

Effect of Pressmud and Spentwash in Integration with Phosphogypsum on Yield and Economics of Wheat on Sodic Soils

P. Pagaria and K.L. Totawat

Department of Agricultural Chemistry & Soil Science, Rajasthan College of Agriculture, MPUA&T, Udaipur 313 001, India

Abstract: A field experiment was conducted during 2001-02 and 2002-03 at Research Station, Vallabhnagar (Udaipur, Rajasthan), to study the effect of pressmud (0.5, 10, 15 t ha⁻¹) and spentwash (0, 2.5, 5.0, 7.5 lac L ha⁻¹) with phosphogypsum (0, 25, 50% GR) on wheat productivity. Incorporation of phosphogypsum at 25% GR in integration with either pressmud or spentwash decreased the soil pH, EC and ESP and highest wheat grain yield was recorded with the treatment phosphogypsum at 25% GR. alone or with either pressmud (15 t ha⁻¹) or spentwash (7.5 lac L ha⁻¹). Incorporation of phosphogypsum beyond 25% GR had no significant effect on grain as well as straw yield of wheat. Incorporation of soil amendment increased the net returns and B:C ratio of wheat crop. The net returns and B:C ratio was under phosphogypsum at 50% and 25% GR, respectively, alone or with either spentwash at 7.5 lac L ha⁻¹ or pressmud at 15 t ha⁻¹.

Key words: Spentwash, pressmud, economics, wheat.

Out of 13.5 Mha of salt affected soils in India, sodic soils occupy 3.6 M ha (Bhargava and Kumar, 2004). Sodic soils are capable of alkaline hydrolysis, i.e., predominated with sodium bicarbonate, sodium carbonate and sodium silicate. Their reclamation essentially requires a soluble source of calcium, whether mobilized from native CaCO₃ or added externally through soil amendment.

Pressmud, a sugar factory waste, is either a rich source of calcium carbonate process, 61% CaCO₃ or organic matter sulphitation process, 26% OC and thus can act as an effective ameliorant for sodic soils. Spentwash, a distillery waste, is acidic (pH 4.0) effluent capable of generating gypsum in the soil from the native CaCO₃ of the calcareous sodic soils. Though gypsum is the most commonly and widely used amendment for the reclamation of sodic soils,

but complete reclamation of sodic soils is a capital-intensive proposition. Utilization of industrial wastes, which are either a source of soluble calcium or capable of generating calcium in soil, will not only economise the process of reclamation, but will also safeguard the environment from its degradation through waste disposal. An effort has been made to reclaim sodic soil using of sugar industry and distillery wastes in integration with phosphogypsum, a by-product of phosphoric acid plant.

Materials and Methods

A field experiment was conducted during 2001-02 and 2002-03 at Research Station, Vallabhnagar (Udaipur, Rajasthan) to study the effect of pressmud and spentwash in integration with phosphogypsum on wheat productivity. The soil of experimental field was sandy clay loam in texture, calcareous

sodic in nature having CaCO_3 ranging from 9.5 to 13.5% and ESP ranging between 28 to 34, medium in available macro and micronutrients status and having impervious dense surface, subsurface and subsoil layers, indicating extremely poor soil drainage. Two separate experiments, one using pressmud in integration with phospho- gypsum and the other using spentwash in integration with phosphogypsum were conducted separately to assess the efficiency of these soil amendments in the reclamation of calcareous sodic soils. The treatment comprised of one time application of four levels of pressmud (0, 5, 10 and 15 t ha⁻¹) and spentwash (0, 2.5, 5.0 and 7.5 lac L ha⁻¹) in integration with three levels of phosphogypsum (0, 25, and 50% GR). Wheat variety Raj-3077 was taken as a test crop. Pressmud and gypsum were applied through broadcasting and surface incorporation while spentwash was applied as surface sprinkling through PVC pipe. A basal dose of 62.5 kg N, 60 kg P₂O₅ and 25 kg ZnSO₄ ha⁻¹ was given at the time of sowing. In addition, 62.5 kg N ha⁻¹ was given in two equal splits in standing crop. Economics of different treatments were worked out based on the prevalent prices of inputs and sole prices of outputs. The economics of treatments are reported in terms of net returns per hectare and B:C ratio.

