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Reclamation of Calcareous Sodic Soil of Southwestern Rajasthan Using Industrial Waste

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Abstract

A field experiment was undertaken for two consecutive years, 2001-2002 and 2002-2003 at Livestock Research Station, Vallabhnagar (Udaipur, Rajasthan) to reclaim the soil having pH 9.2, EC 2.2, $CaCO_3$ 9.5 % and ESP 35. The treatments 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 phospho-gypsum (0, 25 and 50 per cent G.R.) were applied in a randomized block design replicating each treatment thrice. The result of investigation indicates that incorporation phosphogypsum at 25% GR in integration with either pressmud and spentwash decreased the soil pH, EC and ESP and increased the grain yield of wheat. Utilization of these industrial by-product in agriculture not only improved the productivity of agricultural land but also save the environment from its degradation through their disposal in the near by vicinity of the industries.

Keywords – Spentwash, Pressmud, Phosphogypsum

Introduction

Out of 14.6 mha of salt affected soil in India, sodic soil occupies 6.9 m ha[1]. These soils are predominated with salts viz. sodium bicarbonate, sodium carbonate and sodium silicate, which are capable of alkaline hydrolysis. The sodicity hinders agricultural production or even makes it impossible owing to presence of excessive exchangeable sodium, deteriorating the soil physical conditions and ionic environment. Once these soils are reclaimed they will become normal productive soils in the due course of time. Their reclamation essentially requires a soluble source of calcium whether mobilized from native $CaCO_3$ or added externally through soil amendment containing soluble calcium.

Pressmud, a sugar factory waste, is either a rich source of calcium (Carbonation process, 61% $CaCO_3$) or organic matter (Sulphitation process, 26 % Organic Carbon), can act as an effective ameliorant for sodic soil. Likewise, Spentwash, a distillery waste, is acidic (pH 4.0) effluent capable of generating gypsum in the soil from the native $CaCO_3$ of the calcareous sodic soils.

An effort was made to develop suitable technique for the reclamation of calcareous sodic soil by making the use of sugar industry and distillery wastes in integration with phosphogypsum, a by-product of phosphoric acid plant.

Experimental

A field experiment was undertaken for two consecutive years, 2001-2002 and 2002-2003 at Livestock Research Station, Vallabhnagar (Udaipur, Rajasthan) to reclaim the soil having pH 9.2, EC 2.2, $CaCO_3$ 9.5 % and ESP 35. Vallabhnagar is situated 42 Km in east of Udaipur. The treatments 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}) separately in integration with three levels of phosphogypsum (0, 25 and 50 per cent G.R.) were applied in a randomized block design replicating each treatment thrice. A buffer ring of one meter was made around each plot for providing the separation between each treatment. Measured quantities of pressmud and gypsum were applied through broadcasting and surface incorporation, while, spentwash was transported in a rubber lined tanker from the distillery and measured quantities was sprinkled over the soil surface using water meter and rubber hose pipe. The ridges of each plot were strengthened manually and plots were left for exposure to natural rains to establish a leaching process in *kharif* 2001.

Wheat variety Raj.3077 was grown during *Rabi* 2001-02 and 2002-03 with a basal dose of 60 Kg N, 60 Kg P_2O_5 and 25 Kg $ZnSO_4$ ha^{-1} at sowing, while, 60 kg N ha^{-1} was given in standing crops as top dress in two equal splits. The wheat crop was irrigated at all the critical stages using 5 cm of water at each irrigation. Just after sowing, irrigation was given to ascertain proper germination. The subsequent irrigations were given as per the need. In total five irrigations were given. The water used for irrigation was not only saline but also having high residual sodium carbonate (RSC) 8.9 and adjusted sodium adsorption ratio (adj. SAR) of 36.6. Green manuring with dhaincha was also done in *Kharif* 2002 to speed up the reclamation process. Surface soil samples (0-15) from individual plot were withdrawn and examined for the improvement in physico-chemical properties, if brought in and grain as well as straw yield of wheat were recorded to asses the treatment effect.

Results and discussion

It is apparent from the examination of data on soil pH, EC and ESP that incorporation of pressmud or spentwash decrease the pH, EC and ESP (Table 1 and 2). The lowest value of pH, EC and ESP to the tune of 8.15, 1.00 and 25.36 under pressmud and 8.06, 1.06 and 26.97 under spentwash incorporation was recorder under the treatment receiving pressmud at 15 t ha^{-1} or spentwash at 7.5 lac L ha^{-1}. Like pressmud or spentwash, incorporation of phosphogypsum also decreased the pH, EC and ESP of the soil and the lowest value was observed in the treatment receiving phosphogypsum at 50 % GR. An examination of interaction between phosphogypsum and pressmud or spentwash revealed that the lowest value of soil pH, EC and ESP was recorded for the 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. An increasing level of phosphogypsum incorporation at varying levels of pressmud or spentwash as well as increasing levels of pressmud or spentwash incorporation at varying levels of phosphogypsum definitely decreased the soil pH, EC and ESP. A reduction in soil pH, EC and ESP in the present investigation can be attributed to the potential acidity and higher content of calcium, magnesium and sulphur in the spentwash[2] as well as production of CO_2 and organic acids in the course of pressmud decomposition when used lead to amelioration of sodicity[3,4], as well as to increased root mass production and increased microbial activity in the rhizosphere under congenial environment as a consequence of improved soil physical condition. A relatively higher value of ESP even after amelioration of sodic soil in the present investigation is indicative of rebuild-up of exchangeable sodium as a consequence of irrigation of land in question with highly sodic water (adsj. SAR 36.6 and RSC 8.9). A decrease in pH, EC and ESP of the soil due to incorporation of various soil amendments has also been reported previously[5-7].

