

Pressmud: A potential ameliorant

for greening the sodic lands

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Continuous use of bicarbonate dominated residual alkalinity in irrigation water results in build-up of excessive salt concentration (Na^+) and soil sodicity (soil $\text{pH} > 8.5$). This process adversely affects the plant growth and soil physico-chemical properties consequently impacting crop yields. Mined gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is the most preferred ameliorant in sodic areas where farmers use it to reclaim and manage their lands owing to comparatively lower price due to provision of government subsidy, ease in application as compared to other chemical amendments. However, the gypsum production/availability is limited to 6-7 million tonnes/year in India (by-product gypsum and natural gypsum) from all available resources. To reclaim huge chunk of ever increasing sodic soils (caused by anthropogenic and natural process), the sole dependence on gypsum for reclamation purpose seems to be over-burdened enforcing the farmers to look forward for other alternatives.

Key words: FFP, Gypsum, Impact analysis, Pressmud, Sodic Soil, Sugar mill

PRESSMUD, an organic waste by-product in sugar industries is produced in the range of 3–8% of the crushed cane, depending on the nature of sugar manufacturing process. Pressmud enhances organic matter content of soil, improves soil physical conditions, acts as a soil conditioner and valuable nutrient source for macro and important micronutrients (Zn, Cu, Fe and Mn) generally found deficient in calcareous alkaline soils.

Sodicity led abiotic stress and farmers' issue

Haryana has been able to reclaim its large area of sodic soil using gypsum as a reclamation ameliorant. However, in many parts of state, the soil is still sodic either in patches or solely. Looking to the changing scenario of agriculture and climatic factors, there is need of integrating agricultural inputs in reclamation and management process of sodic soils which would be quite sustainable in long run. In Kaithal district covering 6 blocks, nearly 11.3% of total geographical area (26,301 ha) area is

salt affected, out of which 15,986 ha (6.8%) is sodic and 10,315 ha (4.4%) is saline in nature. Within Kaithal block, sodic soils (6,122 ha) predominate where groundwater (bicarbonate dominated underground water) used for irrigation purpose is also sodic. These soils are slightly (4,313 ha) to moderately (1,809 ha) sodic in nature. Saline soils (804 ha, 0.3%) are also located at selected places only in the lower topographic

zone. The district Kaithal has a co-operative sugar mill having crushing capacity of 2,500 tonnes of cane per day (TCD) and produces tonnes of press mud. Huge volume of unused pressmud causes great disposal problems for the sugar industry and environment (Fig. 1).

Farmers' issue, technology assemblage and application

Studies have shown the beneficial



Fig. 1. Piling-up of sugarcane pressmud around the sugar mill

effects of organic amendments like pressmud in neutralization of high RSC waters, reduction in sodicity buildup and improvement in crops productivity. This necessitated the idea to showcase the potential of pressmud towards reclaiming the sodic soils and yield improvement on farmers' field. To pursue this idea, five villages (Mundri, Kathwar, Geong, Sampli Kheri and Bhaini Majra) were selected as a part of the pilot study under Farmers FIRST Programme (FFP) within a vicinity of 8-10 km radius of Kaithal sugar mill. A systematic and extensive survey on soil and water quality indicated that 40.1% of the total cultivable area in 5 villages is sodicity affected (soil pH₂>8.5) with 90% area confirmed with high residual alkalinity in irrigation water (RSC_{iw}>2.5 meq/l, threshold value defining the critical limit for safe use of underground water for irrigation purpose). Laboratory analysis of collected soil and water samples indicated inter-dependence of sodicity buildup and irrigation water alkalinity (R²=0.64) (Fig. 2). Targeted farmers were consulted to understand their field problems and intensive transect walk, group discussions and personal interactions were held to record their knowledge and practices of sodic soil reclamation and crop management practices.

One important point emerged from the formal discussions that farmers of this area though are using gypsum as reclamative ameliorant but they do not have sound knowledge regarding systematic approach of soil pH based gypsum application. In addition, they are not taking into account the gypsum required for neutralizing the adverse effects of high RSC water (RSC_{iw}) being applied to irrigate seasonal (rice-wheat) crops. None of the interviewed farmer had ever applied pressmud for reclaiming the sodic soils. With this backdrop and to convince farmers, multi-stakeholders' meet involving farmers, scientists, representatives of Haryana Land Reclamation and

