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Potentiality of organics in reclaiming sodic soil

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ABSTRACT

An incubation study was conducted at AICRP laboratory, ADAC&RI, Trichy to assess the efficiency of different amendments in reclaiming soil sodicity. Sodic soil samples were treated with different amendments such as inorganic source (gypsum) and organic amendments (vermicompost, green manure, goat manure, poultry manure, coir pith compost and FYM) and at weekly intervals, the physico-chemical properties related with sodicity of the treated soils were analysed. It was found that gypsum was effective in reducing soil sodicity. However, organic amendment such as vermicompost was at par with gypsum in reclamation of soil sodicity.

***Keywords**:* Incubation, gypsum, sodic soils, vermicompost.

In the food production sector, soil degradation due to soil salinization and sodification has become one of the universal concerns agriculture is facing. Around the world nearly one billion hectares of soil were facing severe levels of salinization and sodification problem that need immediate attention (FAO, 1994). The problem of soil salinity and sodicity also leads to desertification (Tóth *et al*., 2008). In addition to chemical inorganic amendments like gypsum, organic amendments are studied for their efficiency in reclaiming soil sodicity as addition of organic matter to soil improves soil health through various beneficial functions, thus helping in effective reclamation (Roy *et al.*, 2006). Therefore, this study was conducted in order to investigate the utilisation of economical organic amendments as sources of soil sodicity reclamation in comparison with gypsum.

MATERIALS AND METHODS

A column study was conducted at AICRP Laboratory, ADAC&RI, Trichy to evaluate the effects of gypsum and organic amendments in reclaiming sodic soils. The organic amendments such as Farmyard manure, goat manure, poultry manure, vermicompost, green manure (*Sesbania aculeata*) and coir pith compost *etc*. were collected from ADAC&RI farm, Trichy. Bulk soil samples were procured from different blocks of ADAC&RI, Trichy and analysed for its pH and EC so as to confirm its sodicity and was taken for the further study. After collection, the soil samples were shade dried, processed, passed through 2 mm sieve and then the soil was filled in the column pipes. The bulk soil was divided into sections each of 250 g. For each 250 g of soil, calculated amount of amendments were added, mixed thoroughly and filled in the columns. Gypsum was added based on Ca^{2+} equivalent basis as per gypsum requirement of the calcareous sodic soil and other organic manures were added as per blanket recommendation *i.e* 5 t ha^{-1}.

For columnar study, PVC pipes of length 50 cm and diameter 7 cm was used in which one end of the pipe was covered with a wire mesh. Through the other open end, it was filled with gravels followed by the soil sample with the added amendments up to a height of 30 cm and the pipe was fitted vertically to a wall. The soil samples were moistened to the field capacity with distilled water and maintained throughout the investigation period by adjusting the moisture on weight basis at 25 ± 0.5^0C. Three replications each of the treatments were considered following the layout of Factorial Completely Randomized Block Design. The physico-chemical properties of the soil samples amended with organic and inorganic materials were analyzed at weekly intervals and compared with the control sample where no amendments were added, to compute the efficiency of each amendment in reclaiming sodic soils. The amendments used for the study were A_1: gypsum, A_2: goat manure, A_3: poultry manure, A_4: vermicompost, A_5: green manure (*Sesbania aculeata*), A_6: coir pith compost.

The bulk soil used in the study was clay loam in texture with alkaline soil pH (pH= 8.7), non-saline (0.46 dSm^{-1}), medium in organic carbon content (0.53 %), available nitrogen, phosphorus and potassium content of 207, 17.12 and 315 kg ha^{-1} respectively. Table 1 and 2 depict the physico-chemical properties of the experimental soil and the organic amendments.

