PAPER No. 473

Gypsum as an Amendment for the Reclamation of Saline Sodic Lands

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In saline sodic lands there are two components which need elimination to bring the soil to normal productive condition. They are salinity and sodicity. Salts get dissolved in irrigation water, when applied in excess and are leached down but sodicity persists. In calcarious sodic lands a part of exchangeable sodium is replaced by calcium which comes into solution from calcium carbonate. It produces sodium carbonate which invariably raises the pH of the soil solution to a high level. The soil becomes dispersed and decreases abnormally the leaching and sodium replacement of processes. Thus the period for reclamation is enhanced. To hasten the reclamation process the application of some suitable soil amendment is made to provide divalent cations to neutralize sodium carbonate and to replace the exchangeable sodium in the soil.

The easily available amendment in Pakistan is Gypsum. It is calcium sulphate in hydrated form ($CaSO_4 . 2H_2O$) and is found in massive formations. Its solubility in water at 25°C is 0.26 percent. As it is very low, the chances of its being lost by deep percolation with excessive irrigation applications in saline sodic lands are ceased.

To demonstrate its beneficial effect to reclaim saline sodic lands some work has been carried out at the Laboratory level and the results achieved therefrom are reported here.

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REVIEW OF LITERATURE

I-Kelley (1951) applied gypsum to an alkali soil at the rate of 10 - 12 and 15 tons per acre. The plots were flooded continuously for three weeks. He found that the exchangeable sodium was effectively removed to a depth of four feet and practically a barren land was converted into a high productive land.

2-Haider (1959) reported that leaching with water alone was in-effective while gypsum in combination with leaching effectively reclaimed a "Bara" soil.

3-R.C. Renord and C.A. Bower (1960) used sea water for reclaiming a sodic soil. The sea water contained 11.6 meq/I of ca+Mg. They pointed out that with the use of only 4 feet of Sea water combined with 6 feet of Clorado River water, reduced the initial exchangeable sodium percentage of the soil from 39 to 5 and reduced the time of reclamation from 120 days to 12 days.

4-G.R. Dutt: et al (1972) pointed out that the amounts of water and gypsum required for reclaiming the soil were highly dependent upon the quality of water used for leaching.

5-B.K. Khosla and I.P. Abra (1972) studied the effect of gypsum of varying fines on the composition of saturation extract of a saline sodic soil. They reported that much of the gypsum is utilized in precipitating the soluble carbonates to form relatively insoluble calcium carbonate. Gypsum of slightly finer than 0.59 mesh would be more effective than that of the coarse grades. The amount of gypsum needed to neutralize the soluble carbonates is shown to be indicative to the minimum amount of amendments required to start the reclamation of a saline sodic soil high in carbonates.

6-Bower (1962) recommended that for soils having a gypsum requirement upto 5 meq/ 100 gms of soil growing of rice and green manure crops could be depended upon for reclamation of a saline sodic soil in a reasonable period of time.

7-Zaidi and Qayyum (1968) reported that the rate of reclamation increased considerably with the use of gypsum and farm yard manure and the income obtained with the use of amendments for reclamation is more than that with leaching without amendments.

MATERIALS AND METHODS

The experiment was carried out in glazed pots. 28 cms. in dia-meter and 28 Cms. deep. There was a hole close to the bottom on one side of the pot to pass the leachate. Saline sodic soil used for the study was brought from the Raiwind Distt : Kasur. it was taken from the upper one foot

layer of the soil. It was prepared and sieved through 0.2 mm mesh. It was analysed for its mechanical ingradients : sand, silt and clay. It was also analysed to find out its salinity and sodicity status, calcium carbonate, base exchange capacity and exchangeable sodium percentage. The analysis results are gien here under in Table–I.

Table–1 showing the analysis results of the soil.

						PERCENTAGE OF				
					Clay	Silt	Sand			
					14.2	28.8	56			
			Texture					Loam		
Saturation %	pH	EC x 106	Ca + Mg	Na	Co_3	HCO_3	CI	SO_4	SAR	
				Milli equivalent/Liter						
35	9.8	25	1.5	265	4.6	9.50	190.5	61.9	308.1	

Gypsum requirements tons per acre foot of the soil	=	9.62
C.E.C.	=	6.0
Exchangeable sodium meq/100 grams	=	5.7
Exchange sodium %	=	95
Calcium Carbonate %	=	18

A one centimeter deep layer of sand was placed at the botoom of each pot. On it 18 k. grams of soil was packed uniformly.

Gypsum was applied on the basis of its full requirements. Four treatments were kept in view. They were : 1 control, 2 Application of gypsum to meet the full requirements of the soil.

3. Application of Gypsum to meet half the requirement of the soil and (4) application of gypsum to meet one quarter requirements of the soil. There were four replications of each treatment. Gypsum was mixed in the top 7 cm upper layer of the soil. 4 litres of canal water was applied to each pot which raised the moisture percentage of the soil to its field capacity level. The soil was allowed to settle for 7 days. Leaching with canal water was started. Water was applied, when the water given previously had just disappeared. The leaching process was completed within 15 days.

