Journal of Science and Technology 11(June 2013): 86-90

NUTRIENT DYNAMICS IN MUNGBEAN T-AMAN CROPPING PATTERN UNDER DIFFERENT LEVELS OF LIME

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Received 05 November 2012, revised January 25 2013, accepted 05 February 2013

ABSTRACT

Liming is an important and eco-friendly soil management practice for proper plant nutrition in acid piedmont plain soil. A field experiment was conducted using eight levels of lime, viz., 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 t ha^{-1} from dolomite in piedmont plain soil to grow summer mungbean for investigating the dynamics of soil acidity and macronutrient content. The experiment was laid out RCBD replicated thrice following mungbean T-aman cropping pattern. After liming the pH of soils was increased sharply with the increased rate of liming. Liming increased both exchangeable Mg and Ca in subsoil region but higher increase was observed for Mg than that of Ca. Liming at the higher rate was in favor to the decline in subsoil acidity, especially for the later period of the experiment. The lime @2.0 t ha^{-1} was better where more plant nutrients became available by increasing the concentration of K, Ca, Mg, N and P and slight decreased in concentration of organic matter. The changes of soil chemical properties like pH, OM and other macronutrients availability were significantly increased due to application of deferent levels of lime. The study revealed that liming contributed for higher mungbean yield and might be beneficial for higher crop yield.

Key words: Lime, nutrient dynamics, mungbean-Taman pattern

INTRODUCTION

Himalayan piedmont plain soils (Inceptisols) characterized by kaolini-zation and enrichment of aluminum are one of the agriculturally important soils in subtropical areas of Bangladesh. The area distributed mainly over Dinajpur sadar, Kaharol, Khansama upazila under the district of Dinajpur and Pirgonj, Atawary, Thakurgaon sadar, Debigonj under the district of Thakurgaon and Panchagarh sadar, Tetulia upazila under the district of Panchagarh district in the northern part of Bangladesh. There are 0.60 million ha of cultivated upland Himalayan piedmont plain soils in subtropical Bangladesh (SRDI 1975). Current agricultural production level of the piedmont soils is low to medium because of serious problems with degradation of soil fertility, water loss and soil erosion, and drought in summer and autumn. Besides, high content of exchangeable Fe, Al and low pH in the soil are well known limiting factors for crop production. Applications of lime and farm-yard manure can reduce soil acidity. Iron toxicity in the subsoil restricts the development of crop root system, which in turn decreases the drought tolerance and the use of subsoil nutrients. The beneficial effect of lime is well recognized in crop production in the southern China (He 1981). In acid soil, low P and Fe toxicity are considered as two major yield-limiting factors on crop production of piedmont soils in the Northern part of Bangladesh (SRDI 1984). Little information available about the lime requirement of piedmont soils in the study area. The purpose of the study was to find out the requirement of lime of that particular soil and to study the nutrient dynamics in mungbean-T-aman cropping pattern.

MATERIALS AND METHODS

Experimental site and soil properties The experiment was conducted at the agricultural farm of Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh during April 2009 to November 2009. The physical and chemical properties of the soil have been presented in Table 1.

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Table 1. Generral soil properties of the study area

a) Morphological properties

i)	Locality	Dinajpur
ii)	Soil series	Ranisankail series
iii)	AEZ	1, Old Himalayan Piedmont plain
iv)	Soil type	Hyperthermic aeric haptaquept under inceptisol order
v)	Physiographic unit	25^{o}38′ N latitude and 88^{o}41′E longitude
vi)	Topographic	Plain land
vii)	Drainage	Well drainage
viii)	Flood level	34.5 m above the mean sea level
ix)	Climate	Sub-tropical medium to heavy rainfall in kharif and scanty in rabi season, Average annual rainfall 1820 cm and yearly average temperature 21.1^{o}C.
x)	Vegetation	Fallow-mungbean-T-aman

b) Physical properties

Sl. No.	Parameter	%
i)	Sand	60
ii)	Silt	27
iii)	Clay	13
iv)	Textural class	Sandy loam
v)	Depth	1-15 cm

c) Chemical properties

Sl. No.	Parameter	Value	Remark	Critical limit*
i)	pH	5.50	Strongly acidic	-
ii)	Organic Matter (%)	1.10	Low	-
iii)	Total N (%)	0.06	Very low	0.12
iv)	Available P (μg g^{-1})	37.62	Very high	7.0
v)	Available K (meq 100 g^{-1})	0.21	Medium	0.12
vi)	Available Ca (meq 100 g^{-1})	1.16	Low	2.0
vii)	Available Mg (meq 100 g^{-1})	0.48	Low	0.50
viii)	Available S (μg g^{-1})	18.42	Medium	10.0
ix)	Available B (μg g^{-1})	0.15	Very low	0.20
x)	Available Zn (μg g^{-1})	1.93	high	0.60
xi)	Available Cu (μg g^{-1})	0.84	Very high	0.20
xii)	Available Fe (μg g^{-1})	109.6	Very high	4.0
xiii)	Available Mn (μg g^{-1})	0.30	Very Low	1.0