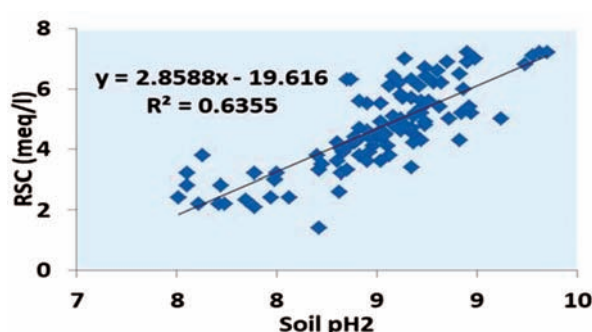


Fig. 2. Inter-relationship indicating buildup of soil sodicity and irrigation water alkalinity

Table 1. Composition of pressmud

Parameters	Value
pH ₂	5.2 ± 0.08
EC ₂ (dS m ⁻¹)	1.1 ± 0.06
Moisture	48.8 ± 1.5%
Carbon (%)	30.7 ± 1.1%
Nitrogen (%)	2.31 ± 0.5%
Sulphur (%)	1.44 ± 0.07%
Calcium (%)	2.17 ± 0.05%
Magnesium (%)	1.08 ± 0.03%

Development Cooperation and State Department of Agriculture was helped regarding potential use of sugarcane pressmud along with gypsum in reclaiming the sodic lands and sustaining agricultural productivity in affected areas.

To initiate the work, pressmud samples were taken from the nearby Kaithal Sugar mill and analyzed for nutritional composition (Table 1). Since the technology demonstrations are to be carried out in farmers' participatory mode and there remains large heterogeneity under field conditions owing to variable soil sodicity and irrigation water alkalinity, therefore, technology validation trials were categorized into six groups according to stress intensity, such as soil pH₂<8.25, 8.25-8.50, 8.50-8.75, 8.75-9.00, 9.00-9.25 and >9.250 and for RSC<3, 3-4, 4-5, 5-6, 6-7 and >7 meq/l. To demonstrate the

complementary effect of pressmud, participatory research was carried out at 37 locations in the rice-wheat production system covering 2,000 m² area at each location. Pressmud was applied @ 10 t/ha (dry weight basis) as improved practice (IP) and compared with farmer's practice (unamended control) (FP) (Fig. 3). Pressmud was applied in the month of June and incorporated into top 10 cm soil layer 15-20 days prior to rice transplanting.

Outcome

Complementary effects of applying pressmud as reclamative/neutralization ameliorant proved its effectiveness in sustainable use of poor quality waters for rice-wheat system under sodic soils. Grain yields of rice and wheat harvested from 37 locations of farmers' field in terms of system productivity (wheat equivalent yield) strongly reflected the influence of soil sodicity (soil pH) and residual alkalinity in irrigation water (RSC_{iw}). The cumulative yield gain with the application of pressmud (as reclamative/neutralization ameliorant) was relatively better with the increase in soil pH and deterioration of irrigation water quality (Fig. 4). Rice and wheat yields in response to pressmud application under sodic soils revealed yield advantage ranging between 11.7 to 17.5% in rice and 9.5 to 18.9% in wheat in comparison to farmers' practice (un-amended control) depending on variable soil pH with continuous use of high RSC waters (mean values mentioned against each soil pH category). Overall, the yield improvement to the extent of 15.3% in rice and 14.4% in wheat was recorded with pressmud application.

Continuous irrigation with high RSC waters resulted in gradual rise in soil pH₂ depending on the residual alkalinity in irrigation waters. Complementary effects of pressmud application were visualized by reduction in

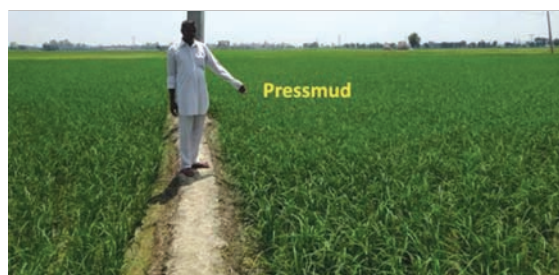


Fig. 3. Intervention of pressmud application on sodic field of Shri Tarsem Singh in village Kathwar, Kaithal.

Table 2. Rice and wheat yields in response to pressmud application under sodic soils

Soil pH range	Average soil pH	Average RSC _{iw} (meq/l)	Paddy 2017 (kg/ha)			Wheat 2017-18 (kg/ha)		
			Control	PM @ 10 t/ha	% increase	Control	PM @ 10 t/ha	% increase
<8.25 (N=6)	8.18	2.30	3,288	3,675	11.7	4,588	5,039	9.5
8.25-8.50 (N=7)	8.39	3.44	3,019	3,414	13.1	4,128	4,617	11.9
8.50-8.75 (N=7)	8.65	4.29	2,676	3,066	14.7	4,043	4,613	13.9
8.75-9.00 (N=8)	8.89	5.47	2,544	2,993	17.8	3,677	4,289	16.7
9.00-9.25 (N=5)	9.11	6.03	2,448	2,887	17.9	3,341	3,908	17.0
>9.25 (N=4)	9.38	6.70	2,324	2,732	17.5	3,457	4,107	18.9
Overall (N=37)	8.86	5.26	2,743	3,157	15.3	3,925	4,474	14.4

sodicity buildup depending on the initial soil pH₂ and irrigation water alkalinity (Fig. 5). Continuous use of high RSC waters increased mean soil pH₂ by 0.17 units while pressmud use reduced soil pH₂ by 0.33 units from the mean initial value of 8.70.