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RESULTS AND DISCUSSION

Soil reaction

In untreated control, no significant changes in soil pH took place. However, in other treatments, soil pH gradually decreases but in a slow manner. Gypsum showed highest reduction in soil pH followed by green manure > FYM > poultry manure > FYM > vermicompost > goat manure > coir pith compost. The reduction in soil reaction due to the application of gypsum might be due to the combined effect of more than one factor especially the replacement of Na^+ by Ca^{2+} ions and the formation of neutral salts with SO_4^{2-}. Due to this reduction in sodium concentration, the decrease in soil pH took place. Moreover, the solubility of gypsum is enhanced due to the increased activity

Table 1: Physico-chemical properties of the experimental soil sample

Sl. No.	Parameters	Values
1.	pH	8.70
2.	EC (dSm^{-1})	0.46
3.	Nitrogen (kg ha^{-1})	207.00
4.	Phosphorus (kg ha^{-1})	17.12
5.	Potassium (kg ha^{-1})	315.00
6.	Organic carbon (%)	0.53
7.	Exchangeable Ca^+ [c mol(p^+)kg^{-1}]	16.10
8.	Exchangeable M^{g+} [c mol(p^+)kg^{-1}]	8.45
9.	Exchangeable Na^+ [c mol(p^+)kg^{-1}]	19.21
10.	Exchangeable K^+ [c mol(p^+)kg^{-1}]	3.10
11.	ESP (Exchangeable sodium percentage) %	31.99

Table 2: Physico-chemical properties of the organic amendments taken for the study

Parameters	Goat manure	Poultry manure	Vermicompost	Green manure	Coir pith compost	FYM
pH	7.83	7.70	7.50	6.70	7.50	7.41
EC (dSm^{-1})	2.60	6.80	1.20	1.10	0.80	0.45
TOC (%)	33.10	29.30	17.50	29.20	46.76	25.20
Total nitrogen (%)	3.00	3.03	1.20	1.10	1.24	1.02
Total phosphorus (%)	1.00	2.63	0.30	0.20	0.06	0.69
Total potassium (%)	1.50	1.40	0.56	0.40	1.20	1.36
Total sodium (%)	0.15	0.21	0.13	0.17	0.24	0.03
Total calcium (%)	1.20	0.65	2.54	0.65	0.48	0.99
Total magnesium (%)	1.30	0.55	1.43	0.48	0.50	0.32

Table 3: Change in soil pH during incubation with various amendments

Amendments	7^{th} days	14^{th} days	21^{th} days	28^{th} days	35^{th} days	Mean	Standard deviation
Control	8.70	8.72	8.71	8.71	8.72	8.71	0.01
Gypsum	8.30	8.20	7.80	7.40	7.30	7.80	0.45
Goat manure	8.67	8.65	8.40	8.10	7.87	8.34	0.35
Poultry manure	8.60	8.40	8.20	8.00	7.60	8.16	0.38
Vermicompost	8.65	8.62	8.40	8.20	8.01	8.38	0.27
Green manure	8.50	8.32	8.10	7.60	7.02	7.91	0.60
Coir pith compost	8.65	8.63	8.50	8.20	7.99	8.39	0.29
FYM	8.60	8.40	8.30	7.90	7.77	8.19	0.35

coefficient of calcium and sulfate as a result of increased ionic strength of solution and the formation of the sodium sulfate ion pair (Abdel-Fattah, 2012). Organic manures like FYM, vermicompost *etc.* were efficient in reducing the soil pH because of the production of organic acids produced during its decomposition or increased CO_2 activity that forms carbonic acid (Anwar *et al*., 2003).

Electrical conductivity

Gradual reduction in EC was observed in all the treatments except control. The efficiency of the amendments in reducing EC was as follows: vermicompost > goat manure > poultry manure =FYM > green manure= gypsum > coir pith compost. Organic amendments were found to be highly effective in decreasing EC. The result was in harmony with the findings of Jalali and Ranjbar (2009) and Wang *et al*., 2014 as shown in table 4.