Results and Discussion

The lowest values of pH, EC and ESP to the tune of 8.15, 1.00 and 25.36 under pressmud (15.0 t ha⁻¹) and 8.06, 1.06 and 26.97 under spentwash (7.5 lac L ha⁻¹) incorporation were recorded. Incorporation of phosphogypsum also decreased the pH, EC and ESP of the soil and these were lowest 50% GR. Interaction between

phosphogypsum and pressmud or spentwash revealed that the lowest values of soil pH, EC and ESP were recorded in treatment receiving the highest level of pressmud (15 t ha⁻¹) or spentwash (7.5 lac L ha⁻¹) in integration with phosphogypsum at 50% GR. A reduction in soil pH, EC and ESP (Table 1) in the present investigation can be attributed to the potential acidity and higher contents of calcium, magnesium and sulphur in the spentwash (Sharmila Rahale and Bose, 2004), as well as production of CO₂ and organic acids during pressmud decomposition (Pathak, 1999), as well as to increased root mass and increased microbial activity in the rhizosphere under congenial environment as a consequence of improved soil physical conditions.

Incorporation of phosphogypsum increased the grain and straw yields of wheat (Table 2). Interaction between pressmud and phosphogypsum revealed that incorporation of pressmud at 15 t ha⁻¹ in conjunction with phosphogypsum at 50% GR gave the highest yield of wheat grain (4360 kg ha⁻¹) and straw (6510 kg ha⁻¹) after two years of study, which were closely followed by the treatment receiving pressmud at 15 t ha⁻¹ in conjunction with phosphogypsum at 25% GR. However, the differences were statistically not significant. Similarly, incorporation of spentwash up to 7.5 lac L ha⁻¹ also increased the grain and straw yield (7380 kg ha⁻¹) of wheat though the variations recorded were statistically not significant (Table 2). Incorporation of phospho-gypsum in the soil significantly increased the grain and straw yields of wheat. During 2002-03 highest grain (4910 kg ha⁻¹) and straw (7380 kg ha⁻¹) yields were recorded under

Table 1. Effect of pressmud and spentwash incorporation in integration with phosphogypsum on pH, EC and ESP of sodic soils after two year of experiments

PG % GR	Pressmud (t ha ⁻¹)					Spentwash (lac L ha ⁻¹)				
	0	5	10	15	Av.	0	2.5	5.0	7.5	Av.
pH										
0	9.03	8.50	8.50	8.47	8.63	8.67	8.70	8.73	7.97	8.52
25	8.60	8.50	8.30	8.07	8.37	8.93	8.67	8.33	8.17	8.53
50	8.77	8.30	8.13	7.93	8.28	8.80	8.13	8.00	8.03	8.24
Av.	8.80	8.43	8.31	8.15		8.80	8.50	8.36	8.06	
EC										
	PM		PG		PMxPG	SW		PG		SWxPG
SEm±	0.039		0.034		0.068	0.072		0.063		0.125
CD 5%	0.115		0.100		0.199	0.212		0.183		0.367
ESP										
0	1.60	1.33	1.27	0.98	1.30	1.22	0.95	1.22	1.29	1.17
25	1.33	1.23	1.05	1.20	1.20	1.07	1.30	1.15	1.05	1.14
50	1.23	1.10	0.93	0.82	1.02	1.23	1.59	0.82	0.90	1.14
Av.	1.39	1.22	1.09	1.00		1.17	1.28	1.06	1.08	
	PM		PG		PMxPG	SW		PG		SWxPG
SEm±	0.010		0.009		0.018	0.012		0.010		0.020
CD 5%	0.031		0.027		0.053	0.034		NS		0.059
ESP										
0	33.99	31.13	28.08	27.21	30.10	33.97	31.13	29.47	28.25	30.70
25	30.33	28.25	28.17	26.51	28.32	29.65	27.55	27.53	27.18	27.98
50	29.53	29.12	26.51	22.36	26.88	30.39	27.21	26.31	25.48	27.35
Av.	31.39	29.50	27.59	25.36		31.24	28.63	27.77	26.97	
	PM		PG		PMxPG	SW		PG		SWxPG
SEm±	0.346		0.300		0.599	0.352		0.305		0.610
CD 5%	1.015		0.879		1.757	1.033		0.894		NS

PM: Pressmud, PG: Phosphogypsum, SW: Spentwash, Av.: Average.

phosphogypsum at 50% GR. The grain and straw yields recorded under phosphogypsum at 25% GR were statistically at par with those at 50% GR.