Impact analysis

The partial budgeting technique was employed to estimate the incremental economic benefits obtained by pressmud application in sodic soils (Table 3). The study revealed that the overall added returns/monetary benefit obtained from the system was of ₹ 24,799/ha against the added cost of ₹ 4,920/ha incurred towards pressmud application @ 10 t/ha (including material cost, labour cost and transportation charges). The study indicated an incremental input-output ratio of 5.04 for each rupee invested towards the cost of pressmud application.

Lessons learned

Precised irrigation water management strategies with soil reclamation techniques are the key management issues needed to be strongly addressed in sodic agro-ecosystems. Pressmud application not only helped in better utilization of

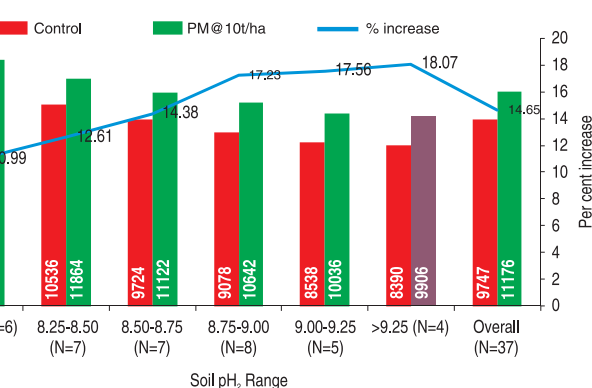


Fig. 4. System productivity (wheat equivalent yield) in response to reclamation/neutralization ameliorant using pressmud vis-à-vis farmers' practice under sodic soils

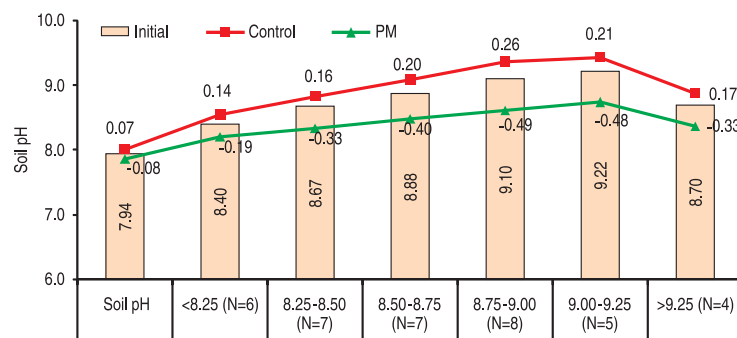


Fig. 5. Change in soil pH due to pressmud application (before and after) vis-à-vis farmer's practice

Table 3. Partial budgeting for system productivity (wheat equivalent yield) in response to pressmud application under sodic soils

Soil pH range	Added returns (₹/ha)	Added costs (₹/ha)	Incremental input-output ratio
<8.25 (N=6)	22,069	4,920	4.49
8.25-8.50 (N=7)	23,041	4,920	4.68
8.50-8.75 (N=7)	24,255	4,920	4.93
8.75-9.00 (N=8)	27,135	4,920	5.52
9.00-9.25 (N=5)	25,990	4,920	5.28
>9.25 (N=4)	26,303	4,920	5.35
Overall (N=37)	24,799	4,920	5.04

by-product while achieving the sustainable yields in sodic environment (rice-wheat system), but also help in reducing the dependency on gypsum suggesting pressmud as an alternate ameliorant in sodic water

irrigated ecologies.

Scientific diagnosis of sodicity in soil and water, holding strong farmers-scientist interface, and strengthened participatory research could work as suitable and location specific adaptive strategies to manage sodicity. Otherwise, the farmers of sodicity affected areas would become hopeless with the day by day deteriorating crop yields. Such examples of participatory work can be more viable in arresting not only the land degradation (soil sodicity) but also enhancing the crop yields whereby farmers' livelihood can be strengthened in more sustainable ways. Long-term trials can generate useful insights for convincing the policy makers so that such agro-techniques receive policy support for managing the widespread problems in different parts of country with similar agro-ecological situations.

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