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Influence of different sources of liming materials on post-harvest properties of the soil for maize crop grown in acid soil of Odisha

Rahul Dev Behera, Sipra Das and Sushanta Kumar Pattanayak

Abstract
A field experiment was conducted to study the "Influence of different sources of Liming materials on post-harvest properties of the soil for Maize crop Grown in Acid soil of Odisha" in the village Bajpur in Khorda District of Odisha during Kharif, 2013.The soil was ameliorated with three different sources of liming materials (paper mill sludge @ 0.1LR, Stromatolyte @ 0.1 & 0.2 LR and Calcium Silicate @ 0.2 LR) added with soil test based dose with or without FYM. Results indicated the post-harvest soil properties indicated that the soil turned acidic irrespective of the amelioration measure taken. The carbon content also decreased irrespective of the treatments. Where N was not added from external source its status decreased but increased where it was applied. Irrespective of P application the status decreased but was maintained at higher level. The available K status decreased invariably in all the treatments except in control treatment. The S status in rest of the treatments increased compared to initial status in all the treatments except for control.

Keywords: Acid Soil, Liming materials, Soil reaction, organic carbon, Available nitrogen, phosphorous, potassium and sulphur

Introduction

Amelioration of acid soils with liming materials is a common practice (Quoggio *et al.*, 1995) [18], but other materials are also used as acid soil amendment, such as gypsum, phosphate rocks (He *et al.*, 1996) [8] and some industrial byproducts (Abbaspour *et al.*, 2004, Franco-Hernandes and Dendooven, 2006) [1, 6]. The most common management practice to ameliorate acid soils is the surface application of lime and other calcareous materials (Bolan *et al.*, 2003). In India, approximately one-third of the cultivated land is affected by soil acidity (Mandal 1997) [12]. Majority of these soils are concentrated in north-eastern region of India, with nearly 65% of its area being under extreme forms of soil acidity (pH below 5.5) (Sharma and Singh 2002). Crop productivity on such soils is mostly constrained by aluminium (Al) and iron (Fe) toxicity, phosphorus (P) deficiency, low base saturation, impaired biological activity and other acidity-induced soil fertility and plant nutritional problems (Patiram 1991; Manoj-Kumar *et al.* 2012) [17, 13]. The main aim of soil liming is to neutralize acidic inputs and recovering the buffering capacity to the soil (Ulrich, 1983) [31].

Acid soils are prevalent in areas experiencing high annual rainfall of about 1500 mm or more (Conyers, 1986) [5]. These soils, especially the ultisols and oxisols usually have problems associated with Al toxicity, low nutrient status, nutrient imbalance and multiple nutrient deficiencies (Sanchez, 1987; Adiloğlu and Adiloğlu, 2004) [19, 2]. Under pH 4 or less, most macronutrients become limited to the plant and a toxic form of Al (Al3+) increases its availability and can be a major limiting factor of plant growth and production in acid soils (Kochian, 1995; Matsumoto, 2000) [10, 14]. The benefits of liming include increased soil pH, calcium and magnesium saturation, neutralisation of toxic concentrations of Al, increase in phosphorus, improved nutrient uptake by plants and increased crop yield (Nicholaides *et al.*, 1983) [15]. Applications of industrial wastes as fertilizer and soil amendment have become popular in agriculture.

Paper mill sludge is produced as a by-product of paper production that disposal of this material presents a problem for the mill (Mahmood and Elliot, 2006). Acidity–induced soil fertility problems coupled with traditionally minimal use of mineral fertilizers are often held responsible for low levels of crop productivity in the state. Lime application along with integrated nutrient management is often recommended to increase the phytoavailability of essential nutrients and ameliorate the other acidity-induced fertility constraints on such soils (Haynes 1984) [7].

The main objective of the present study was to determine the influence the different sources of the liming materials on post-harvest properties of the soil for Maize crop Grown in Acid soil of Odisha.