The highest grain (4090 kg ha⁻¹) and straw (5930 kg ha⁻¹) yields of wheat during year 2002-03, were recorded under the treatment receiving phosphogypsum at 50% GR, though, the yield values observed under the treatment receiving phosphogypsum at 25% GR closely followed and remained

statistically at par. Likewise, a definite increase in grain and straw yields of wheat were apparent as a consequence of pressmud incorporation up to 15 t ha⁻¹, but the effects were statistically not significant.

Spentwash and phosphogypsum together did not influence grain and straw yields of wheat. However, incorporation of spentwash at 7.5 lac L ha⁻¹ in conjunction with phosphogypsum at 25% GR or 50% GR resulted in almost comparably grain

Table 2. Effect of pressmud and spentwash incorporation in integration with phosphogypsum on grain and straw yield of wheat after two year of experiments

PG % GR	Grain yield (t ha ⁻¹)					Straw yield (t ha ⁻¹)				
	Pressmud (t ha ⁻¹)									
	0	5.0	10	15	Av.	0	5.0	10	15	Av.
0	3.10	3.25	3.30	3.35	3.25	4.20	4.55	4.70	5.04	4.62
25	3.63	3.94	4.08	4.13	3.94	5.22	5.72	6.07	6.22	5.80
50	3.78	4.00	4.23	4.36	4.09	5.28	5.81	6.11	6.51	5.93
Av.	3.50	3.73	3.87	3.94		4.90	5.36	5.63	5.92	
	PM	PG	PMXPG			PM	PG	PMXPG		
SEm±	1.482	1.284	2.567			2.526	2.188	4.375		
CD 5%	NS	3.764	NS			NS	6.416	NS		
	Spentwash (lac L ha ⁻¹)									
	0	2.5	5.0	7.5	Avg.	0	2.5	5.0	7.5	Av.
0	3.36	3.63	3.82	4.09	3.72	4.45	5.06	5.30	6.09	5.23
25	4.61	4.75	4.90	5.03	4.82	6.34	6.68	6.98	7.25	6.81
50	4.88	4.91	4.93	4.95	4.91	7.04	7.40	7.41	7.68	7.38
Av.	4.28	4.43	4.55	4.69		5.94	6.38	6.56	7.00	
	SW	PG	SWXPG			PM	PG	SWXPG		
SEm±	1.728	1.496	2.993			2.743	2.376	4.752		
CD 5%	NS	4.389	NS			NS	6.968	NS		

SW: Spentwash, PM: Pressmud, PG: Phosphogypsum, Av.: Average.

and straw yields during both the years. While, the highest straw yield (7680 kg ha⁻¹) of wheat was recorded under spentwash at 7.5 lac L ha⁻¹ in conjunction with phosphogypsum at 50% GR.

Incorporation of phosphogypsum together with pressmud or spentwash increased the grain and straw yields of wheat during both the years. Phosphogypsum at 25% GR significantly increased the grain as well as straw yields, however, beyond 25% GR had no significant effect. The increase in wheat yield due to soil amendments may be attributed to the reduction in mechanical impedance in the plough zone through improved soil structure (Patil and Choudhary, 2002) and

improvement in soil chemical parameters (Sharmila Rahale *et al.*, 2001). The increased dry matter production provided better source sink relationship (Evans, 1980) enabling greater synthesis and translocation of photosynthetes to reproductive organs, which ultimately resulted in improved grain yield of wheat.

