EFFECT OF CERTAIN AMENDMENTS ON PHYSICAL AND CHEMICAL PROPERTIES OF SALINE-SODIC SOIL

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Various chemical amendments including gypsum, sulphuric acid, pressmud and farmyard manure were tried on a saline-sodic soil in Lyallpur for two years. Application of these amendments was followed by alternate flooding and ploughing, and heavy irrigations during the experimental period. Soil samples collected after four months of these amendments were examined for percolation rate, pH of the saturated soil paste, exchangeable sodium percentage, and exchangeable calcium plus magnesium.

Percolation rate of the soil was increased with different amendments. Farmyard manure and pressmud gave the highest rate of increase. The order of effectiveness of the amendments was farmyard manure, pressmud, gypsum, sulphuric acid, and sulphur. Exchangeable sodium percentage (ESP) was effectively lowered by all the amendments, the most effective amendment being gypsum. ESP was lower in case of soil from lower depths. Exchangeable calcium plus magnesium increased in case of all amendments, but it was highest in case of gypsum treatment.

INTRODUCTION

Most of the investigators have achieved tangible results in reclaiming saline-sodic soils with the application of gypsum, sulphur, sulphuric acid and other chemical amendments. In addition, pressmud and farmyard manure, which are available in Pakistan at a cheaper rate, may be used for reclamation. They supply calcium to replace exchangeable sodium on one hand and provide the plant-nutrients on the other. Moreover, they improve the physical condition of the soil. Expected economic utility of these resources has led to compare and evaluate their reclaiming potentialities.

REVIEW OF LITERATURE

Haider (1959) concluded that if 50 per cent gypsum requirements of a saline-alkali soil were fulfilled and complete leaching was accomplished, exchangeable sodium percentage was lowered to less than 5. The pH decreased and Ca and Mg contents increased with an increase in the quantity of gypsum added. The increased application of gypsum increased total salts in the absence of

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requisite leaching but when leaching was complete, total soluble salts decreased. He also found that, when a saline-sodic soil was leached with two feet water, exchangeable sodium and potassium decreased from 5.83 to 3.62 and from 0.98 to 0.90 me/100 g. of soil, respectively. Even one foot column of water was found sufficiently effective to cause an increase in calcium plus magnesium.

Wahhab (1960) compared the reclaiming potentiabilities of calcium sulphate, sulphur and farmyard manure on "Bara" soils. He observed a decrease in pH and exchangeable sodium and an increase in the moisture holding capacity, percolation rate and exchangeable calcium of the treated soil.

Hussain (1963) observed that non-saline alkali soils in West Pakistan could be reclaimed with the application of sulphur provided good leaching facilities were available. However, cost of reclamation (about Rs. 70.00 per acre) rules out the feasibility of its general adoption. Green manuring with *janter* (*Sesbania sculesta*) was recommended as a good alternate for the former Punjab soils, provided extra water supply is at the disposal of the farmer.

Uppal (1962) applied 20 maunds of sulphuric acid to an acre of alkali soil. After a lapse of three years' period of leaching, rice crop was grown. It was observed that the same field, before and after the treatment, gave 0.9 and 15.00 maunds per acre, respectively; but it was concluded that the quantity applied was very expensive and uneconomical.

Kanwar and Chawla (1963) applied gypsum and pressmud to compare the effectiveness of these amendments. They found that gypsum was slightly more effective than pressmud (24.5 per cent calcium) to lower the pH and electrical conductivity and to increase hydraulic conductivity of saline-alkali soils. They applied amendments to supply 0 to 100 per cent gypsum requirements of the soil. They observed that 30 per cent level of gypsum and 50 per cent level of pressmud were most efficient in building up the exchangeable calcium and in improving the physical condition of the soil. Yields of rice and wheat crops were found to be the best at these levels of amendments. They further observed that almost 90 per cent of exchangeable sodium was replaced at 100 per cent levels of these amendments. Addition to complete fertilizer increased the yield and the reclamation was enhanced.