Materials & Methods

The soil of the experimental site was loamy sand in texture with 76 per cent sand, 14 per cent silt and 10 per cent clay with 1.75 Mg m-3 of bulk density. The soil was strongly acidic in reaction (pHw 4.94). The organic carbon status was medium, i.e. 5.7 gkg-1 with lime requirement of 3.2 t CaCO3ha-1. The CEC of the experimental soil was 6.29 cmol (p+)kg-1 soil with 1.04, 0.60 and 0.44 cmol (p+)kg-1 soil of exchange acidity, acidity due to Al3+ and H+ respectively. The available nitrogen, phosphorous, potassium and sulphur in soil were 169 (low), 105 (high), 143 (medium) and 17 kgha-1 (low) respectively. The available Boron and Zinc content were very low, i.e. 0.15 and 0.41 mgkg-1 soil respectively. Three different types of liming materials were used in the experiment. These were Paper Mill Sludge (PMS), Stromatolyte (ST) and Calcium Silicate (CS). Liming materials were applied mixed with and without FYM in the field. Absolute control treatment was included without any addition of external source of nutrients. The test crop Maize (Hishell-hybrid) received 10 treatments. Each treatment was replicated three times and imposed over statistically laid out field with Randomized Block Design (RBD) in the field. The initial and post-harvest soils were also collected, dried under shade, grind with wooden hammer and sieved through 2mm sieve. The samples were preserved in polythene bags with proper labels for analysis. The sand, silt and clay content of the soil samples were determined by Bouyoucos Hydrometer method as described by Piper (1950). Soil pH was determined in 1:2.5 soil: water ratio by pH meter as described by Jackson (1973) [9]. The exchange H+ and Al+3 were determined by following the methods Lin and Coleman (1980) as described by Page *et al.*, (1982) [16]. The lime requirement of the acid soil was determined by Woodruff Buffer method. The Cation Exchange Capacity of the soil was determined by successive extraction of soil with neutral 1N ammonium acetate as per the procedure outlined by Page *et al.*, (1982) [16]. The Organic carbon content of soil was determined by wet digestion procedure of Walkley and Black as outlined by Page *et al*, 1982 [16]. Available nitrogen in soil was determined by alkaline KMnO4 method (Subbiah and Asija, 1956).Available phosphorous in the soil was determined by Bray's 1 method (Bray and Kurtz, 1945) as out lined by page *et al.*, (1982) [16]. Available potassium was determined by extracting the soil with neutral normal ammonium acetate solution and estimated by flame photometer. Available sulphur was determined by extracting the soil with 0.15 per cent CaCl2 solution and determined color by turbidimetric method using BaCl2 (Chesin and Yien, 1951).

Result and Discussion

Post-harvest soil properties

The post-harvest soil properties after Maize have been presented in Table-1.

Table 1: Post Harvest Properties of soil

Treatments	pH	OC	N	P	K	S
		(g/kg)	(kg/ha)			
Absolute control	4.47	3.9	164	91	65	16
STD	4.54	3.2	169	60	64	49
STD + PMS @ 0.1 LR	4.10	3.8	178	52	73	57
STD+PMS @ 0.1 LR + FYM	4.20	4.0	181	45	70	55
STD +ST @ 0.1 LR	4.37	4.2	198	59	67	49
STD +ST @ 0.1 LR +FYM	4.55	4.4	152	43	72	50
STD + ST @ 0.2 LR	4.43	3.7	206	46	71	52
STD + ST @ 0.2 LR + FYM	4.66	4.0	193	81	83	51
STD + Ca-Si @ 0.2 LR	4.48	4.0	189	75	63	55
STD + Ca-Si@ 0.2 LR+FYM	4.54	4.4	160	43	75	48
Initial soil	4.94	5.7	169	105	143	17

Soil reaction:

Initial soil was strongly acidic in reaction (pH 4.94) Post harvest soil reaction indicated that irrespective of the treatments the soil reaction turned more acidic (drop in pH), ranging from 4.10 to 4.66 (Table-1, Fig-1). The application of liming materials with FYM gives the higher pH compare to the application of lone sources of liming materials. The application of stromatolyte @ 0.2 LR with FYM gives the higher pH (4.66).

