IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 3 Ver. I (Apr. 2014), PP 101-112
www.iosrjournals.org

Assessment of Nutrient Dynamics Affected By Different Levels of Lime in a Mungbean Field of the Old Himalayan Piedmont Soil in Bangladesh

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Abstract: *A study was conducted to evaluate the effect of liming in the Himalayan Piedmont acid soil of Bangladesh on nutrient dynamics under different levels of lime in mungbean (Vigna radiate) field followed by T. Aman (transplanted rice) cultivation, during the period of December 2010 to October 2011. Five levels of lime were applied, viz, T_1: control, T_2: 1.0, T_3: 1.5, T_4: 2.0, T_5: 2.5, ton lime ha^{-1}. The pH of soils after liming was increased steadily with the increased rate of liming. The different treatments were showed up varying results where more plant nutrients became available by increasing the concentration of K, Ca, Mg, N, P, S, B, Cu and Mn; and slight decreased in the concentration of OM, Fe and Zn that make the soil environment favorable for plant growth.The changes of soil properties like pH, OM and some plant nutrients availability were significantly increased due to application of lime resulted in increased summer mungbean yield. The number of pods plant^{-1}, number of seeds pod^{-1}, 1000 seeds weight and grain yield were significantly affected by liming. The treatment T_3 (1.5 t lime ha^{-1}) produced Mungbean grain yield of 1.6 t ha^{-1} respectively which was significantly greater than those found in T_1, T_2, T_4 and T_5 treatments. Thus, the application of 1.5 t lime ha^{-1} is recommended for the cultivation of summer mungbean and the desired soil pH (>6.5 but < 7.0), which increased availability of nutrients in the study area.The study revealed that liming increases soil pH as well as changes other chemical properties of soil, which is beneficial to sustain high yield and may be an important soil management tool for mungbean cultivation in acid piedmont soil in the North East Bangladesh where soil acidity is predominant.*

Keywords: *Acid soil, Lime, Old Himalayan Piedmont Soil, Mungbean, Nutrient Availability*

I. Introduction

Nutrient availability in soil depends on pH. Most plant nutrients are available in neutral soil having pH 6.6 to 7.4. Soil acidity is a major growth-limiting factor for plants inmany parts of the world (Adams, 1980). Almost half of the soils of Bangladesh have varying degrees of soil acidity, except some Gangetic alluvial soils, all soils of Bangladesh are acidic to neutral (FRG, 2005) having pH 4 to 7 and are deficient of Ca and Mg. About 1.4 million hectare of land under Himalayan piedmont soil (AEZ 1) characterized by low pH and rich of phosphorus (SRDI, 2008). But the crop production potential is limited in these area due to less availability of phosphorous and toxicity of aluminum. The injudicious extraction of plant nutrients by growing crops without proper replacement causes plant nutrient deficiency, soil organic matter depletion, increased toxicity and soil compaction (Karim *et al*, 2001). This leads to deterioration in soil physical, chemical and biological properties. The soils of North west part of Bangladesh are light textured, low in OM and strongly acidic to moderately acidic in nature, pH ranges from 4.5 to 5.5 (FRG, 2005). The status of available P, Ca and Mg of these soils are low. Aluminum toxicity is responsible for poor yield in acid soils. The adverse effect of acid soils on plant growth is mainly related to the presence of aluminum, manganese and iron in toxic concentration and deficiency of phosphorus, calcium, magnesium and molybdenum (Arshad*et al*., 1997; Maschner, 1991 and Edmeades, *et al*., 1995). Soil acidity also inhibits biological nitrogen fixation, reduced nodulation and growth in legumes (Alva *et al.,* 1987). While, the principle of liming is that when pH of the soil decreases below the optimum range for the growth of specific crop variety lime is needed (Ocampo, 2000). Liming on acid soil increases the availability of P, Ca, Mg and Mo and renders iron and manganese insoluble and harmless, increases fertilizer effectiveness and decreases plant diseases (Sahai, 1990). Thus, the crop may have a better nutrition and the crop may produce a good yield. In problem soils, i.e., acid soil, farmers are applying a large amount of fertilizers for their major crops like rice, wheat etc. but they do not get desired yield. Unless the soil pH is raised around neutrality, the availability of nutrient element will limit the growth of plant.

Mungbean (*Vigna radiate*) has small root systems but its root nodulation helps a portion of N nutrition. Liming in the area that supplies Ca might enhance root development and root nodulation. Thus, it helps water absorption by increased root growth and N nutrition by symbiosis. On the other hand, increased root growth supplies more organic matter to soil resulting more organic carbon in soil. Therefore, the hypothesis is that liming promotes root growth and root nodulation, and helps for better pulse production and deposit more C and N in soil. Pulses grow well in free Ca rich soil but soil of Old Himalayan Piedmont plain and Agro-ecological Zone-1 has low Ca and Mg. Therefore, under such circumstances, proper application of lime as a commercial alternative and ecologically sound means of reducing external inputs by improving internal resources, which will increase the yield and quality of mungbean. So, the hypothesis is that the application of lime on crop field will improve the soil nutrient availability by increasing soil pH, and will increases crop yield when it is practiced routinely at right time with recommended amounts.

Liming promotes the decomposition of organic matter by making condition more favorable for the growth of microorganisms. The bacteria that fixed nitrogen from the air both non-symbiotically and in the nodules of legumes are specially stimulated by the application of lime. The successful growth of most soil microorganisms depends upon lime that satisfactory biological activities cannot be expected if calcium and magnesium levels are low. Therefore, present work has been designed for the following objectives: (a) to know the soil nutrient content changes under different levels of liming during mungbean cultivation followed by T. Aman, and (b) to evaluate the chemical properties of soils under liming condition, and (c) to find out the trend of fertility improvement after liming in piedmont soils.