Eight levels of lime viz, 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 t ha^{-1}, respectively, were applied. The experiment was laid out in a RCBD with three replications having 24 combinations. The cropping pattern was mungbean-T-aman-Wheat/Fellow. Dolomite was used as liming material. The ground limestone was surface-applied only at initiation of this experiment.

Soil samples (0–15 cm) were collected before and after liming, soil samples mungbean-T-Aman field at 20-d interval from 4 May to 13 December 2009. All the properties of soil were tested in the Soil Resource Development Institute, regional station Dinajpur. The land was sandy loam and was ploughed and fertilized for mungbean as per Fertilizer Recommendation Guide (BARC 2005). The initial soil sample (before liming) was analyzed for both physical and chemical properties. Three soil samples were collected randomly from each block and mixed together for composite samples. Soil pH was measured with the help of a glass electrode of pH meter. Organic C was determined by wet oxidation method (Page *et al.* 1982) and organic matter was calculated.. Total N in soil was determined by micro-Kjeldahl method. Available P was extracted by Bray and Kurtz method for acidic soil, Petersen (1999). Available P, and K were determined by the diffusion absorption method, Bray-1 method, and extract-flame photometric method, respectively (Hesse 1972). Exchangeable Ca and Mg were extracted and determined by the atomic adsorption method. The data were analysed statistically for comparing mean difference using MSTATC program.

RESULTS AND DISCUSSION

Soil pH: The pH is an important indicator to express the acidity or alkalinity of soil. The soil acidity decreased in response to different levels of lime application. The soil pH was sharply increased by liming within the first few days and thereafter

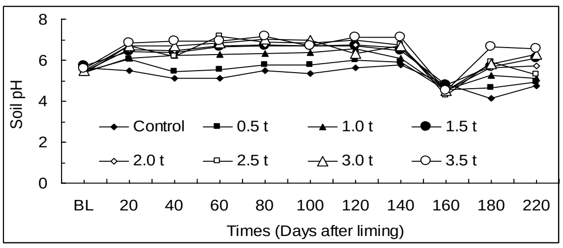

Figure 1. Soil pH status before liming (BL) and at different days after liming (DAL)

gradually declined (Figure 1). The pH value of initial soil was 5.50. The increase in soil pH may be due to increase inavailable Ca and Mg in soil. The pH values were increased 7.14 up to 140 days after liming (DAL) with the increased levels of lime application, but at 160th, 180th, and 220th day it was decreased due to application of nitrogenous fertilizers in T-Aman crop field. The possible reason could be due to the NH_4^+ released from urea -N reacted with soil CO_2 and produced carbonic acid and increased acidity resulted in low soil pH. The pH of soil steeply increased during the first 20 days after liming, then slowly increased and finally slightly decreased with time until the end of 120 days of experimentation. Meng *et al.* (2004) studied with five lime rates (0, 3.75, 7.5, 11.25 and 15.0 t ha^{-1}) on a red soil (Ultisol) for 15 years to determine changes of soil acidity and effect on crop yields.

Soil organic matter: The soil organic matter content have been presented in Figure 2. The organic matter content in initial soil was slightly higher than soils collected after liming. After liming, available P tended to decrease. This was possibly due to the liming effect which increased pH of the acidic soil, as well as microbial activities. The soil organic matter was decreased possibly due to increased microbial activities. It was expected that liming would bring an increase in microbial activity and a decreased in organic matter content in the soil. But the effect of liming may vary with time and environment condition such as soil temperature and moisture etc. These finding was also in agreement with the observation of Curtin *et al.* (1998) that it was expected that liming will bring an increase in microbial activity and a decreased in OM content in the soil. But the effect of liming may vary with time and environment condition such as soil temperature and moisture as reported by Kreutzer (1995). Similar observations were also reported by Renato *et al.* (2003).