During this period the pots were kept covered with a polyethylene sheet to intercept the rainfall to avoid overflow of water in case of high rainfall was received. Electrical conductivity of the leachate was found out after applying the last irrigation for leaching. Air dry decomposed farm yard manure and ammonium sulphate were added to the soil in each pot at the rate of 70 gms. and 2 gms. respectively before transplating the rice crop.

Rice plants of variety Basmati 370 were planted on 9.8.1983. They were put in at 4 spots in each pot at equal distances from each other - 2 plants were put in at one point. Irrigations were applied as per requirements of the crop and water was put in any pot when water given to it previously had just disappeared. The crop matured and was removed on 26.10.1983. The paddy was weighed to find out its yield. The infiltraton rate of the soil was found out after removing the crop.

Complete record of the rainfalls received and the mean maximum and the mean minimum temperatures was maintained during the entire growth period of he crop and given here under in Table-2.

Table–2 Showing the rainfall and the Mean maximum and minimum monthly temperatures.

2.8.83	...	0.86"	
4.8.83	...	1.40	
5.8.83	...	0.05	
8.8.83	...	0.09	
12.8.83	...	0.41	
17.8.83	...	0.54	
19.8.83	...	4.20	
24.8.83	...	0.09	
25.8.83	...	0.79	
26.8.83	...	0.81	
29.8.83	...	1.22	10.46"
1.9.83	...	0.45"	
3.9.83	...	0.32	
10.9.83	...	0.58	
20.9.83	...	0.06	1.41"
8.10.83	...	0.63	
12.10.83	...	0.53	
		1.16"	1.16"

August
Max : ... 34.80°C
Min : .. 25.68°C

Sept :
Max : ... 35.05°C
Min : ... 24.24°C

From 9.8.83 to 26.10.83 10.63" rainfall was received which was in addition to the irrigation applied.

RESULTS AND DISCUSSIONS

Table – 3 showing the mean values of :

		Control	Gypsum full	Gypsum ½	Gypsum ¼
1–	EC x 10^3 of the leachate after completing the leaching process	8.60	3.80	3.20	3.30
2–	pH of the leachate after completing the leaching process.	9.43	8.33	8.50	8.50
3.	Irrigation water used during the period of leaching	29.3 11.55"	45.7 18.00"	45.7 18.00"	45.7 18.00
4.	EC x 10^3 of the leachate after removing the crop.	9.02	2.48	1.99	1.59
5.	pH of the leachate after removing the crop.	9.02	8.00	8.20	8.30
6.	SAR of the leachate after removing the crop.	24.98	0.95	1.30	3.53
7.	Infiltration rate of the soil after removing the crop (mm/hour)	0.22	1.07	0.92	0.82
8.	Irrigation delta applied during the growth period of the crop	70.50	95.50	94.50	91.00
9.	Yield of paddy in gms.	12.92	12.68	14.78	12.76

The results of electrical conductivity of the leachate after completing the leaching process show that in all the treatments except in case of control, it was less than 4 m mhos/cm which is the limit for a normal non saline soil but in control it was 8.6 m mhos/cm which is very high. The pH values of the leachate after finishing the leaching process indicate that they had been reduced to the level of a good soil in all gypsum treatments whreas they remained high in case of control. These observations agree with those of Kelley (1955), Haider (1959) and others.

The irrigation delta used to leach the soil show that in the initial stage all the gypsum

treatments behaved equally well, whereas in control the water passed through the soil column was much less. It was because of the dispersed condition of the soil which obstructed the downward movement of the soil moisture.

After removing the rice crop the analysis results of the leachate of the soil indicate that salinity had been removed in all the treatments but sodicity persisted in control which is also cofirmed by the high pH, SAR and low infiltration rate of the soil in case of this treatment. (Fig-1). The finding has been further supported by the irrigation delta applied to raise the rice crop. (Fig-2). It was the least in case of control and was more or less uniform in all the gypsum treatments. However, a trend existed which showed that there was some decrease in the infiltration rate of the soil which corresponded to the quantity of gypsum applied. The crop yield results show that there was no significant effect on the yield of paddy from which it is concluded that the rice crop is highly tolerant to the sodicity.

CONCLUSIONS

1. The reclamation of a saline sodic soil by simple leaching with canal water is a very slow process. With the aplication of gypsum even though it is applied to the extent of 1/2 or 1/4 of the total requirement of the soil, it is accelerated and can be achieved within a limited period of time.

2. The infiltration rate of a sodic soil is increased with the application of gypsum. The increase is almost equally effective with its application to meet the full, 1/2 and 1/4 requirement of the soil. However, a trend exists which indicates that there is a slight decrease in its values which corresponds to the quantity of gypsum applied.

3. Rice is a highly sodic resistant crop.

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