1
M 35 tha^{-1}	42.1	44.2	32.8	17.6
M 20 $t.ha^{-1}$	38.5	41.0	28.6	17.3
PM 40 $t.ha^{-1}$	37.8	40.8	20.5	6.8
PM 20 $t.ha^{-1}$	34.6	37.1	26.6	10.1
FYM 50 $t.ha^{-1}$	29.4	33.9	19.7	8.0
FYM 30 $t.ha^{-1}$	32.6	36.0	16.8	6.0
Flood 4-5 cm	44.2	42.3	20.7	6.6
AF & D	29.7	33.7	21.2	8.8
Control	19.5	9.4	-1.7	-4.1

Table 4: Percent decrease in soil SAR at different depths as affected by various treatments

Treatment	% Decrease Soil Sampling Depths (cm)			
	0-15	15-30	30-60	60-90
100% GR	60.1	28.7	31.2	20.7
50% GR	56.2	23.9	28.3	19.2
M 35 $t.ha^{-1}$	51.6	18.1	24.0	14.3
M 20 $t.ha^{-1}$	48.7	13.6	22.7	10.5
PM 40 $t.ha^{-1}$	48.7	13.4	20.4	10.9
PM 20 $t.ha^{-1}$	48.0	12.6	22.4	7.7
FYM 50 $t.ha^{-1}$	46.9	9.7	15.3	2.5
FYM 30 $t.ha^{-1}$	44.1	4.3	10.8	2.3
Flood 4-5 cm	49.2	13.7	54.9	10.5
AF& D	46.2	6.9	14.0	2.0
Control	-0.47	-0.79	-1.15	-0.80

Table 5: Percent decrease in soil ESP at different depths as affected by various treatments

Treatment	% Decrease Soil Sampling Depths (cm)			
	0-15	15-30	30-60	60-90
100% GR	51.6	24.8	26.4	17.3
50% GR	47.5	20.3	23.7	16.0
M 35 $t.ha^{-1}$	42.6	15.0	20.1	11.9
M 20 $t.ha^{-1}$	39.9	11.2	16.2	8.4
PM 40 $t.ha^{-1}$	39.9	11.1	16.8	8.7
PM 20 $t.ha^{-1}$	39.2	10.2	14.7	6.2
FYM 50 $t.ha^{-1}$	38.0	7.9	12.3	1.7
FYM 30 $t.ha^{-1}$	35.5	3.4	8.5	0.0
Flood 4-5 cm	40.4	11.3	16.9	8.4
AF & D	37.4	5.4	11.1	2.1
Control	-0.29	-0.6	-1.0	-0.5

GR = Gypsum Requirement, M = Molasses, PM= Press Mud, FYM= Farm Yard Manure, AF & D= Alternate Flooding & Drying, Control= No treatment

Table 6: Correlation coefficient values of pH, ECe, SAR and ESP

	pH	ECe	SAR	ESP
pH	1 .000			
ECe	0.797**	1.000		
SAR	0.696**	0.618**	1 .000	
ESP	0.774**	0.719**	0.970**	1.000

treatment at each sampling depth recorded opposite results compared to treated plots, where the pH value started to increasing instead of decreasing.

The results of this study reveals that decrease % in pH value at upper most sampling depth may be due to deep plowing where soil had enough reaction with irrigation water and applied amendment. The results of this study proved 100% GR and 50% GR superior among the treatments. Molasses, pressmud were placed in second batch of amendments after gypsum. The findings do not confirm the results of Kanwar and Chawala, (1963) who reported that application of gypsum in quantities higher than 30% of the gypsum requirements were not necessary.

Ece: The detrimental effect of treatments on saline sodic soil responded positively in reducing ECe of the soil. Among the tested soil amendments 100 % GR proved it self efficient in reducing ECe from 14.7 to 5.53 m.mhos/cm (62.3% decrease) followed by 50% GR requirement (47.1% decrease) at 0-15 cm soil sampling depth (Table-3). The decrease in ECe at the onward sampling depths by soil amendment showed that as the sampling depth increased the reduction percentage in ECe also tend to decrease. Among the field practices flooding was effective on the upper most sampling depth.