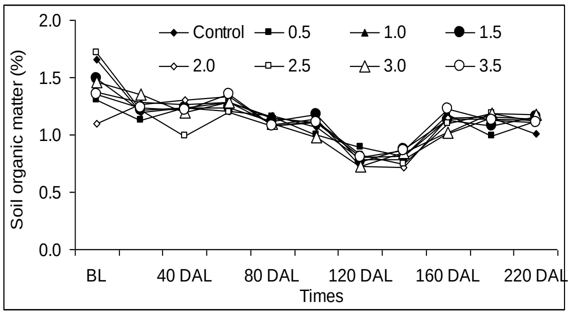

Figure 2. Soil organic matter before liming and at different days after liming

Nitrogen: The soil N content in mungbean and T-Aman crop field have been presented in Figure 3. The N content of initial soil was very low. After liming, the total N content in the study area was not

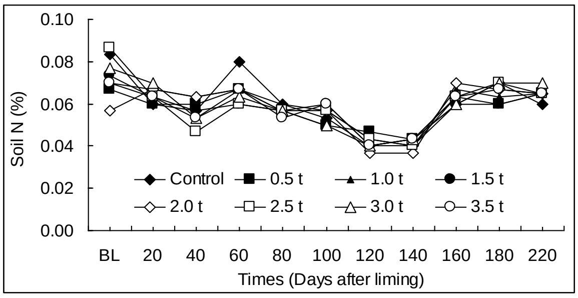

Figure 3. Soil N status before liming and at different days after liming

remarkably varied (Figure 3). But it was slightly increased after 160th day after liming, possibly due to the application of N fertilizers in T-Aman crop. The dynamics of soil N in the crop field showed a characteristics phenomenon for nutrient management. Because, the farm area was an irrigated and sandy loam soil, thus, nitrogen content had lower than non-irrigated soils. The fact may be due to the leaching losses of NO_3-N and also the deficiency of organic matter leading to shortage of N in the soil. Similar observations were also reported by Well *et al.* (1990) and Ritter (1989).

Calcium: The Ca content in mungbean and T-Aman crop field soils have been delineated in Figure 4. The available Ca of the initial and soil before liming were 1.61 and 2.17 meq 100 g $soil^{-1}$, respectively. After liming, Ca content varied from 1.92 to 2.74 meq 100 g $soil^{-1}$ treatments. The liming material used which on dissolution released a large amount of Ca and thus the available Ca increased in soil after liming. The status of available Ca on soils was positively correlated with the rate of lime application, because application of lime increased the soil pH, which increased available Ca in soil. This result agreed to report of Garcia (1975) that the pH of acid soils increased due to liming, and adsorption was higher with higher rate of lime application and calcium deficiencies are ameliorated.

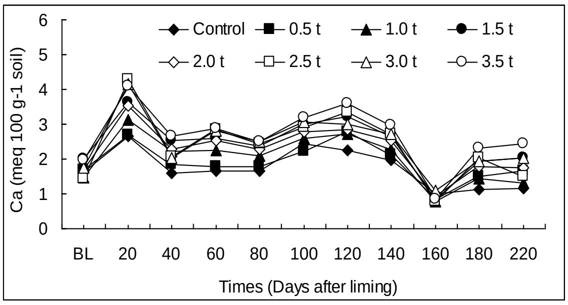

Figure 4. Soil Ca status before liming and after liming at different days of experiment

Magnesium: After liming, available Mg in soil samples collected were increased gradually with increased rate of lime application (Figure 5). The content of available Mg in initial soil was 0.48 meq 100 g $soil^{-1}$ which ranged to 0.55 to 1.10 and 1.10

meq 100 g soil^{-1} across the treatment after liming. The liming material used which on dissolution released a large amount of Mg that increased the pH of soils.

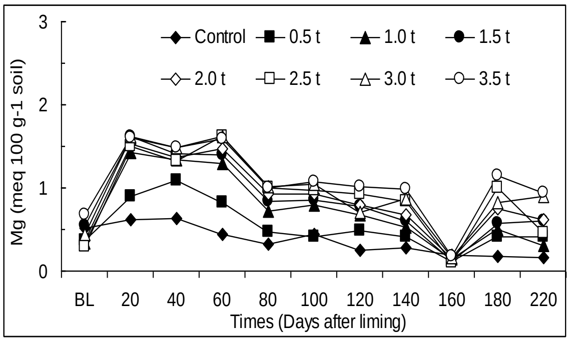

Figure 5. Soil Mg status before liming and after liming at different days of experiment

Potassium: Figure 6 shows the soil exchangeable K content during mungbean and T-Aman crop cultivation. The result shows that soil K was variable during the crop cultivation. Application of lime increased the K availability of soils up to 40 DAL and then remained constant or little decreased, irrespective of the doses of lime used. The highest concentration of K was released when lime was applied @ 1.5 t ha^{-1}. Similar observations were also reported by Culleton *et al.* (1999) and explained that the supply of exchangeable K in the soil is often low in acid soils, due to the formation of soluble K salt by soil acids and their loss by leaching from the soil. The availability of K began to decline below soil pH 6.0. The dynamics of K in soil indicated the spatial differential distribution treated with different levels of lime.