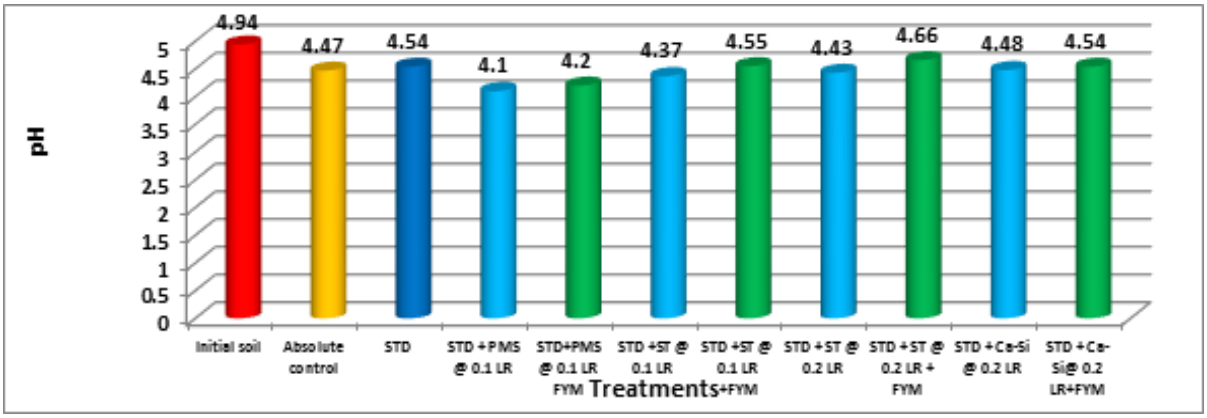

Fig 1: Soil reaction in post-harvest properties of the soil

Organic Carbon

Initial organic carbon was medium in status (5.7 g/kg). It had also decreased under each treatment irrespective of FYM application ranging from 3.2 to 4.4 gkg^{-1} (Table-1, Fig-2). The application of liming materials with FYM gives the higher organic carbon status of the soil compare to the application of lone sources of liming materials. The application of stromatolyte @ 0.1 LR and calcium silicate @ 0.2 LR with FYM gives the higher organic carbon status (4.4 gkg^{-1}).

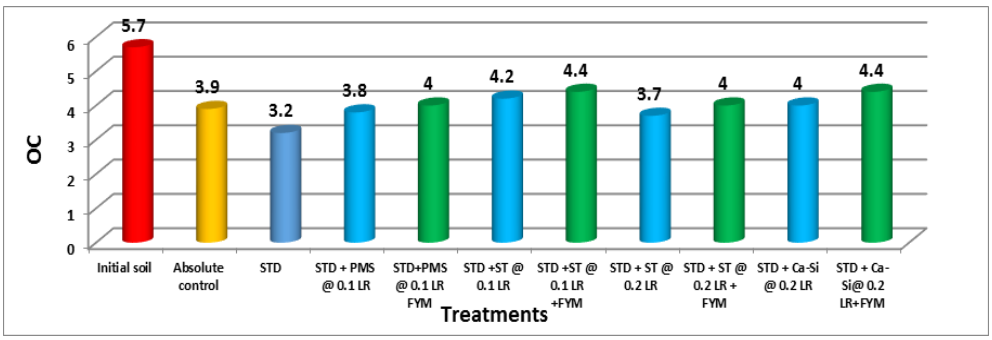

Fig 2: Soil organic carbon status in post-harvest properties of the soil

Available N status:

Its status was low initially (169kg/ha), remained under low status after the harvest of the crop, but showed some increasing trend under all treatments except in control, STD + ST @ 0.1LR +FYM, STD + CS @ 0.2 LR+FYM treatments (Table-1,Fig-3). The application of lone sources of liming material gives the higher nitrogen status compare to combination with FYM.

