INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2001/03–3–316–318
http://www.ijab.org

Comparison of Sand, Gypsum and Sulphuric Acid to Reclaim a Dense Saline Sodic Soil

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ABSTRACT

An experiment was conducted on a salt affected soil at farmer's field to compare different amendments (gypsum, H_2SO_4, farm yard manure and sand) in various possible combinations in RCBD for assessing their effectiveness on soil reclamation. The soil was dense saline sodic {EC_e = 10.24 dS m^{-1}, pH_s = 9.57 and SAR = 28.70 (me L^{-1})$^{1/2}$ } with clay loam texture. Rice variety Shaheen and wheat variety Inqalab-91 were sown as test crops. Recommended doses of NPK fertilizers were applied to the respective crops. Field was irrigated with tubewell water having EC_{iw} = 0.84 dS m^{-1}, SAR = 8.09 (me L^{-1})$^{1/2}$, RSC = 4.25 meL^{-1}. Reduction of 7% in pH of the soil was observed due to application of 0.1% sand at the end of second year of cropping. The lowest pH was recorded with gypsum and FYM. The same combination of gypsum and FYM reduced the EC_e more than the rest of the treatments. Reduction in the SAR was significant with the application of gypsum and H_2SO_4 in the second year. Sanding alongwith gypsum application significantly enhanced the grain yield in both crops. However, gypsum @ 100% GR added with FYM and gypsum @ 75% and H_2SO_4 increased the yield for the first year of rice crop. The yield trend of wheat was other way round.

Key Words: Gypsum; H_2SO_4; FYM; Wheat; Rice

INTRODUCTION

A vast area (10 mha) of world irrigated farmland is salt affected causing significant losses to the annual crop yield (Rhoades & Loveday, 1990). Pakistan has a 6.2 mha area lying barren due to twin menace of salinity and waterlogging (GOP, 1996). Reclamation of sodic soils is a serious concern at international level. The sodic soils are characterized by high pH, high exchangeable Na, deficiency of Ca and poor physical conditions. Various amendments have been used for the reclamation of such soils in the past. Hydrochloric acid and H_2SO_4 had been tested for amelioration and improvement in drainage. These amendments lowered the soil pH, reacted with soluble carbonates and replaced the exchangeable sodium with calcium (Muhammad, 1999; Sharma *et al*., 1996). Gypsum has been successively used in different ways to reclaim salt-affected soils (Ahmed *et al*. 1986; Ahmed *et al*., 1988; Chaudhry & Ullah, 1982). Sodic soils when clayey in nature have very compact mass. Addition of sand improved the percent pore space, hydraulic conductivity and degree of clay dispersion except the bulk density (Hussain *et al*., 1990). Materials capable of loosening these soils may play important role in improving the porosity of the soil, which may result in improving the rate of percolation of water and penetration of roots of the plants. This study was conducted to record the comparative effects of some of such materials.

MATERIALS AND METHODS

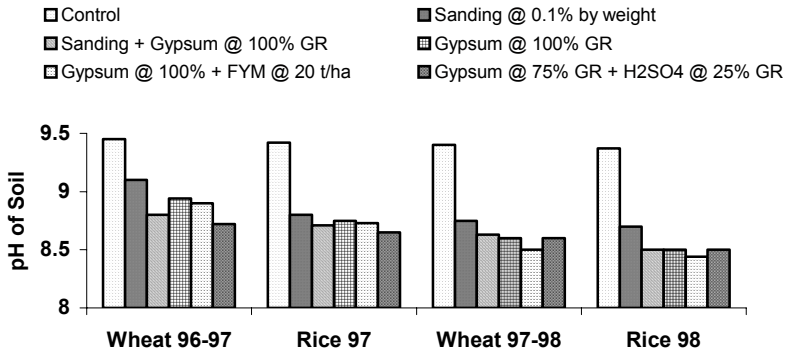
An experiment was conducted on farmer's field near Duleke by-pass Pindi Bhattian to compare reclamation effect of different amendments on a dense saline sodic soil (texture = clay loam, EC_e = 10.24 dS m^{-1}, pHs=9.57, SAR=28.70 (me L^{-1})$^{1/2}$. The treatments applied in RCBD design were: T1= Control; T2= Sanding @ 0.1% by weight of upper 15 cm of soil; T3= Sanding + Gypsum @ 100% GR; T4= Gypsum @ 100 GR; T5= Gypsum @ 100% GR + FYM @ 20 t ha^{-1}; T6= Gypsum @ 75% GR + H_2SO_4 @ 25% GR