II. Materials and Method

The experimental field is located at $25^{0}38'$ N latitude and 88^{o} 41' E longitude at the Agricultural Farm of Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh during the period from December 2010 to April 2011. The Agro-Ecological Zone belongs to Old Himalayan Piedmont Plain. The soil series is Ranisankail, sandy loam textured, a member of Hyperthermic Aeric Haplaquepts under the order Inceptisols having only few horizons, developed under Aquic moisture regime and variable temperature conditions (UNDP and FAO, 1988). The soil is non-calcareous Brown Floodplain Soils, Piedmont alluvium parent material and moderately well drained. The study area posses sub-tropical climate; the rainfall is heavy during Kharif season (April to September) and scanty in Rabi season (October to March).

Experimental design and treatments: The experiment was laid out in a Randomized Complete Block Design. All the treatments were replicated three times with 5 treatments. There were altogether 15 (5×3) unit plots and each plot having the measurement of 3m × 2m. Inter-block and inter-plot spacing were 1m and 0.7m, respectively. There were five different rates of lime application in Mungbean (BARI mug-6) as follows: T_1: Control, T_2:1.0 t lime ha^{-1}, T_3:1.50 t lime ha^{-1},T_4:2.0 t lime ha^{-1} and T_5:2.50 t lime ha^{-1}. The liming material had 15.5% Ca and 6.5% Mg. The liming material was applied to the soil on 21 March 2011 during land preparation.

Fertilizer application: The total amount of urea, TSP, MOP, Gypsum and Boric acid were applied during final land preparation. Nitrogen was applied @ 22 kg ha^{-1} from urea, P @ 5 kg ha^{-1} from TSP, K @ 19 kg ha^{-1} from MoP, S @ 10 kg ha^{-1} from gypsum and B @ 1.05 kg ha^{-1} from boric acid. All fertilizers were incorporated to soil by spading one day before sowing on 27 March 2011.

Soil and plant sampling, analysis and processing: The initial soil sample (before liming) was analyzed for both physical and chemical properties. Then after liming, seed sowing, growing stage and after crop harvest soils were analyzed for soil pH, organic matter, total N and available P, K, B, Zn, Ca, Mg, Fe, Mn and Cu contents, respectively. Before land preparation, a composite soil samples were collected randomly from 10 different spots of the whole field from a depth of 0-15 cm on 11 March 2011. Also three soil samples were collected from each block on the same day. After designing the experimental plots 24 composite soil samples were collected from each plot before liming. Then after liming, seed sowing, and growing stage and after crop harvest at every time composite soil samples from each plot were collected with a interval of about 30 days during 4 May to 13 October 2011. In these way a total number of twelve times soil samples were collected (total no. of samples were 1+24×11=265) plot wise. While data were collected on the following yield and yield components for Number of pods $plant^{-1}$, Number of seeds pod^{-1}, 1000 seeds weight (g) and Grain yield (kg ha^{-1})

Soil textural analysis was done by hydrometer method (Buoyoucos, 1927). The textural class was determined following Marshall's triangular coordinate using USDA system. Soil pH was measured with the help of a glass electrode pH meter, the soil-water ratio being 1:2.5 (Jackson, 1962). Organic carbon of soil was determined titrimetrically by Walkley and Black method, with the oxidation of organic matter in presence of potassium dichromate and sulphuric acid, called wet oxidation method (Page *et al.*, 1982). The amount of organic matter was calculated by multiplying the percent organic carbon with the van Bemmelen factor, 1.73 (Piper, 1950). Total N content in soil was determined by micro-Kjeldahl method. Available P content was extracted from soil extraction by- 1) Olsen's Method for alkaline soil and 2) Bray and Kurtz method for acidic soil (Petersen (1999). The content of Ca and Mg was measured by atomic absorption spectrometer (AAS). Exchangeable K content of soil was measured from above extraction by flame photometer (Page *et al*., 1982). Cu and Zn were measured by AAS on undiluted soil extracts. Fe and Mn were measured by AAS on soil extracts diluted 1:10 or more with water maintaining the same concentration of soil extracting solution as in the standard solutions. Digestion and followed by absorbance was measured at 420 nm on a spectrophotometer for boron.

The collected data on different parameters analyzed using MSTAT-C developed by Russel (1986). The treatments means were compared by Least Significant Difference test (LSD) at 5% level of significance.

III. Results and Discussion

Soil pH

The pH values of soil that were collected from the field at different times were increased steadily with the increased rates of lime application (Figure 1). The pH value of before liming was 5.61, 5.51, 5.44, 5.82 and 5.52, respectively. Just after liming, pH of the tested soils were raised above 8.0 in all cases but declined to 5.61, 5.62, 6.27, 6.65 and 6.7 in treatment T_1, T_2, T_3, T_4, and $T_{5,}$ receptivity, after 30 DAL. The increase in soil pH was due to available Ca and Mg in soil. On the other hand, comparing the average pH status of initial soil just after liming (JAL), the highest pH were at the initial stage of the experiment, but at 150th day it was decreased due to application of nitrogenous fertilizers in T. Aman crop on August 10, 2011. Because the urea fertilizer reacted with soil and produced excess hydrogen ion and increased acidity of soil. These finding was also in agreement with the observation of Rao *et al., (*1982) and Basak, (2010). A significant increase in pH was obtained with lime application and the better pH range was observed with treatment T_5. Similar observations were also reported by Saltave et al., (2009) and Murali (1976), that pH of soil steeply increased during the first 30 days after liming, then soon it started to decrease with time until the end of 180 days of experiment.

