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EFFECT OF LIMING MATERIALS ON YIELD, P RELEASE AND P UPTAKE BY SUMMER MOONG IN A TYPIC DYSTOCHREPT

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ABSTRACT

An incubation study was carried out to evaluate the release of fixed phosphorus from native sources of a Typic Dystochrept with three sources of lime (pressmud, Lime sludge and Agricultural lime) and four levels of lime (0, 25, 50 and 100 % lime requirement value).Results showed a progressive increase in release of phosphorus from 0 to 45 days of incubation. Irrespective of the sources of lime, liming @ 50 % lime requirement showed significantly higher release of available P from soil (23.70 kg ha^{-1}) over control, but it was at par with 100 % LR value (23.44 kg ha^{-1}). The incubation study was also supported by a pot culture experiment, taking Summer moong (var-SG-1) as a test crop, which indicated the highest dry matter yield with press mud (11.20 g pot^{-1}) followed by Agricultural lime (9.20 gpot^{-1}). Phosphorus uptake by the crop increased significantly in Agricultural lime treated soil with 50 % LR (38.80 mg pot^{-1}), the difference however, being non significant with 100 % LR value.

Keywords: Available phosphorus, sources of lime, lime requirement, yield, phosphorus uptake, acid soil

INTRODUCTION

Phosphorus is one of the major plant nutrients of limited availability in acid soils of Assam. The fixation of native and applied phosphate is generally considered as the main cause of its low availability. Liming of acid soils has been found to enhance the availability of P (Sarkar *et al* 2014).Liming increases the soil pH, reduces the activity of iron and aluminium, increases available P status in soil and in turn increases the productivity of the soil. Generally agricultural limestone having 110 % $CaCO_3$ equivalent is used as a liming material. But press mud and lime sludge which are organic wastes from sugarcane factory and paper mill, respectively, can also act as liming materials for acid soil management as these contain about 80% (Sewaram et al 1992) and 87.64% (Anon1993) $CaCO_3$, equivalent, respectively. Moong (*Vigna radiata*) being a legume, plays a vital role in the maintenance of soil fertility because of its nitrogen (N) fixation and narrow C: N ratio in crop residue. Phosphorus (P) also plays an important role in legumes because of its role in root development and greater atmospheric nitrogen fixation. Among major nutrients used in crop production, the use efficiency of P is minimum. Management of phosphorus is, therefore, imperative in continuous cropping systems because of its fixation in soil. Very little work has been done on the release of fixed phosphate in Typic Dystochrept of Assam with the sources of liming materials mentioned above. Keeping in view of the above facts, an attempt was made to study the effect of different sources and levels of lime on the release of fixed phosphate and response of *Summer moong* to liming in Typic Dystochrept of Assam.

MATAERIALS AND METHODS

Bulk surface soil samples (0-15 cm) was collected from a location of Instructional Cum Research Farm of Assam Agricultural University, Jorhat, representing Typic Dystochrept, which did not receive phosphate fertilisation in recent past. Soil sample was prepared as usual and the physico-chemical characteristics were determined following standard procedure (Jackson, 1973). The soil of the experimental site had :pH 4.5,sand 68.6%, silt 9.8%, clay 21.6%, organic carbon 11.38 g kg^{-1},available phosphorus (P) 22.80 kg ha^{-1},available potassium (K) 72.8 kg ha^{-1},exchangeable Ca 2.4 cmol (p+) kg^{-1}, cation exchange capacity 5.5 cmol (p+) kg^{-1}. The lime requirement of the soil was determined by Buffer Curve method which was found to be 0.89 t ha^{-1} $CaCO_3$, to bring the pH to 6.8.