Incorporation of pressmud up to 15 t ha⁻¹ or spentwash up to 7.5 lac L ha⁻¹ increased the net returns and B:C ratio of wheat crop (Table,3). The maximum net returns (Rs. 17,290) and B:C ratio (1.31) for pressmud were recorded at 15 t ha⁻¹ and net returns (Rs. 22,983) and B:C ratio (1.75) for spentwash these were at 7.5 lac L ha⁻¹ as against Rs. 13,538 and 1.03 (no- pressmud)

Table 3. Effect of pressmud and spentwash incorporation in integration with phosphogypsum on net returns (Rs ha⁻¹) and B:C ratio after two years of experiments

PG % GR	Net return (Rs. ha ⁻¹)					B:C ratio				
	Pressmud (t ha ⁻¹)					Spentwash (lac L ha ⁻¹)				
	0	5	10	15	Av.	0	2.5	5.0	7.5	Av.
0	11219	12499	12959	13609	12572	0.92	1.02	1.06	1.11	1.03
25	14625	17044	18262	18725	17164	1.12	1.30	1.39	1.43	1.31
50	14771	16612	18339	19538	17315	1.05	1.19	1.31	1.39	1.24
Av.	13538	13585	16520	17290		1.03	1.17	1.26	1.31	
	PM	PG	PMXPG			PM	PG	PMXPG		
SEm±	1050	912	1820			0.08	0.07	0.14		
CD 5%	NS	2670	NS			NS	0.21	NS		
	SW	PG	SWXPG			SW	PG	SWXPG		
SEm±	1225	1061	2120			0.09	0.08	0.16		
CD 5%	NS	3112	NS			NS	0.23	NS		

SW: Spentwash, PM: Pressmud, PG: Phosphogypsum, Av.: Average.

against Rs. 13,538 and 1.03 (no- pressmud) and 19,399 and 1.47 (no- spentwash), however, the differences were statistically non-significant. Incorporation of phosphogypsum up to 25% GR significantly increased the net return and B:C ratio of wheat crop over no- phosphogypsum incorporation. The net return and B:C ratio were highest under phosphogypsum at 50% GR and 25% GR, respectively, during both the years. A perusal of interaction between phosphogypsum and pressmud or spentwash indicated that it has no significant effect on the net returns and B:C ratio of wheat crop. Further, application of pressmud at 5, 10 and 15 t ha⁻¹ and spentwash at 2.5, 5.0 and 7.5 lac L ha⁻¹ marginally increased net returns and B:C ratio. Lowering of the

B:C ratio with the application of soil amendments is attributable to its long lasting residual effect on nutrient availability and improved soil physico- chemical conditions (Table 3). This economic evaluation of soil amendments needs to be carried out on long term basis. Zalawadia *et al.* (1997) while working on the effect of different spentwash levels on yield of wheat also reported an increased returns and B:C ratio with the application of spentwash.

References

- Bhargava, G.P. and Kumar, R. 2004. Genesis, characteristics and extent of sodic soils of the Indo-Gangetic alluvial plain. In *Extended Summaries (Plenary, Invited and Voluntary papers) of International Conference on Sustainable Management of Sodic Lands*, pp.

- 15-22. UP Council of Agricultural Research, Lucknow, India.
- Evans, L.T. 1980. The physiological basis of crop yield. In *Crop Physiology*, pp. 327-355. Cambridge University Press, UK.
- Pathak, H. 1999. Reclamation of saline-alkali soil with gypsum, pressmud and zinc sulphate. *Journal of the Indian Society of Soil Science* 46: 155-157.
- Patil, G.D. and Chaudhary, R.D. 2002. Effect of levels of spentwash on CO₂ evolution, yield and uptake of nutrients by maize (*Zea mays* L.). *Madras Agricultural Journal* 89: 726-729.
- Sharmila Rahale, C. and Bose Subash Chandra, M. 2004. Sodic soil reclamation using distillery spentwash. In *Extended Summaries (Plenary, Invited and Voluntary papers) of International Conference on Sustainable Management of Sodic Lands*, pp. 330-332. UP Council of Agricultural Research, Lucknow.
- Sharmila Rahale, C., Veeraputhirau, R., Sardha, P., Sheik Dawad, M. and Subash Chandra Bose, M. 2001. Effect of distillery spentwash application on the chemical properties of alkali soils. In *Proceedings of National Seminar on Use of Poor Quality Water and Sugar Industrial Effluents in Agriculture* (Eds. Subhash Chandra Bose, A.R.M. Karoon, S. Pazhanielan and M. Sivanathan), pp. 78. ADAC&RI, TNAU, Trichurapalli.
- Zalawadia, N.M., Raman, S. and Patil, G. 1997. Influence of diluted spentwash of sugar industries application on yield of and nutrient uptake by sugar cane and changes in soil properties. *Journal of the Indian Society of Soil Science* 45: 767-769.