INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2000/02–1-2–83–85

# Reclamation of Sodic Soils: Horizontal Flushing at different Time Intervals after Application of Gypsum

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## ABSTRACT

An experiment was conducted in a saline sodic soil on farmer's field at Pindi Bhattian to reclaim it under restricted infiltration and drainage during 1995-97. The original soil had an $EC_e$ = 5.25 $dSm^{-1}$, SAR = 49.9 and pH = 9.8. Gypsum was applied @ 100% GR , while the irrigation water was flushed out at different time periods (12, 24 & 36 hours) of gypsum application except control. Wheat (Inqlab -91) - rice (Basmati-385) - wheat crop rotation was practiced during the experiment. Wheat yield significantly increased (38, 48 & 70%) with the increase in flushing time, compared to control. A 26% decrease in the SAR of the soil was noted at the time of wheat harvest. An increase in the $EC_e$ of soil was recorded at the time of wheat harvest, while an increase in the $EC_e$ of soil resulted when water was flushed after 12 hours of gypsum application. A delay in the water flushing by 24 and 36 hours decreased the $EC_e$ significantly. There was a non-significant decrease in pH except the 36 hours flushing. A further decrease in soil SAR and $EC_e$ has been noted after the second and third crop of rice and wheat, respectively. It was followed by a significant increase in wheat yield during 1996-97. Horizontal flushing 36 hours after gypsum application proved to be the best intervention as it significantly improved soil physical properties as well as wheat yields.

**Key Words:** Reclamation; Sodic soil; Horizontal flushing; Gypsum application

## INTRODUCTION

Application of gypsum to the saline and saline sodic soils results in a reaction with fixed $Na^+$ on soil complex and transforms it into a soluble form which increases the concentration of total soluble salts especially the $Na^+$ in soil solution (Haider, 1964). This $Na^+$ leaches down with the irrigation water. Application of gypsum associated with simple leaching is less effective because most of the heavy sodic soils are non porous and there is usually a hard pan formed at certain depth (Muhammed & Khaliq, 1975). It checks the percolation of water and therefore, there is no way to get rid of excessive $Na^+$ from the soil. Gypsum also improves the hydraulic conductivity of the saline-sodic soil (Ghafoor & Muhammed, 1981). One method to get rid of excessive soluble salts in the solution is to flush out the surface water after completion of reaction of gypsum with the soil particles (Ahmed *et al.,* 1992). The solubility of gypsum is low. The time required for the completion of chemical reaction after gypsum application may vary from soil to soil and is yet to be calibrated. Rice crop is known to be more suitable than wheat for the reclamation of saline-sodic soils (Ghafoor *et al.*, 1985). Therefore, the experiment was planned to explore the effect of flushing of irrigation water at different time periods of application of gypsum, under wheat-rice crop rotation.

## MATERIALS AND METHODS

A field experiment was conducted at farmer's field in Soil Salinity Research Institute (SSRI), Pindi Bhattian in saline-sodic field conditions ($EC_e$ = 5.25, SAR = 49.9 and $pH_s$ = 9.8) to reclaim it under restricted infiltration and drainage during 1995-97. The soil was leveled and prepared by conventional method. The crop rotation was wheat-rice-wheat. Net plot size was 12m X 15m. Gypsum was applied in soil @ 100% GR. Following treatments were applied afterwards:

1. Gypsum @ 100% GR + Flushing of applied water after 12 hours.
2. Gypsum @ 100% GR + Flushing of applied water after 24 hours.
3. Gypsum @ 100% GR + Flushing of applied water after 36 hours.
4. Conventional method (No flushing but water was left for vertical leaching).

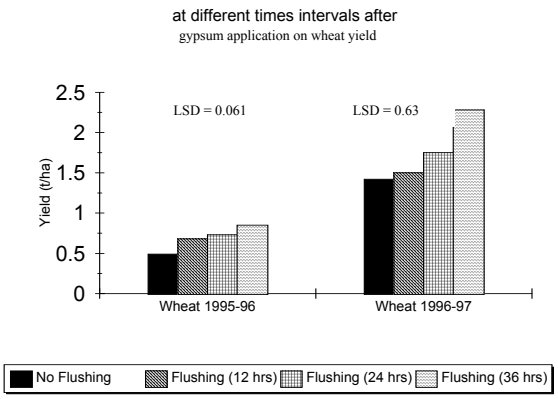
The experiment consisted of three replications with RCBD. Date of initiating the experiment was 13-11-95. Field was irrigated with canal water and water was allowed to stand for the completion of soil *vs* gypsum reaction. Water in the control plots was kept undisturbed, while horizontal flushing of water was carried out after 12, 24 and 36 hours after gypsum application. The field was allowed to dry up till proper moisture conditions. The $pH_s$, $EC_e$ and SAR of soil was observed before and at the time of crop harvest. Wheat variety Inqlab-91 was sown. Rate of fertilizer application was uniform (120 - 100 - 0 NPK kg $ha^{-1}$). Crop was harvested at maturity, data recorded and soil samples were obtained for

analysis. Subsequently, rice variety Bas-385 was sown but the crop failed due to high $EC_e$. The second wheat crop was obtained in 1996-97. Data were recorded and soil analysis was carried out. Data were processed for statistical analysis. Yield (t $ha^{-1}$) was also recorded. Rice crop was grown in the same field during 1996. Yield of rice crop (1995-96) could not be taken because of failure due to flood conditions. Wheat crop was again sown during 1996-97 and above mentioned parameters were recorded.