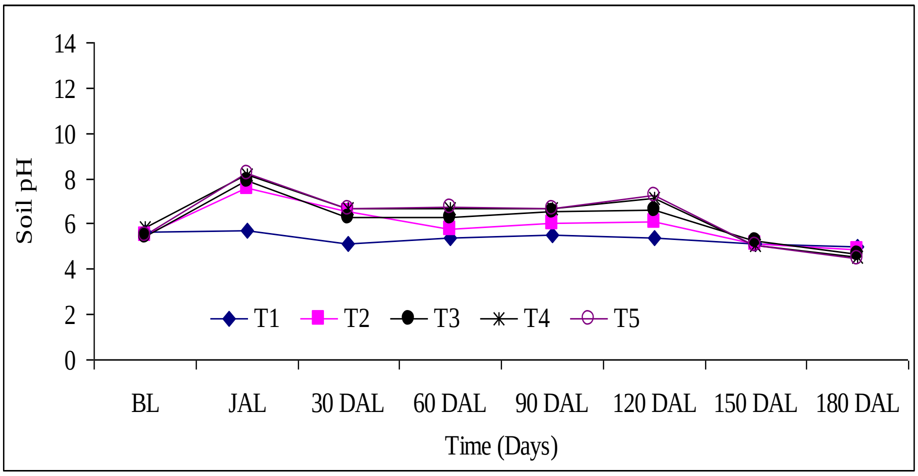

Figure 1. Soil pH under different levels of limes in summer mungbean followed by T. aman field.

Soil Organic Matter

The average soil organic matter content in initial soil was slightly higher than soils collected after liming (Figure 2). This was due to the liming effect which increased pH of the initial acidic soil, as a result of higher microbial activities of the soil. These finding was also in agreement with the observation of Curtin *et al.*, (1998) and Basak, (2010), as it was expected that liming brought an increase in microbial activity and a decreased in OM content in the soil. However, the effect of liming may vary with time and environmental condition such as soil temperature and moisture as reported by Kreutzer (1995). Similar observations were also reported by Renato *et al.*, (2003). Soil textural properties like sandy loam soil could be also a possible cause for the decreased organic matter in the soil of experimental site.

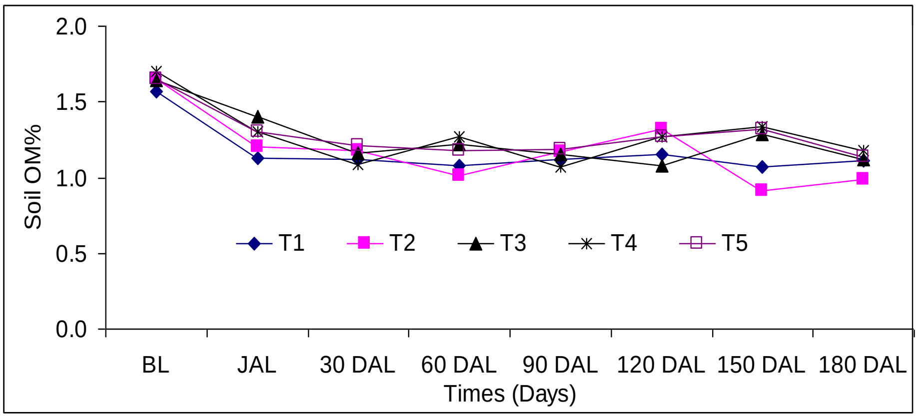

Figure 2. Soil OM status before liming and at different days after liming

Total Nitrogen

Figure 3 shows the total nitrogen in the tested soils collected from Mungbean field followed by T. Aman. The average total nitrogen content of initial soil was very low. After liming, at 30 DAL, the higher total nitrogen content was observed, this might be due to the higher soil pH increased the organic matter mineralization and microbial activity and fertilization for the crops. But considering 180 days, after liming the total nitrogen content in the study soil was not remarkably increased or reduced, i.e., the variation amongst the treatment was non-significant. But it was slightly increased at 150th DAL, possibly due to the application of nitrogenous fertilizers for T. Aman crop. Because, the farm area was an irrigated and sandy loam soil and nitrogen content had lower than non-irrigated soils. This might be due to the leaching losses of NO_3-N, gaseous losses of nitrogen and also the deficiency of organic matter leading to shortage of nitrogen in the study area. Similar observations were also reported by Well *et al.*, (1990) and Ritter (1989).