Korchagina and Kuznetsov (1966) reported that application of gypsum or of gypsum plus cow-dung (farmyard manure) before trees and shrubs were planted on ploughed-up virgin solonetz, improved the physical and chemical properties of the soil when determined twelve years afterwards. Cow-dung alone was observed to have little effect on such properties.

MATERIALS AND METHODS

The work reported in the paper was carried out in the Soil Science Department, West Pakistan Agricultural University, Lyallpur, during 1965-67.

In the campus area of the Soil Science Department, Field-B 13/20 was selected for reclamation purposes as its soil was characterised to be saline-sodic in nature. This field was heavily irrigated on 20th June, 1966; 1st July, 1966 and 1st August, 1966 followed by tractor cultivation after attaining moisture condition suitable for cultivation, each time (*wattar*). Finally it was levelled and plots were laid out in triplicate simple randomised blocks. The six treatments comprised addition of gypsum (10 tons per acre), sulphur (2 tons per acre), sulphuric acid (6 tons per acre), pressmud (10 tons per acre), farmyard manure (40 tons per acre), and an untreated check. The net size of the experimental plot was 80 by 8 feet, approximating 1/68th of an acre.

These materials except sulphuric acid were broadcast and then cultivated into the soil. Sulphuric acid, however, was applied with the irrigation water. Liberal irrigations were given each fortnight after the addition of the amendments. Soil samples were taken before and four months after the addition of the amendments and examined for various characteristics.

In order to study the effect of different treatments on the properties of the soil, composite soil samples from each plot were taken at 0—6, 6—12 and 12—24 inch depths. The soil samples thus collected were brought in the laboratory, air dried, ground so as to pass 2 mm. seive and analysed for the following physical and chemical characteristics : 1. Percolation rate, 2. pH of saturated soil paste, and 3. Soluble and exchangeable cations *i.e.*, sodium, potassium and Calcium+Magnesium. Analytical Methods followed were those given in the U.S. Handbook 60.

RESULTS AND DISCUSSION

Physical Properties

Exploitation of potential fertility of a soil depends upon the physical condition of the soil. Plant nutrient elements, howsoever adequately present, will not be of any use to the plant unless their availability to the plants is ensured throughout the growing season.

Percolation rate

The effect of various amendments on the percolation rates in soils are illustrated in Fig. 1. The plots receiving no amendment also indicated a slight increase in the percolation rates. This may be attributed to the effect of leaching and cultivated. All treatments improved the percolation rates,