Sub plot size was 15 x 12 m, in three replications. Two crops each of rice and wheat were grown in rice-wheat rotation. Rice variety Shaheen basmati was sown as a first crop to which fertilizers @ 100-70-50 kg ha^{-1} (N, P_2O_5, K_2O, respectively) were applied. Wheat variety Inqlab-91 was sown during Rabi season and fertilizers @ 120-100-50 kg ha^{-1} N, P_2O_5 + K_2O were applied. The experiment was laid down in a RCBD. As the canal water was not available, the field was irrigated with tube well water of EC_{iw} = 0.84 dS m^{-1}, SAR=8.86 (me L^{-1})$^{1/2}$ and RSC = 4.25 me L^{-1}. The data for paddy yield of rice and for grain and straw of wheat were recorded which were subjected to statistical analysis (Gomez & Gomez, 1976).

RESULTS AND DISCUSSION

A non-significant reduction in soil pH was observed under control treatment. Application of different amendments reduced the pH of the soil under both wheat and rice cropping. Addition of 0.1% sand alone to the field reduced the pH with the consecutive crops, and at the end of second year a 7% decrease in pH was noted. Impact of sanding along with gypsum @ 100% GR had significantly reduced the pH. However, the lowest pH was observed with a combination of gypsum @ 100% GR and FYM @ 20 t ha^{-1} (Fig. 1). The soil pH was reduced to permissible limit of

Fig. 1. Effect of sanding, Gypsum and H_2SO_4 on pHs of the soil



less than 8.5, at the end of the experiment, with different combinations of amendments.

Sanding alone reduced the EC_e of soil upto 11% during second year of crop (Fig. 2). Lowest EC_e (around 4 dS m^{-1}) was noted in gypsum and FYM combination after harvest of rice-98, followed by other gypsum based treatments. At the end of two years, sanding was the least effective amendment, as far as reduction in soil EC_e was concerned. A gradual reduction in EC_e was noted with passage of time and cropping. Gypsum alone was less effective than rest of the amendments except sanding. However, at the end of study its effect was similar to other treatments but significantly better than the sanding alone (Fig. 2).

Lowest value of SAR was observed by the application of gypsum @ 75% GR + H_2SO_4 @ 25% GR during the whole experimental period. Reduction of SAR by sanding was significant than control but less than the rest of the treatments. Gypsum @ 100% GR and FYM @ 20 t ha^{-1} was not so effective during the first crop but later on the effect was significant in wheat and rice crops (Fig. 3). With cropping, a gradual decrease in SAR was also noted in all the treatments, which was more pronounced in gypsum combined treatment.

Maximum grain yield in both the crops was obtained by the treatment of sanding + gypsum. Effect of gypsum + FYM and gypsum + H_2SO_4 was significantly higher than rest of the treatments during the first rice crop only. In the second year, in the control plots, the wheat grain yield increased but rice grain yield decreased as compared with those in the first year of the study (Fig. 4).

Addition of sand to the soil improved leaching of salts. Gypsum and FYM combination further enhanced this effect (Hussain *et al*., 1990). Presence of H_2SO_4 may have directly reduced the soil pH. The effect of gypsum and FYM as a combination with H_2SO_4 was significant because addition of H_2SO_4 with that of gypsum and/or FYM might has been used in enhancing the solubilization process (Chaudhry & Ullah, 1982). The original soil was saline sodic in nature, which was very compact. Addition of sand had loosened the soil and increased its porosity in the upper layers. Addition of gypsum and/or FYM enhanced the chemical reaction and exchanged the sodium ions with Ca^{2+} on the soil exchange complex. The Na ions in soluble form leached down due to improved soil physical conditions (Ahmed *et al*., 1986). The roots of growing crop plants also played a vital role in the reclamation of soil. Their effect was both ways; physical and addition/decay of organic matter. All these factors collectively helped in reducing the soil EC_e. Less

Fig. 2. Effect of sanding, Gypsum and H_2SO_4 on electrical conductivity of the soil