Incubation study

An incubation study was conducted with three sources of lime *viz*., Lime sludge collected from Hindustan paper mill Ltd., Jagiroad, Nagaon, Assam and pressmud collected from Nagaon Co-operative sugar mill Ltd., Assam and Agricultural limestone at their four levels viz., 0, 25%, 50 % and 100 % lime requirement (LR) of the soil to monitor the changes in "P" release behaviour with time. The study was conducted with 200 g of air dried soils taken in polythene bags, maintaining soil moisture content at 60% water holding capacity. This was achieved by weighing the soil every alternate day and supplying the water deficit. The experiment was replicated

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thrice and kept in the laboratory at 25^0C minimum and 28^0C maximum temperature. Representative samples of moist soil were collected from each bag and extracted with Bray and Kurtz No.1 extractant (Bray and Kurtz 1945). Solution P was determined by the method of Dickman and Bray (1940).

Green house experiment

A pot culture experiment was carried out during Kharif season of 2012 in the green house of the Department of Soil Science of Assam Agricultural University Jorhat, to study the effect of different sources and levels of lime on the release of fixed phosphate and response of *Summer moong* to liming in Typic dystochrept of Assam. Sowing was done on 11 August 2012. Four kg of soil was taken in each pot and each pot received the same treatments as that in the incubation study. The treatments were replicated thrice in a randomized block design. *Summer moong* (*var-SG-1*) was taken as a test crop. Five seeds were sown in each pot and finally three healthy seeds were allowed to grow up to pod initiation stage. Recommended dose of 15 kg N ha^{-1} as urea was given to each treatment. Plant growth was measured by taking the dry matter yield of the crop at pod initiation stage. Phosphorus content in plants was determined by vanado-molybdophosphoric acid yellow colour method in diacid extract phosphorus uptake was calculated by multiplying content value with dry matter yield.

RESULTS AND DISCUSSION

Available P in soil

With respect to release of available P, Agricultural treated soil was found to be significantly higher (25.03 kg ha^{-1}) than Lime sludge (20.44 kg ha^{-1}) and Pressmud treated soil (20.04 kg ha^{-1}) and both Lime sludge and Pressmud treated soils were statistically at par (Table 1).This might be due to the fact that Agricultural Lime, being the pure source of $CaCO_3$ might have been more effective in supplying Ca^{2+} and Mg^{2+} to the soil system, which in turn had decreased the Al^{3+} concentration and thereby favoured the P release in the soil. Among the interaction treatments, Agricultural limestone treated soil with 100% LR released highest P (28.66 P kg ha^{-1}) .This may be due to the fact that Agricultural Limestone having higher $CaCO_3$ equivalent might have helped in easy break down of Al and Fe phosphate in soil, thereby making P available to plants. More release of P at 100% LR was also reported by by Ranjit *et al.* (2007).

Table 1: Available phosphorus (kg ha^{-1}) of soil treated with liming materials

Sources of lime	Level of lime				
	No Lime	25% of LR	50% of LR	100% of LR	Mean
Agricultural lime stone	18.08	25.75	27.66	28.66	25.03
Lime Sludge	18.08	21.23	21.50	20.83	20.44
Press mud	18.08	19.33	21.95	20.83	20.04
Mean	18.08	22.10	23.70	23.44	
C.D. (1%) Level : 0.42, Source : 0.37, Level x Source : 0.73					
Period of incubation (days)					
15	21.10	25.13	26.06	26.13	24.60
30	23.00	25.66	26.93	26.76	25.58
45	24.23	26.90	28.66	27.83	26.90
60	15.46	19.86	21.50	21.13	19.48
75	12.86	18.06	20.23	20.30	17.86
90	11.83	17.00	18.83	18.50	16.54
Mean	18.08	22.10	23.70	23.44	
C.D. (1%)	Period of incubation : 0.52, Level : 0.43, Period of incubation x Level : 1.03				

Liming @ 50% LR was found to be more effective in releasing fixed phosphate (23.70 kg ha^{-1}), which is at par with 100% LR (23.44 kg ha^{-1}) and both 50% and 100% LR values were significantly higher than 25% LR (22.10 kg ha^{-1}) and no lime application (18.08 kg ha^{-1}) . This might be due to the fact that application of lime @50% LR decreased the toxic Al^{3+} content and increased the Ca^{2+} and Mg^2 content of the soil, which created a favourable condition for the release of phosphorus, beyond which the level of lime might have disturbed the system. Among the interaction treatments,45 days of incubation with 50% LR value released more fixed phosphate (28.66 P kg ha^{-1}) and 90 days of incubation with no lime application released the least (11.83 P Kg ha^{-1}).