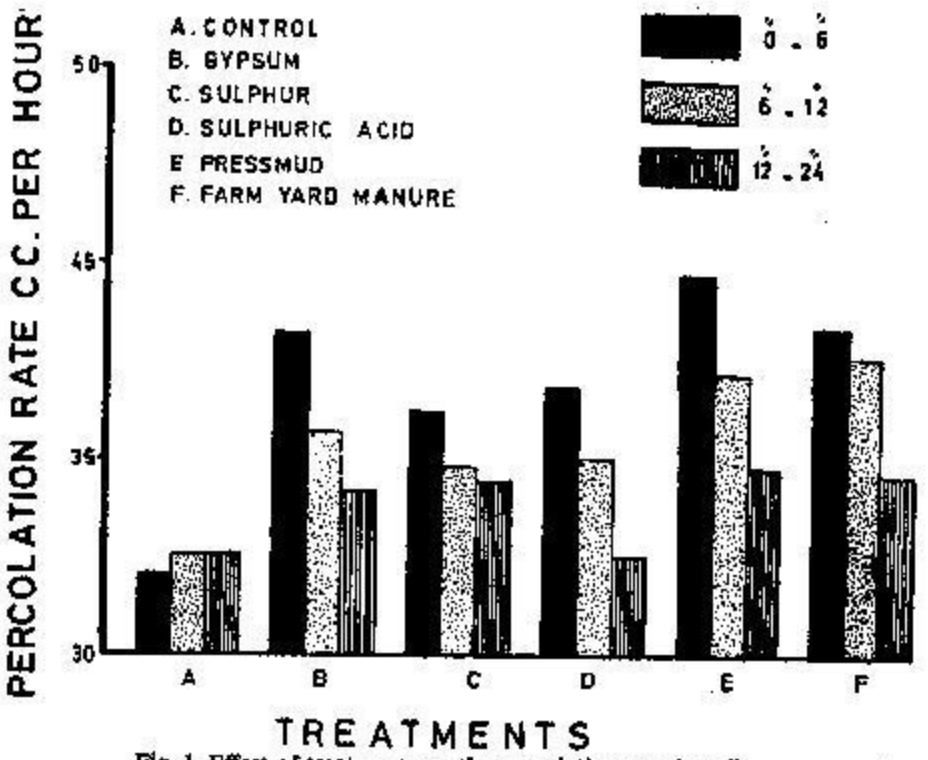

Fig. 1. Effect of treatments on the percolation rate in soils.

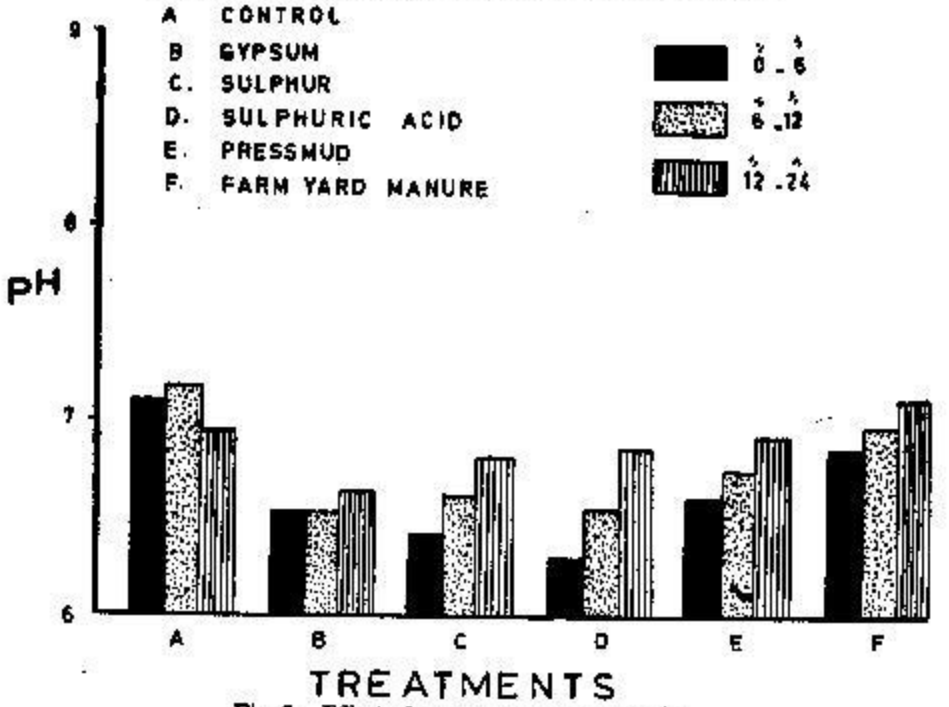

Fig. 2. Effect of treatments on pH of soils.

Pressmud produced maximum effect. Gypsum and farmyard manure had about the same influence which was slightly less in magnitude than that of pressmud. Gypsum treatment increased the percolation rate from 4.8 to 16.8, 5.3 to 11.7 and 5.3 to 7.6 cc./hr. in 0-6, 6-12 and 12-18 inch layers respectively. These results are in agreement with those reported by Ihsan (1966). Sulphur and sulphuric acid treatments also had increased the percolation rate considerably, but the improvement was less than that produced by gypsum or farmyard manure.

pH of saturated paste :

All the treatments decreased the soil pH (Fig. 2). Maximum decrease was caused by gypsum treatment, reducing the pH from 8.0, 8.1, and 7.9 to 7.5, 7.5 and 7.6 in the 0-6, 6-12 and 12-18 inch layers respectively. Sulphur and Sulphuric acid treatments had considerably more effect in the 0-6 inch layer but in the 6-12 and 12-18 inch layers their effect: were either equal to or less than those with gypsum.