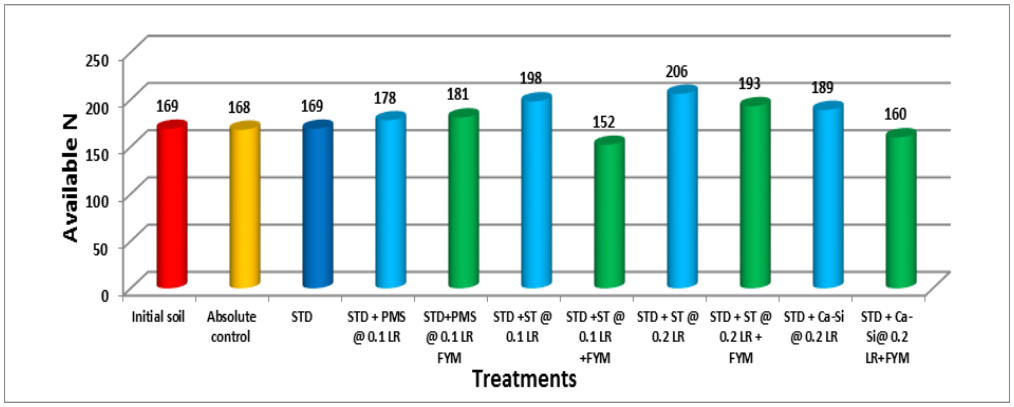

Fig 3: Soil nitrogen status in post-harvest properties of the soil

Bray's-1 available Phosphorous:

The Bray's 1 P status in intial soil was high (105 $kgha^{-1}$). Twenty five per cent less was recommended. The crop removed considerable amount of P under different treatments. The post-harvest soil P status even through decreased but maintained higher level irrespective of the treatments varying between 43 and 91 $kgha^{-1}$(Table-1, Fig-4).

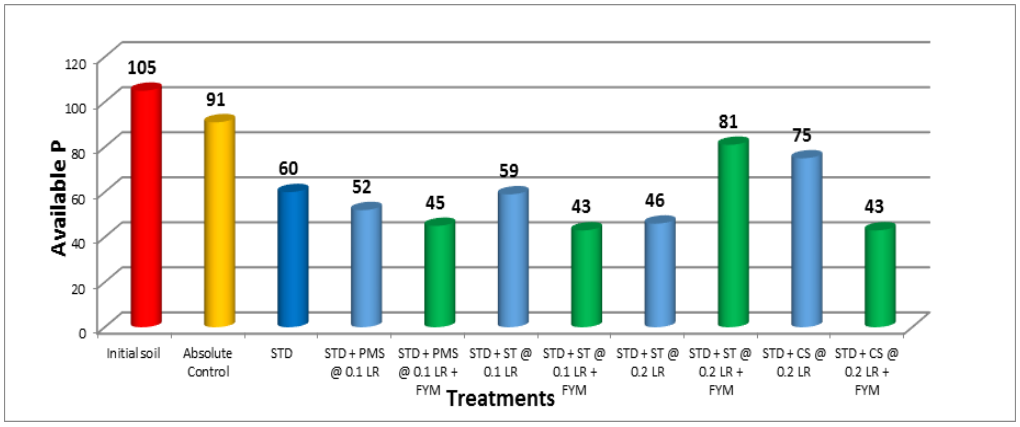

Fig 4: Soil phosphorus status in post-harvest properties of the soil

Available Potassium

The initial K status was medium in status (143 kg/ha). After crop production, inspite of K addition through fertilizers its status decreased and maintained a much lower level ranging from 63-83 kg/ha (Table-1, Fig-5). The application of liming materials with FYM gives the higher potassium status of the soil compare to the application of lone sources of liming materials. The application of stromatolyte @ 0.2 LR with FYM gives the higher potassium status (83 kg/ha).