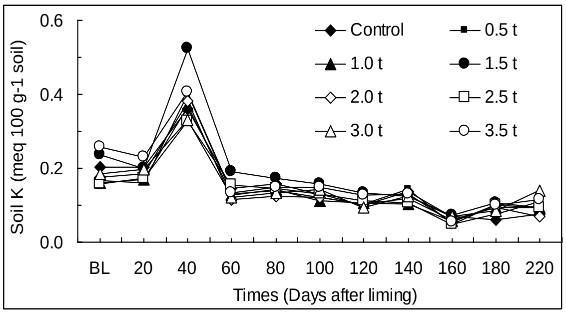

Figure 6. Soil K status before liming and after liming at different days of experiment

Phosphorus: The available soil P content was shown in Figure 7. The average P content in initial soil was slightly higher than the soils collected after liming. The reason behind the fact was the method used in the laboratory. The pH of initial soil and soil before liming were below 6.0. But the pH of soils after liming were higher than 6.01. So, in low pH the availability of P was slightly higher than high pH in the study area. The fact justifies the work done by Robert *et al.* (2005) that there is no specific pH level that result in maximum phosphorus availability. In general soil pH should be maintained in between 6.0 to 7.5 to maximize plant available P. Possibly the higher concentration of P was due to the application of phosphate fertilizer in acidic soil over time because P was immobile. This result agreed with report of Clif *et al*. (1999). They revealed that P is not mobile in the soil and can result in high concentrations over time.

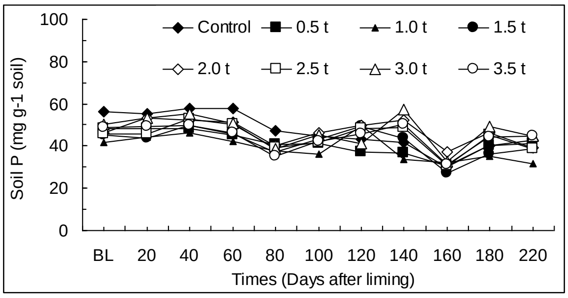

Figure 7. Soil P status before liming and after liming at different days of experiment

Sulpher: The S dynamics in the study field was presented in Figure 8. Available S in the form of SO_4^{2-} were decreased gradually with increase rate of lime application. The available SO_4 content of initial soil was 10 mg g soil^{-1} which ranged from 42 to 39 µg g soil^{-1} across the treatment. After liming, the S content started to increase and attained a maximum value of 48 µg g-1 soil at 40th day. Similarly, after 40

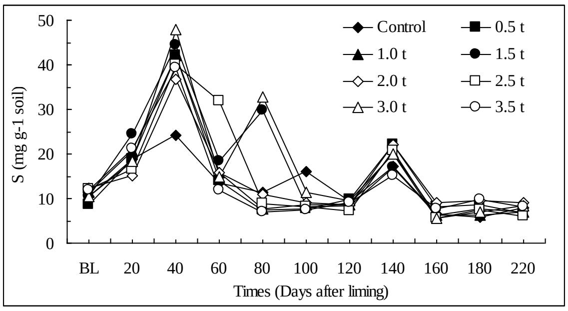

Figure 8. Soil S status before liming and after liming at different days of experiment

DAL, the S content tended to decrease due to plant uptake in mungbean field. After S fertilization in T-Aman field, S content increased followed by decreasing trend.

CONCLUSION

The moderate rate of lime (2 t ha^{-1}) in this experiment is equivalent to the recommended rate of lime (RRL). The present study showed that the amount of lime at 2 t ha^{-1} was suitable for reducing soil acidity and other macronutrient availability in the soil and thereby increasing crop yields. The present result suggested that favourable changes of macro nutrient in the soil by surface- applied lime might be beneficial and eco-friendly tools for successful summer Mungbean–T-aman-Fellow/Wheat cropping patter in acid piedmont soils of northwest Bangladesh.

ACKNOWLEDGEMENTS

We thank Ministry of Agriculture, Government of the Peoples Republic of Bangladesh and Soil Resource Development Institute, Dinajpur, Bangladesh for helping during this study.

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