All the treatments caused a reduction in the exchangeable sodium carbonate contents which might have reflected in the decrease of soil pH. Similar results have been reported by Haider (1959) and Hussain (1963).

Exchangeable Sodium Percentage

All treatment resulted in a decrease of ESP (Fig. 3). Gypsum had maximum beneficial effect. Sulphur and sulphuric acid also produced similar effects to those of gypsum, although slightly less in magnitude. Pressmud and farmyard manure also had significant effects. Pressmud decreased the ESP from 40.2, 40.1 and 44.3 to 19.02, 22.7 and 37.0 in 0.6, 6-12 and 12-24 inch layers respectively; whereas the farmyard manure had lowered the ESP to 25.5, 27.2 and 29.9.

Exchangeable Calcium plus Magnesium

During this experiment various amendments were applied and as far as possible efficient leaching was also carried out. Consequently, soil productivity was restored. The effect of gypsum was highly pronounced when compared with that of other amendments. Various treatments effected calcium plus magnesium contents in different layers of the soil profile differently. However, the increase in the calcium plus magnesium contents declined with depth. This may be due to the fact that the amendments got better chances of being thoroughly mixed with the surface soil than in the sub-soil. Moreover, the calcium contents, in the upper layers, first take part in the exchange reaction and only the unexchanged quantity of calcium gets leached down to the lower strata.

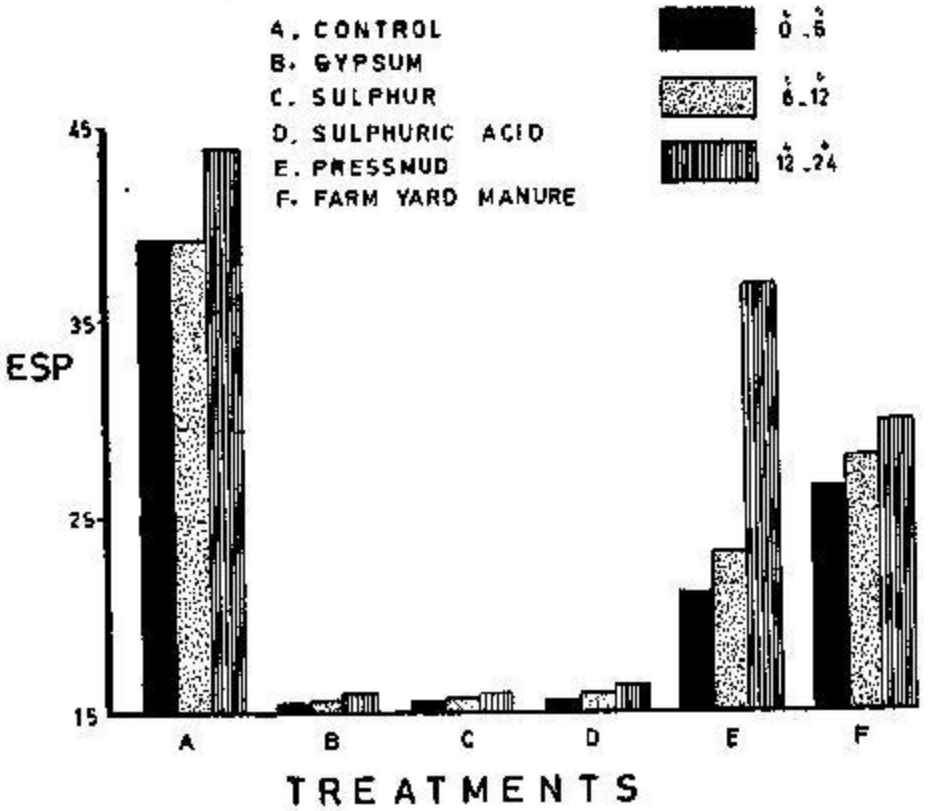

Fig. 3. Effect of different treatments on exchangeable Sodium percentage in soils.

Kanwar and Chawla (1963) and Korchagina (1966) observed similar changes brought about by gypsum, sulphur, pressmud and farmyard manure used for the amelioration of saline-sodic soils.

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