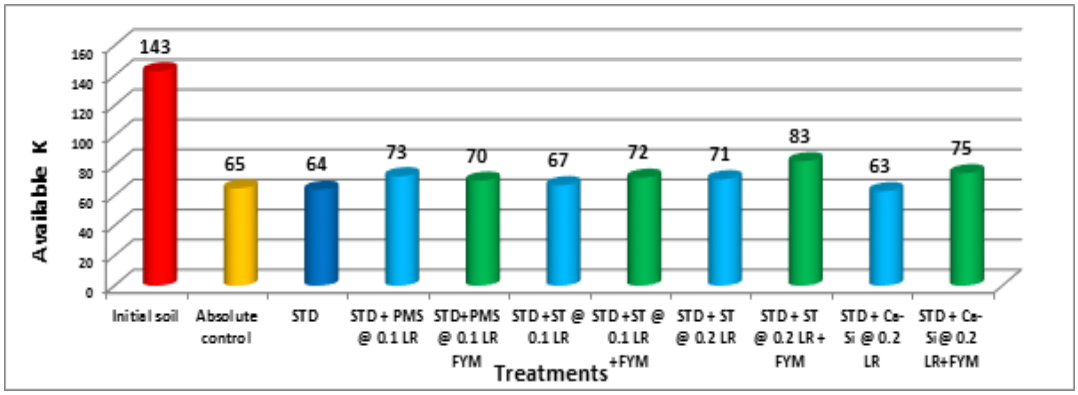

Fig 5: Soil potassium status in post-harvest properties of the soil

Available sulphur:

Its status was low initially (17 kg/ha). Therefore it was applicated through fertilizers from external source except in control. Inspite of crop removal higher sulphur status has been maintained in all the treatments varying between 16 and 57 kgha^{-1}(Table-1, Fig-6). The higher sulphur status (57 kg/ha) was seen in the paper mill sludge @0.1 LR mixed with FYM.

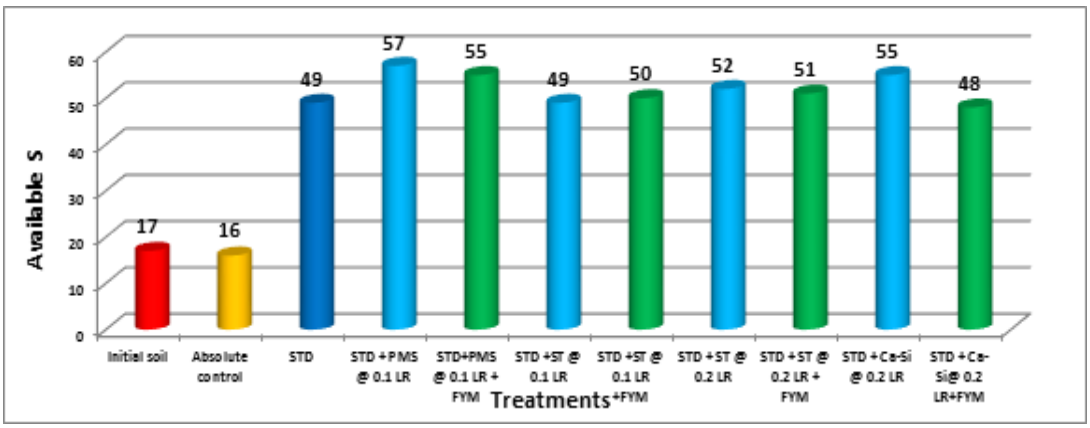

Fig 6: Soil sulphur status in post-harvest properties of the soil

Conclusion

The post-harvest soil properties indicated that the soil turned acidic irrespective of the amelioration measure taken. The carbon content also decreased irrespective of the treatments. Where N was not added from external source its status decreased but increased where it was applied. Irrespective of P application the status decreased but was maintained at higher level. The available K status decreased invariably in all the treatments except in control treatment. The S status in rest of the treatments increased compared to initial status in all the treatments except for control.

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