Interaction between pressmud and phosphogypsum or spentwash though remained statistically non significant but the highest yield of wheat grain was recorded when the highest level of these ameliorants were interacted (Table 2). However, phosphogypsum incorporation at 25% GR when integrated with pressmud at 15 t ha^{-1} or spentwash at 7.5 lac L ha^{-1} also yielded the wheat grain almost at par indicating that a reduction in the use of gypsum to the equivalent of 25% GR is possible when organic (pressmud or spentwash) and inorganic (phosphogypsum) amendments are used in integration.

An improvement in physico-chemical properties of the soil (Table 2) in turn provided a congenial soil environment in the rhizosphere for

Table 1. Effect of spentwash and pressmud incorporation in integration with phosphogypsum on pH and EC of calcareous sodic soil

Phospho gypsum % G.R.	pH					EC				
					Pressmud (t ha^{-1})					
	0	5	10	15	Av.	0	5	10	15	Av.
0	9.03	8.50	8.50	8.47	8.63	1.60	1.33	1.27	0.98	1.30
25	8.60	8.50	8.30	8.07	8.37	1.33	1.23	1.05	1.20	1.20
50	8.77	8.30	8.13	7.93	8.28	1.23	1.10	0.93	0.82	1.02
Av.	8.80	8.43	8.31	8.15		1.39	1.22	1.09	1.00	
	PM		PG		PM X PG	PM		PG		PM X PG
Sem±	0.039		0.034		0.068	0.010		0.009		0.018
CD at 5 %	0.115		0.100		0.199	0.031		0.027		0.053
					Spentwash (Lac l ha^{-1})					
	0	2.5	5.0	7.5	Av.	0	2.5	5.0	7.5	Av.
0	8.67	8.70	8.73	7.97	8.52	1.22	0.95	1.29	1.22	1.17
25	8.93	8.67	8.33	8.17	8.53	1.07	1.30	1.05	1.15	1.14
50	8.80	8.13	8.00	8.03	8.24	1.23	1.59	0.90	0.82	1.14
Av.	8.80	8.50	8.36	8.06		1.17	1.28	1.08	1.06	
	SW		PG		SW X PG	SW		PG		SW X PG
Sem±	0.072		0.063		0.125	0.012		0.010		0.020
CD at 5 %	0.212		0.183		0.367	0.034		NS		0.059

SW= Spentwash, PM= Pressmud and PG= Phosphogypsum

Table 2. Effect of spentwash and pressmud incorporation in integration with phosphogypsum on ESP of calcareous sodic soil and Yield of wheat

Phospho gypsum % G.R.	pH					Yield (t ha $^{-1}$)				
					Pressmud (t ha^{-1})					
	0	5	10	15	Av.	0	5	10	15	Av.
0	33.99	31.33	28.08	27.21	30.10	4.0	4.3	4.6	4.9	4.5
25	30.33	28.25	28.17	26.51	28.32	5.1	5.4	5.7	6.0	5.5
50	29.53	29.12	26.51	22.36	26.88	5.1	5.4	6.0	6.2	5.7
Av.	31.29	29.50	27.59	25.36		4.8	5.0	5.4	5.6	
	PM		PG		PM X PG	PM		PG		PM X PG
Sem±	0.346		0.300		0.599	0.17		0.14		0.29
CD at 5 %	1.015		0.879		1.757	0.48		0.42		NS
					Spentwash (Lac l ha^{-1})					
	0	2.5	5.0	7.5	Av.	0	2.5	5.0	7.5	Av.
0	33.97	31.13	29.47	28.25	30.70	3.6	3.7	3.9	4.0	3.8
25	29.65	27.55	27.53	27.18	27.98	4.7	4.8	4.9	5.1	4.8
50	30.39	27.21	26.31	25.48	27.35	4.9	4.9	4.9	5.1	4.9
Av.	31.34	28.63	27.77	26.97		4.4	4.5	4.6	4.7	
	SW		PG		SW X PG	SW		PG		SW X PG
Sem±	0.352		0.305		0.610	0.13		0.11		0.22
CD at 5 %	1.033		0.894		NS	NS		0.31		NS

SW= Spentwash, PM= Pressmud and PG= Phosphogypsum

enhanced dry matter production of wheat, providing a better source sink relationship[8] enabling greater synthesis and translocation of metabolites to reproductive organs, which ultimately resulted in improvement in grain yield. Betterment in soil structure, soil chemical parameters and grain yield of wheat has also been reported previously[3,6,9,10].

Utilization of these industrial by-product in agriculture not only improved the productivity of agricultural land but also save the environment from its degradation through their disposal in the near by vicinity of the industries.

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