Sampling depths beyond (0-15 cm) was not satisfactory in reducing ECe. The results has an agreement with the findings of Ramzan *et al.* (1982) who reported that 100% gypsum requirement and farmyard manure has maximum reclamation efficiency followed by 50% GR. They however recommended that pressmud is also a cheap source of reclamation which decreases the ECe of the soil.

SAR: SAR values at each sampling depths reduced after the treatment application whereas in control plots the slight increase in SAR value was observed at various soil depth. SAR relatively decreased under 100% GR followed by 50 % GR (60.1% and 56.2% decrease) respectively) at 0-15 cm sampling depth (Table 4). Among the relevant field practices for reclamation of salt affected soils; flooding was more effective in reduction achievement which recorded 49.2% decrease against pre project SAR value. Flooding equally recorded SAR values as in molasses 35 $t.ha^{-1}$ and 20 $t.ha^{-1}$, pressmud 40 $t.ha^{-1}$, and 20 $t.ha^{-1}$. Farmyard manure 50 $t.ha^{-1}$ and 30 $t.ha^{-1}$.

ESP: Regarding the ESP values at various depths under different treatments, negative percent reduction (-0.29) was recorded in control plots (without treatment). However reduction percent of ESP values were achieved maximum under 100 GR and 50%GR which recorded 51.6% and 47.5% decrease at 0-15 cm sampling depth respectively. However, in the following sampling depths beyond 0- 15 the reduction percent was not satisfactory. The reduction percentage of other treatments excluding gypsum ranged between 21 to 42%. Among those molasses, pressmud and flooding simultaneously reduced ESP values (Tabl-5). The results of the study has also agreement with the findings of Chaudhry and Markentin, (1968), Dutt *et al.* (1971) and Poonia *et al.* (1974) who reported that applied gypsum showed maximum efficiency at high ESP values.

Relationship of various parameters of soil chemical analysis with each other: All the parameters of soil chemical analysis showed positive and significant association with each other at I% level of significance. Among all the soil parameters SAR and ESP showed positive perfect correlation recording correlation co-efficient value r = 0.97 (Table-6). The results revealed that as the value of one variable of soil chemical analysis increased the simultaneous increase was found in others and vice versa. This ± and significance level of association is helpful in interpretation of soil variation in chemical analysis for association with each other.

Conclusion

The application of various treatments decreased pH, ECe, SAR, ESP values of the soil where as control plots without any treatment recorded slight increase in each parameter. The result reveals 100% Gypsum requirement for saline-sodic soil was more effective in reclamation, followed by 50% GR. The pre-experiment values of the soil chemical analysis were maximum on the upper sampling depth (0-15 cm) and it was simultaneously constant as depth of sampling increased. The reduction in the values also followed same trend i.e. compared to lower depths the percent decrease in the upper most sampling depth was maximum. The field practices also reduced the pH, ECe, SAR and ESP of the soil but the reduction was not satisfactory except flooding. Flooding in each sampling depth recorded equal data as soil amendments. It was concluded that the soil amendments showed maximum efficiency with the pre scrapping of salt crust, deep plowing, and maintaining the drainage practices. The stabilizing role of irrigation water for reaction in applied amendments and soil practices in another factor which ameliorate the problem soils towards productivity.

Suggestions

1. The field before reclamation should be deep plowed and leveled in a manner to allow the equal spread of irrigation water.
2. The availability of water is another factor for amendment reaction in those problem soils.
3. Use of 100% GR & 50% GR is effective in amelioration of saline-sodic soils.
4. The application of pressmud, FYM are the cheapest sources which have tendency of making pH, ECe, SAR and ESP toward neutral.
5. Continuous flooding should also be considered in those areas where gypsum is not available.

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