The data (Table1) showed that a progressive increase in release of fixed phosphate was found to occur from 0-45 days of incubation and thereafter release of phosphorus decreased til the end of the incubation period. The highest release of fixed phosphate occurred at 45 days of incubation (24.23 kg ha^{-1}) irrespective of the sources and levels of lime. This might be due to the fact that during the initial period of incubation the release of fixed phosphate had taken place gradually to a certain level at which refixation had started and therefore, the release of fixed phosphate showed a decline at later period of incubation. Similar results were reported by Kaloi *et al,* (2011) and Jalali and Zinli (2011). Kotur et al (1991) also observed highest release of P in 14 days of incubation and gradually decreased in 21 days of incubation which indicates lime depletion through adsorption by soil colloids with time and hence the need for regular lime application.

Table 2: Dry matter yield (g pot^{-1}) of crop as affected by lime

Sources of lime	Levels of lime				
	No Lime	25% of LR	50% of LR	100% of LR	Mean
Agricultural lime stone	4.10	8.40	9.20	9.90	7.90
Lime Sludge	4.30	6.80	7.00	7.90	6.55
Press mud	4.20	7.60	11.20	11.90	8.72
Mean	4.20	7.60	9.10	9.90	
C.D. (1%)	Source: 1.03, Level :1.19, Source x Level: 2.06				

Dry matter yield*:* Dry matter yield was highest (8.72 g pot^{-1}) in Pressmud treated soil (Table 2); Pressmud treated soil was statistically at par with Agricultural limestone treated soil (7.90 gpot^{-1}) and both of them were significantly higher than lime sludge treated soil (6.55 g pot^{-1}) in respect of dry matter yield of summer moong. The highest dry matter yield in pressmud treated soil may be attributed to the higher organic carbon content (12.25 %) in the pressmud. Besides, liming @ 100% LR was found to be more effective in increasing dry matter yield. Higher dry matter yield in Pressmud treated soil with 100% LR value may be attributed to the supply of adequate amount of both Ca and organic carbon to the soil system, which might have created a favourable condition for crop growth. Similar results were also obtained by Gagnon and Ziadi (2012), who found significant increase in yield of corn and bean by application of residues from paper and wood mills.

Table 3: Effect of levels and sources of lime on uptake of phosphorus (mg pot^{-1})

Sources of lime	Levels of lime				
	No Lime	25% of LR	50% of LR	100% of LR	Mean
Agricultural lime stone	23.40	26.10	38.80	37.10	31.35
Lime Sludge	23.20	23.80	25.60	26.20	24.70
Press mud	23.40	25.70	31.40	34.80	28.82
Mean	23.33	25.20	31.93	32.70	
C.D. (1%)	Source : 1.72, Level : 1.99, Source x Level: 3.45				

P-uptake*:* Liming increased markedly the P uptake by the crop (Table 3).With respect to uptake, Agricultural limestone treated soil was found to be significantly higher (31.35 mg pot^{-1}) than pressmud (28.82 mg pot^{-1}) and lime sludge (24.70 mg pot^{-1}) treated soil. Besides, liming @ 50% LR (31.93 mg pot^{-1}) was significantly higher than 25% LR (25.20 mg pot^{-1}) and without lime (23.33 mg pot^{-1}), the effect being non significant with 100% LR value. Increase in uptake of P due to liming was also observed in groundnut by Ranjit *et al.* (2007). Kotur et al (1991) also observed highest release of P in 14 days of incubation and gradually decreased in 21 days of incubation which indicates lime depletion through adsorption by soil colloids with time and hence the need for regular lime application.

From the results it can be concluded that Agricultural lime proved promising with respect to P release behaviour and P uptake. Dry matter yield was found to be highest in press mud treated soil and liming @ 100 % LR was found to be more effective in increasing dry matter yield. Pressmud can also be exploited for increased crop production in areas where this material is locally available.

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