Soil organic carbon

With the increase of incubation time, total soil organic carbon content (TOC) was found to increase and highest increase in TOC was found in vermicompost treatment followed by FYM> coir pith compost > poultry manure > green manure> goat manure> gypsum as shown in table 5. The increase in TOC in the treatment with organic

Table 4: Change in soil EC during incubation with various amendments

Amendments	7th days	14th days	21th days	28th days	35th days	Mean	Standard deviation
Control	0.46	0.43	0.45	0.46	0.47	0.45	0.02
Gypsum	0.47	0.47	0.46	0.45	0.43	0.46	0.02
Goat manure	0.53	0.50	0.48	0.46	0.40	0.47	0.05
Poultry manure	0.46	0.45	0.45	0.44	0.41	0.44	0.02
Vermicompost	0.48	0.47	0.46	0.45	0.39	0.45	0.04
Green manure	0.47	0.47	0.46	0.45	0.43	0.46	0.02
Coir pith compost	0.47	0.46	0.45	0.45	0.44	0.45	0.01
FYM	0.45	0.44	0.44	0.43	0.41	0.43	0.02

Table 5: Change in TOC during incubation with various amendments

Amendments	7th days	14th days	21th days	28th days	35th days	Mean	Standard deviation
Control	4.01	4.02	4.01	4.03	4.02	4.02	0.01
Gypsum	4.11	4.12	4.08	4.13	4.15	4.12	0.03
Goat manure	4.05	4.06	4.10	4.17	4.19	4.11	0.06
Poultry manure	4.21	4.24	4.31	4.47	4.54	4.35	0.14
Vermicompost	4.87	5.00	5.11	5.36	5.46	5.16	0.25
Green manure	4.11	4.19	4.28	4.33	4.43	4.27	0.12
Coir pith compost	4.32	4.39	4.48	4.76	4.97	4.58	0.27
FYM	4.43	4.49	4.76	5.07	5.24	4.80	0.35

Table 6: Change in soil ESP during incubation with various amendments

Amendments	7th days	14th days	21th days	28th days	35th days	Mean	Standard deviation
Control	31.99	31.67	31.32	31.87	31.64	31.70	0.26
Gypsum	29.21	20.43	17.32	14.43	12.80	18.84	6.49
Goat manure	30.54	24.60	20.53	14.40	13.78	20.77	7.06
Poultry manure	31.50	30.12	25.50	23.40	21.60	26.42	4.26
Vermicompost	29.76	23.60	17.49	15.94	11.20	19.60	7.20
Green manure	31.87	30.21	26.77	12.43	16.21	23.50	8.68
Coir pith compost	30.65	27.42	26.30	25.55	23.43	26.67	2.66
FYM	30.41	26.40	20.41	16.36	14.90	21.70	6.60

amendments was due to the higher carbon supply from these carbonaceous sources (Jensen *et al.*, 2005). However, there was marked difference between organic carbon loads between these treatments due to different sources of organic matter. The findings were supported by the results of Tejada *et al*. (2006), who reported that the effect of organic amendments on TOC mostly depended on the chemical nature of the organic amendments and likely to affect the rate at which it is decomposed by the microbial community (Hahn and Quideau, 2013).

Exchangeable sodium percentage

Table 6 represents the reduction in ESP in all the treatments except control. The efficiency of the amendments in reducing ESP was as follows: vermicompost> gypsum> goat manure> FYM> green manure > poultry manure> coir pith compost as shown in table 9. Application of amendments enhances granulation, cation exchange capacity (CEC) and releases sufficient amount of Ca^{2+}, Mg^{2+} and K^{+} (Brady and Weil, 2005) that are able to replace Na^{+} ions from exchange sites thus decreasing soil sodicity (Gharaibeh *et al*., 2014).

Gypsum showed its effectiveness in reclaiming soil sodicity in an incubation experiment conducted to assess the potential of different amendments in reducing soil sodicity. However, among organic amendments, vermicompost had given appreciable results in this matter and could be a productive and economical source to reclaim soil sodicity. Further studies can be done in integrated use of both inorganic and organic amendments for better reclamation. Microbial studies on sodic soils in relation to addition of the soil amendments can also be investigated.

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