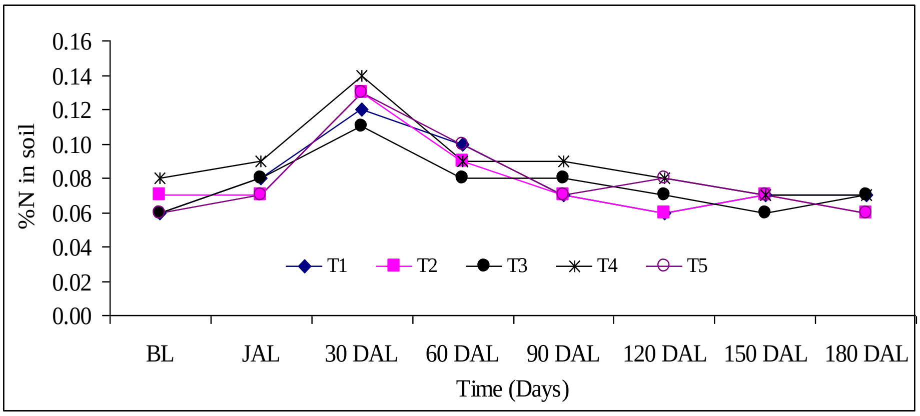

Figure 3. Soil N status before liming and at different days after liming

Phosphorus

The change of soil phosphorous was described in Figure 44. Initially, soil P was low but it started to increase just after liming. The result indicated that lime application increased P availability in the Mungbean followed by T. Aman field. The average phosphorus content in initial soil was lower than soils collected after liming. 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. Where Bray and Kurtz' method was used for P determination, with ammonium fluoride (NH_4F) as extracting solution. The pH of soils that were collected after liming was greater than 6.0 where Olsen's method were used for P determination with sodium hydrogen carbonate solution as extracting solution. Ammonium fluoride extract more P even bound and fixed phosphorus form soil compared with sodium hydrogen carbonate solution. So, in lower pH the availability of P was slightly high than higher pH in the study area. The finding justifies the work done by Robert *etal.*, (2005), there is no specific pH level that result in maximum P availability. Generally soil pH should be maintained 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 is not mobile. This result agreed to report of Clif *et al.*, (1999), they found that P is not mobile in the soil and can result in high concentrations over time.

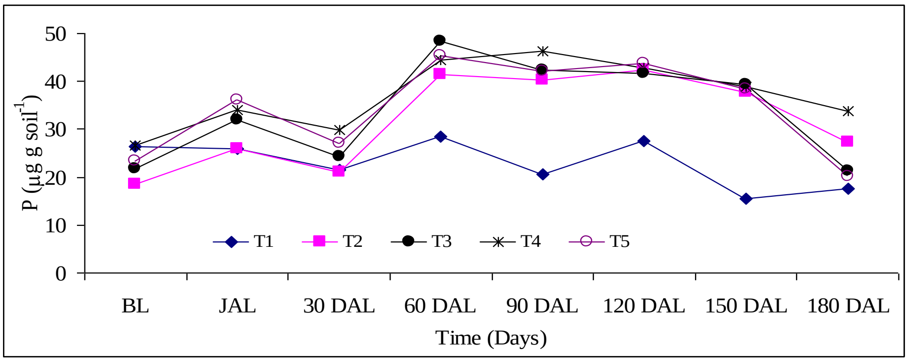

Figure 4. Soil P status before liming and at different days after liming

Potassium

The application of different levels of lime increased K availability of soils at just after liming but it began to decrease than those of initial status to the status that was at before liming (Figure 5). Significant variations among the treatments were observed. But better concentration of available K was obtained with treatment T_4 (1.5 t ha^{-1}). Similar observations were reported by Culleton *et al.*, (1999) and explained that the supply of exchangeable potassium in the soil is often low in acid soils, due to the formation of soluble K salt by acids soil and their loss by leaching from the soil. The availability of K begins to fall below a pH of 6.0. This finding was also in coincided with the finding of Basak (2004) found that liming acid soils promotes potassium availability to plant.

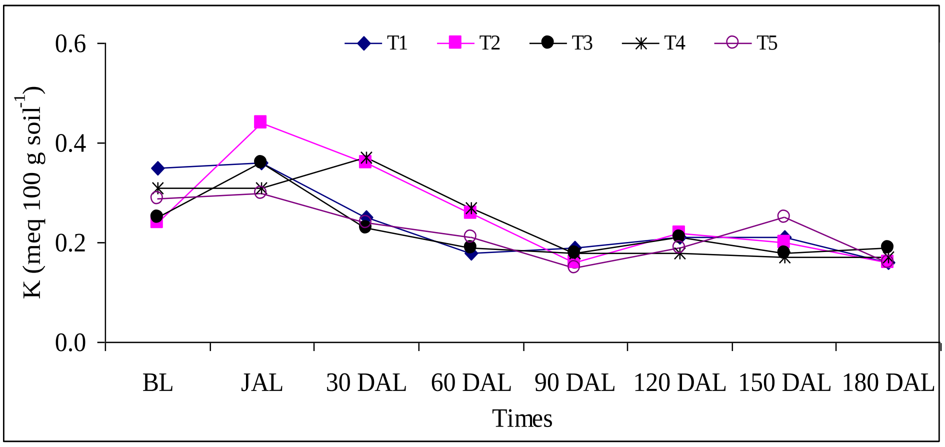

Figure 5. Soil K status before liming and at different days after liming

Sulphur

It is expected that liming will bring an increase in microbial activity and a decrease in the OM content in the soil (Curtin *et al.*, 1998). Clif Little *et al.* (1999) reported that sulphur (S) is like nitrogen and its availability is greatly influenced by the activities of microorganisms. Soil pH that favors forage growth generally favors microbial activity and sulphur availability. Sulphur has great potential to leach along with many of the bases (calcium, magnesium and potassium), which leach out as sulfates.