## RESULTS AND DISCUSSION

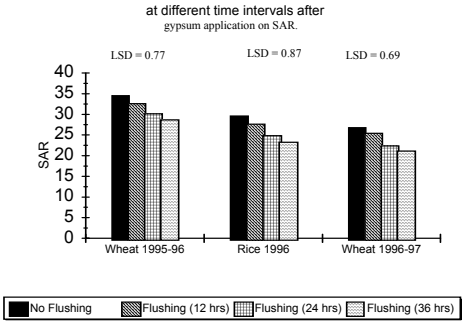
Wheat yield (t $ha^{-1}$) increased with the increase in flushing time after gypsum application. During 1995-96, maximum wheat yield increase which was 73% higher as compared to control was observed in treatment where irrigation water was flushed out 36 hours after gypsum application (Fig. 1).

**Fig. 1. Effect of horizontal flushing at different times intervals after gypsum application on wheat yield**



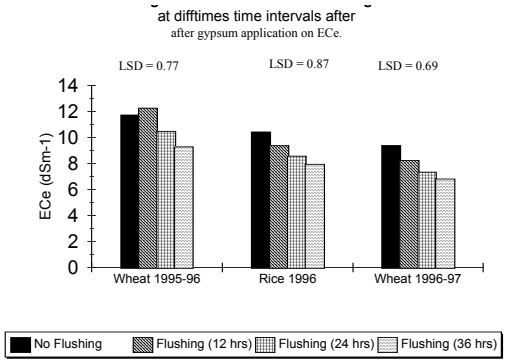

The wheat yield increase in treatments, where irrigation water was flushed out 12 and 24 hours after gypsum application were 38 and 48%, respectively (Fig. 1). However, yield increase in treatment receiving 12 and 24 hours flushing were statistically at par. A significant decrease in the SAR was also observed at the time of final wheat harvest. A 26% decrease in the SAR has been noted at the time of wheat harvest compared to that of " 1995-96 wheat crop" (Fig. 2). The solubility of gypsum is slow and it takes longer to dissolve, therefore the maximum time (36 hrs) after application helped not only to dissolve the gypsum itself in the irrigation water but also provided it a chance to complete the reaction with the adsorbed sodium to the soil particles. A subsequent surface flushing of the irrigation water resulted in the successive removal of dissolved salts from the field. It has been confirmed by the decrease noted in the SAR of the soil.

**Fig. 2. Effect of horizontal flushing at different times intervals after gypsum application on SAR**




The $EC_e$ of the soil increased non-significantly by flushing the irrigation water after 12 hrs of gypsum application. However, by allowing irrigation water to stand in field for 24 and 36 hours significantly and flushing out resulted more salts along with irrigation water (Fig. 3). Flushing out of irrigation water after 24 and 36 hours registered further reduction in $EC_e$ during rice (1996) and wheat (1996-97) (Fig. 3). An early flushing of irrigation water did not help to remove the salts as the reaction of gypsum to sodium salts was underway and only a small amount of the already exchanged sodium salts were removed with the flushed out water. The process of gypsum dissolution continued and release of sodium salts were being constantly added to the soil solution which increased the soil $EC_e$. However, in those plots where the water was flushed out after 36 hours, maximum time was provided for the reaction to be completed and flushing out procedure helped the removal of all dissolved salts from the field followed by a significant decrease in the soil $EC_e$.

**Fig. 3. Effect of horizontal flushing at different times intervals after gypsum application on $EC_e$**




There was significant reduction in pH of soil during wheat (1995-96) and rice (1996) where water was flushed out after 36 hours (Table I). However, all the other treatments did not significantly affect soil pH,

decrease in the value of SAR was linear and significant in each treatment compared to control (Fig. 2). During the rice crop $pH_s$ further decreased a little bit. The $EC_e$ of the control treatment during rice (1996) significantly reduced as against $EC_e$ of control treatment during wheat (1995-96).

**Table I. Effect of horizontal flushing at different time intervals after gypsum application on soil pH. (P<0.05)**

| Flushing after gypsum application (hours) | Wheat 1995-96 | Rice 1996 | Wheat 1996-97 |
|---|---|---|---|
| No flushing | 8.90 A | 8.84 A | 8.81 A |
| 12 | 8.86 A | 8.79 A | 8.74 A |
| 24 | 8.89 A | 8.77 A | 8.68 A |
| 36 | 8.72 B | 8.62 B | 8.59 A |

SAR values observed during rice cultivation were also lower than those at the time of wheat cultivation. Decrease in the pH of soil with the application of gypsum may be related to change in the nature and composition of the exchangeable cations. Gypsum on reacting with $Na^+$ on the soil particles released the cations in the soil solution, which resulted in the increase in the concentration of soluble salts (Fireman & Wadleigh, 1951).

Increase in the crop yield favours the soil reclamation process and this technique may be practiced in the field area on mass level, provided abundant water is available for irrigation and flushing purposes. However, losses of useful ions with the flushing may be considered while using the technology.

Wheat yield during 1996-97 was significantly higher than that of 1995-96. It was 189, 121, 140 and 168% higher compared to 1995-96 in their respective treatments. $EC_e$ of the soil further decreased during wheat crop (1996-97) and this reduction was 27% in the treatment which received flushing 36 hours after gypsum application as against same treatment during wheat (1995-96). However decrease in pH was non significant.

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**(Received 02 December 1999; Accepted 18 January 2000)**