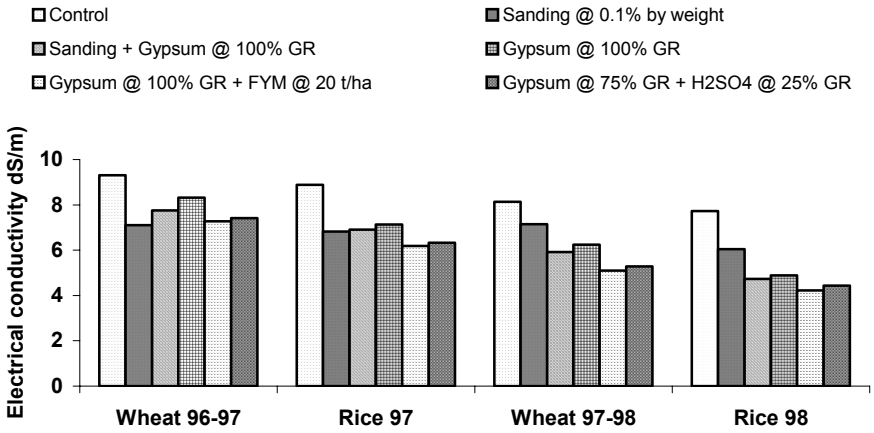


Fig. 3. Effect of sanding, Gypsum and H_2SO_4 on SAR of the soil

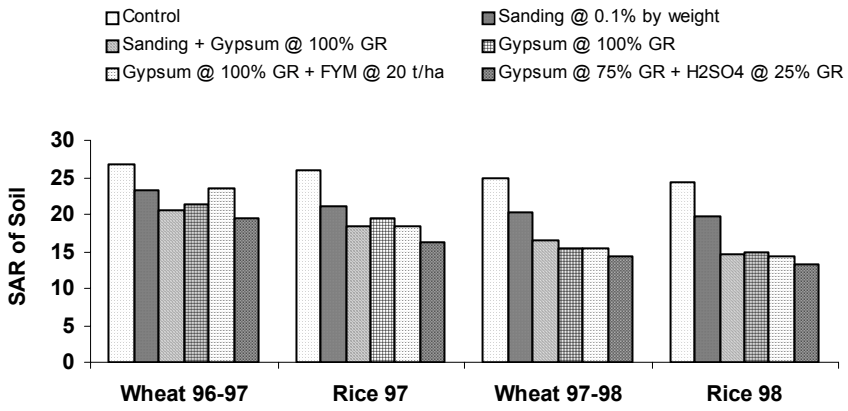
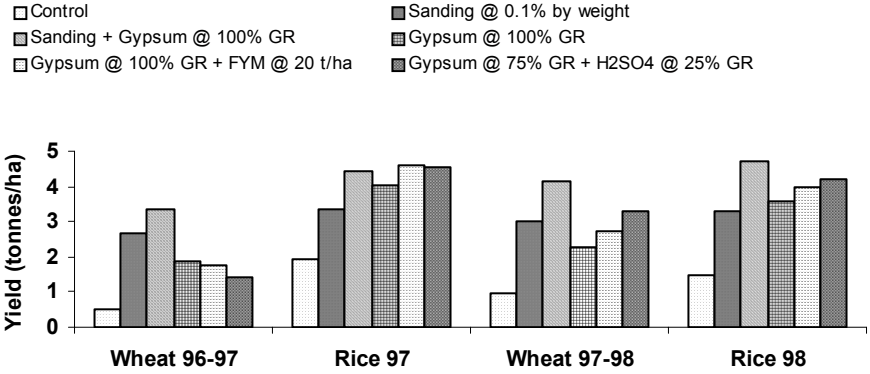


Fig. 4. Effect of sanding, Gypsum and H_2SO_4 on grain yield of rice and wheat (t/ha)



effectiveness of gypsum alone supports the logic in this case. The effectiveness of the applied H_2SO_4 is far higher than that of gypsum, FYM and sanding. A slow rate of dissolution of gypsum and less rate of decomposition of FYM (Ahmad *et al*., 1988) may have shown a significant effect on reduction of SAR for the first year but further cropping affected the process of reclamation. Initially, the experiment had been started with the wheat crop and as the reclamation process was just initiated. Due to incomplete reclamation less grain yield of wheat was recorded. Later at the time of rice crop, the soil amelioration process was comparatively enhanced. Addition of excessive irrigation water for rice crop as a common practice also increased the solubility of gypsum. Thus, the reclamation of soil was faster. Sanding had also helped in improvement of leaching of excessive ions released from soil by calcium either from gypsum or FYM to the deeper layers. Thus concentration of the salts was reduced in the upper layers, which favoured the growth of plant and ultimately a significant increase in rice grain was observed.

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(Received 25 April 2001; Accepted 06 June 2001)