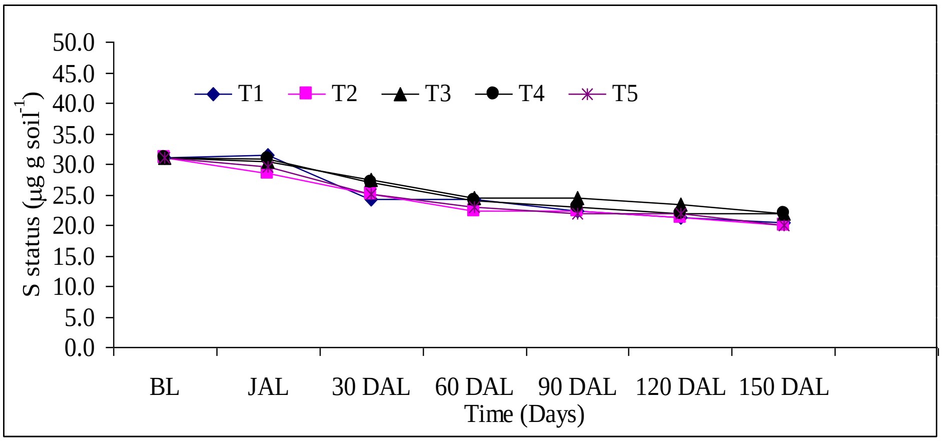

Figure 6. Soil S status before liming and at different days after liming

Calcium

The status of calcium content in soil was presented in Figure 7. Available calcium in the sample that was collected different times of experiment showed the variable Ca content in soils. Just after liming Ca content increased sharply with the increased rates of lime application. The available Ca in the soil before liming was 2.22, 2.72, 2.6, 2.34 and 2.47 meq 100g soil^{-1} respectively, just after liming it showed a higher Ca content. The increasing trend was found up to 90 DAL. The liming material used as Dolochun [Dolomite, $CaMg(CO_3)_2$], 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. The co-efficient of variation was 8.3% and that of LSD was 0.13 at 5% level of significant, which means a significant increased of Ca was obtained with lime application and the better concentration of Ca was observed with treatment T_5. This result agreed to report of Garcia (1975) that the pH of acid soils increases due to liming, and adsorption is higher with higher rate of lime application and calcium deficiencies are ameliorated.Similar observations were also reported by Miller (2000) and Donahue, *et al.,* (1981).

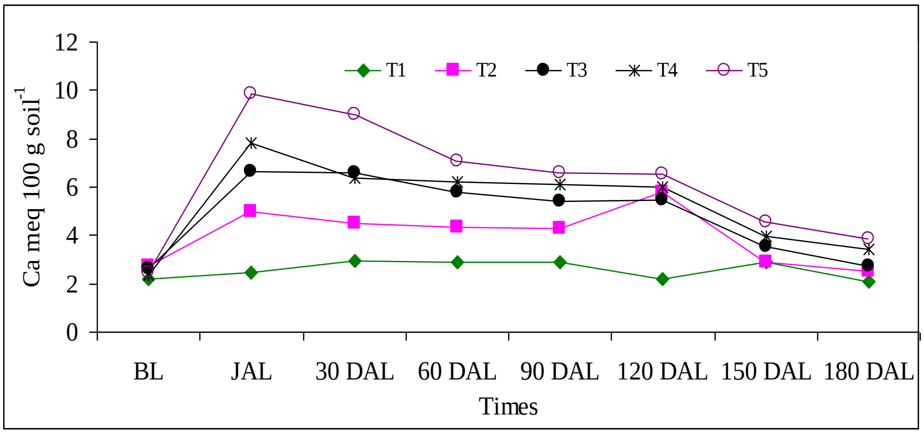

Figure 7. Soil Ca status before liming and at different days after liming

Magnesium

Available magnesium in soil samples collected at different times of experiment, were significantly variable. After liming, it increased gradually with increase rate of lime application (Figure 8). The content of available Mg in soil before liming was 0.63 and 0.7 meq 100/g soil^{-1} which changed to 0.47, 0.97, 0.86, 0.99, and 1.12 meq 100/g soil^{-1} in T_1, T_2, T_3, T_4, and T_5, treatment respectively. The liming material used as Dolochun [Dolomite, $CaMg(CO_3)_2$], which on dissolution released a large amount of Mg that increased the pH of soils. The co-efficient of variation was 22.4 and LSD was 0.1 indicated a significant increase of Mg with lime application and the highest lime rate was more effective than lower rate. But, T_5 was more statistically efficient. This finding was also in coincided with the finding of Garcia (1975). Similar observations were also reported by Miller (2000) and Donahue (1981).

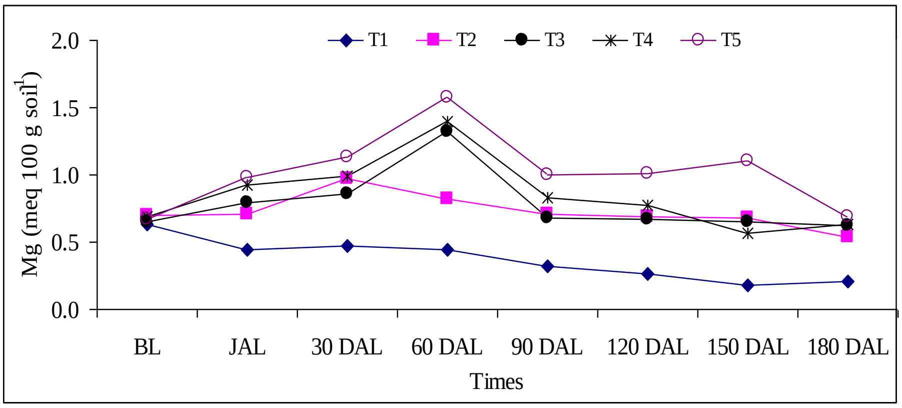

Figure 8. Soil Mg status before liming and at different days after liming

Zinc

The availably of Zn was slightly high in the initial soil and also in soil that collected before liming which decreased slightly after lime (Figure 9). The trend of decreased and increased availability of Zn was possibility due to increased pH after liming and decreased pH after application of nitrogenous fertilizer when pH decreased. Similar observation was also reported by Mikkelsen *et al.*, (1994) that liming sandy acid soil availability of Zn decreased greatly by increased soil pH.

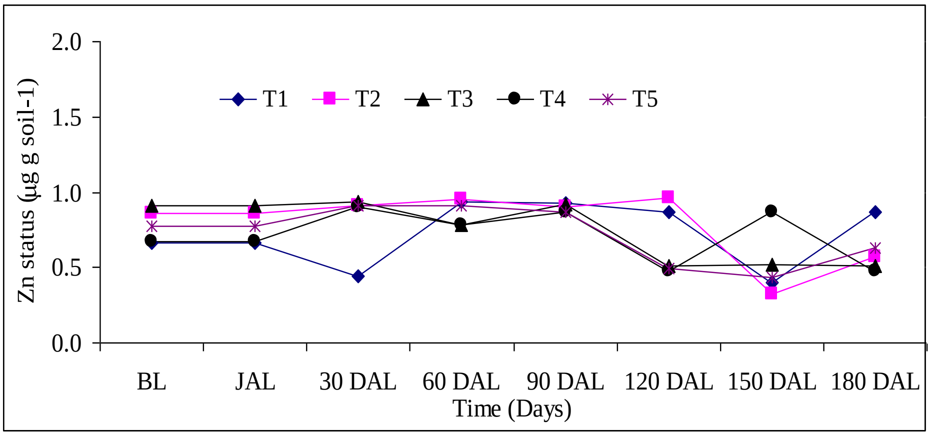

Figure 9. Soil Zn status before liming and at different days after liming

Boron

Available boron in the initial soil was 0.18 µg g soil^{-1} which was below the critical limit 0.2 µg g soil^{-1} (BARC, 2005) which increased steadily with increased rate of lime application (Figure 10). The concentration of available B in the soil samples that were collected after liming increased to 0.41, 0.45, 0.44, 0.42 and 0.82 µg g soil^{-1} in T_1, T_2, T_3, T_4, and T_5 treatment respectively. But better concentration of available B was obtained with treatment T_5 and T_4. Similar observations were also reported by Culleton *et al.*, (1999) and Sultana *et al.*, (2009).

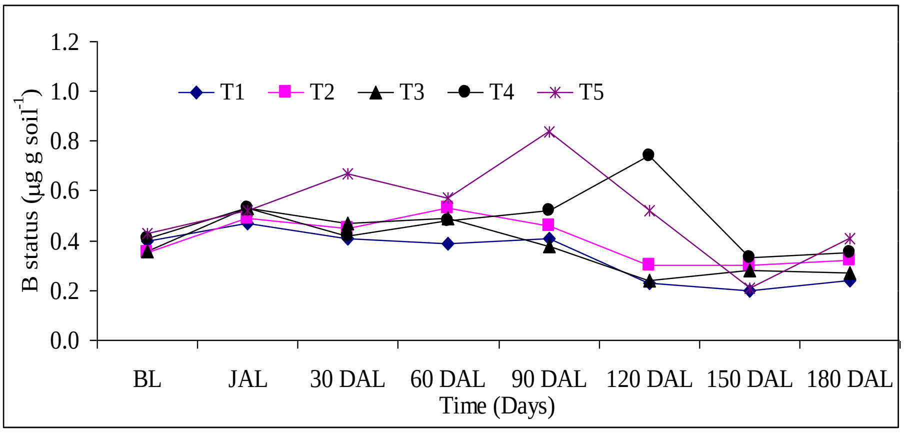

Figure 10. Soil B status before liming and at different days after liming

Iron

The iron concentration has been presented in Figure 11. The iron concentration in initial soil was 110.4 µg g soil^{-1} while as the critical limit and the upper limit of available iron is 4.0 and >15.0 µg g soil^{-1} (BARC, 2005). The concentration of Fe in the initial soil was excessively high but decreased with the increased rate of lime application to 91.87, 128.37, 74.49, 58.338, and 60.41, µg g soil^{-1} in T_1, T_2, T_3, T_4, and T_5, respectively. On the other hand, Fe concentration decreased with increased rate of pH considering the pH of different rate of treatment as shown in Figure 11 and the highest availability of Fe was observed for treatment T_5. It was justified with the explanation of BARC (2005). This findings was also supported by Luthra (1978), Gautom (1996) and Shamsuddin and Alextero (1991).

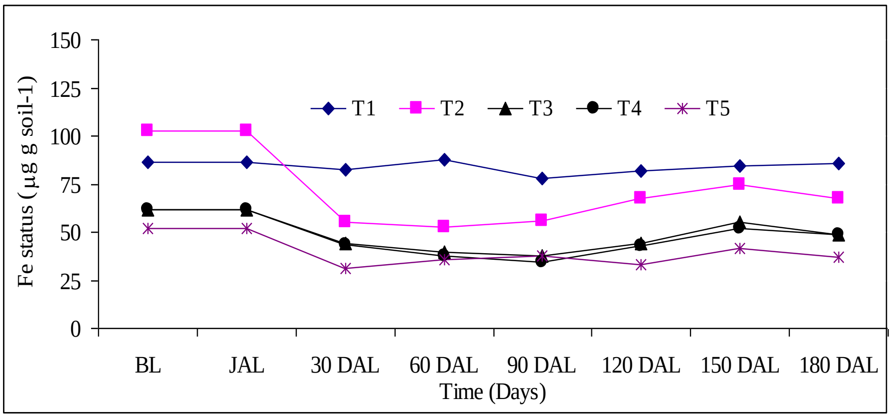

Figure 11. Soil Fe status before liming and at different days after liming

Manganese

Figure 12 shows the variable concentration in Mn during the study period. The manganese concentration was 0 to 0.3 µg g soil^{-1} in initial soil, while the critical limit of Mn is 0.1 µg g soil^{-1} (BARC, 2005). The availability of Mn increased with the increased value of pH up to below neutrality of soil and the concentration were 1.18, 1.37, 1.36, 1.58, 1.12 and 0.83 µg g soil^{-1} in T_1, T_2, T_3, T_4 and $T_{5,}$ respectively. Therefore, the cause was the application of lime that increased the soil pH which helped the release of non-available Mn to available Mn for the treatment T_5 where the pH range was below neutral range of soil. The highest value of Mn was observed at treatment T_2 (Figure 12). It might be possibly due to the low pH of a mineral soil, when appreciable amounts of aluminum, manganese and iron were soluble. However, as the pH increased, precipitation takes place and the amounts of these ions in solution become less and less until at neutrality or somewhat above certain plants may suffer from a lack of available manganese and iron. This is especially true if a acidic sandy soil is suddenly brought to a neutral or alkaline condition by an excessive application of lime. This finding was also in coincided with the finding of Miller (2000) and Donahue (1981).

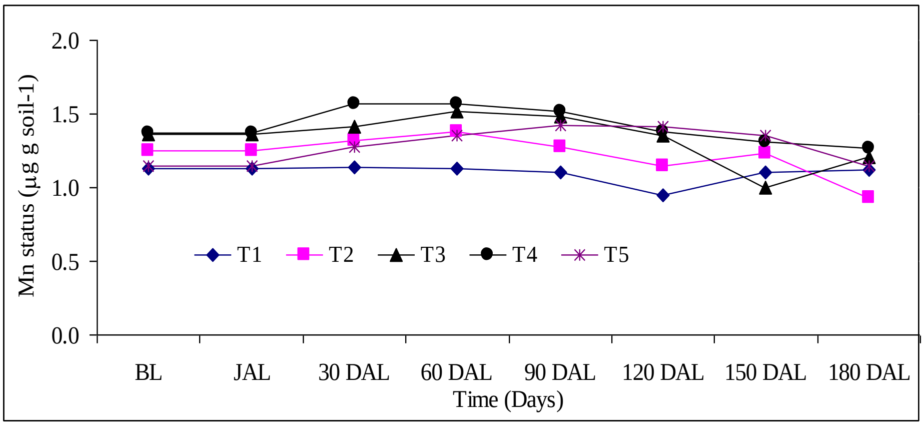

Figure 12. Soil Mn status before liming and at different days after liming

Copper

In the study area, initially the concentrate ion of Cu was at optimum range 0.42- 0.53 µg g soil^{-1} (0.45/-0.60 µg g soil^{-1} (FRG, 2005) and was steadily increased during first 30 days after liming, then slightly decreased up to 60th days as shown in Figure 13. Similar observation was also reported byWilliams *at el.*, (2010) and finally slightly increased at higher level than initial status with time until 180 days of the experiment. Among the eight treatments the availability of Cu remain within the medium to vary high ranges 0.35-1.37 µg g soil^{-1} with T_4 trends was increasing after liming. This was agreed to the finding of that the availability of Cu would increased when the soil pH remain below 7.0 (Figure 13).

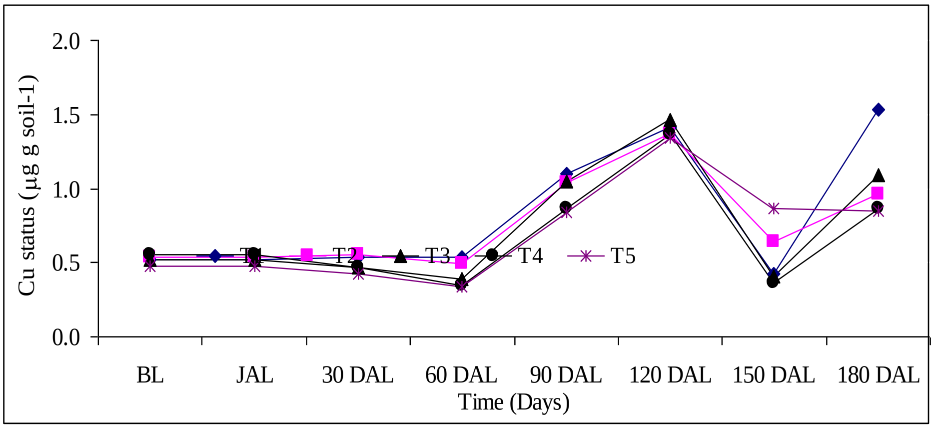

Figure 13. Soil Cu status before liming and at different days after liming

Effect of liming on yield and yield contributing character of summer Mungbean

Number of pods plant^{-1}

Liming effect on number of pods plant^{-1} was found statistically highly significant (Table 1). The highest number of pods plant^{-1} (25.33) was found in T_3 higher than to that of $T_{1,}$ $T_{2,}$ T_4 andT_5. The lowest number of pods plant^{-1} (12.89) was found in T_1. The number of pods plant^{-1} was significantly influenced by the different treatments of lime application. The number of pods plant^{-1} by different treatment varied from 12.89 to 25.33. The highest number of pods was found in the treatment T_3. This is statistically superior to with $T_{5,}$ T_1, T_2 and T_3 treatments. The treatments T_2 and T_3 were statistical identical in producing pods plant^{-1}. The controlled plant showed the significantly lowest number of pods plant^{-1}.The number of pods plant^{-1} of mungbean might be affected due to changes in soil properties in responses to liming. The results are similar to findings of Malik *et al.*, (2006) and Mustary (2010).

Table 1. Effect of liming on yield and yield contributing character

Treatment	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000 seeds weight (g)
T_1	12.89	9.56	54.40
T_2	15.67	9.89	53.89
T_3	25.33	11.88	55.93
T_4	24.67	11.67	54.33
T_5	23.33	11.63	55.22
LSD	1.7	0.3	0.1
CV (%)	7.25	7.25	5.15

Number of seeds pod^{-1}

Liming effect on number of seeds pod^{-1} was found statistically highly significant (Table 1). The highest number of seeds pod^{-1} (11.67) was found in T_4 and similar to that of T_5. The lowest number of pods plant^{-1} (9.56) was found in T_1. The number of seeds pod^{-1} increased due to due to effect of different rates of lime. Seeds pod^{-1} ranged from 9.56 in T_1 to11.88 in $T_{4.}$ The number of seeds pod^{-1} was found maximum in T_3 treatment which is seed statistically similar to T_4 and T_5. The treatment was superior to T_1 and T_2 in regard to number of seeds pod^{-1}. The number of seeds pod^{-1} of mungbean was affected due to changes in soil properties due to liming. The result is in agreement with Sharma *et al.*, (2000), they reported that limes application significantly increased yield of mungbean.

1000 seeds weight

Liming had non-significant effect on the 1000 seeds weight of mungbean (Table 1). The 1000 seeds weight of mungbean varied from 53.89g to 55.33g. The 1000 seeds grain weight for T_3 was highest (55.33g) and the lowest was in T_2 (53.89g). The 1000 seeds weight and grain yield of mungbean was affected due to changes in soil properties due to liming. It appears that liming increased soil pH and availability of nutrients which increased the yield components of mungbean finally higher yields of mungbean.

Grain yield

Liming effect on grain yield was found statistically highly significant (Figure 14). The highest grain yield (1.58 t ha^{-1}) was found in T_3 greater than that of other. The lowest number of grain yield (1.16 t ha^{-1}) was found in T_1. The rate of lime application 1.5 t ha^{-1} significantly increased the grain yield of mungbean compared to control. Application of lime improve seed yield of mungbean to a considerable extent but application of lime at the rate of 1500 kg ha^{-1} was beneficial for higher yield of mungbean. This amount was in agreement with the recommendation of BARC (2005).

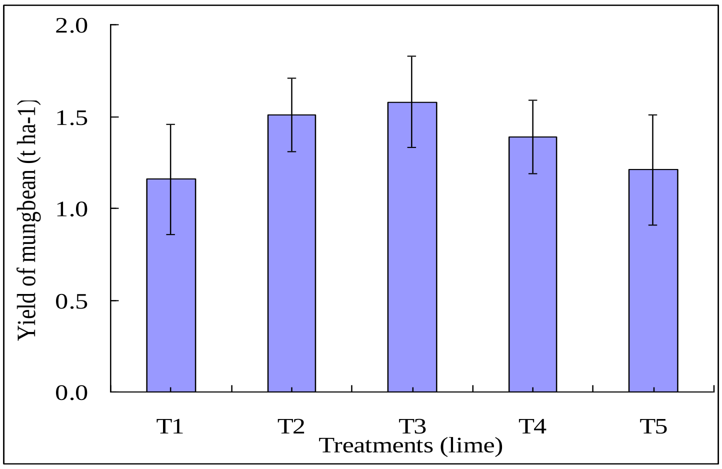

Figure 14. Effect of lime on yield of Mungbean

The grain yield of mungbean was affected by changing soil properties due to liming and growth regulator-NAA. It appears that liming increased soil due to pH and availability of nutrients which increased the yield components of mungbean resulted in higher yields of mungbean. Consequently, the yield of crop depends on genetic variation, soil, environment, proper management etc (FAO, 1998). So, the yield of Mungbean would be beneficial effect of lime application to soil.

IV. Summary and Conclusion

This work evaluated the effect of liming in acid soil on the chemical changes, i.e, plant nutrient availability and yield of mungbean in Mungbean - T. Aman - Fallow cropping pattern.

The pH of the initial soil and soil before liming from different unit plot were steadily increased with the increased rate of liming. The pH of initial soil was 5.50 which increased up to 7.14 by the highest rate of lime application, i.e., T5 treatment. The soil organic matter decreased due to application of lime. After liming the total nitrogen content in the study soil was variable amongst the treatment was not significant. After liming, at 30 days, the higher amount of nitrogen content was observed, this might be due to the higher soil pH increased the organic matter mineralization and microbial activity and fertilization for the crops.

The result indicated that lime application increased the P availability in the Mungbean followed by T. Aman field. The average phosphorus content in initial soil was lower than soils collected after liming. The pH of initial soil and soil before liming were below 6.0, but the pH of soils after liming tended to be higher than 6.01. The higher concentration of P was due to the application of phosphate fertilizer in acidic soil over time because P is not mobile.
A significant variation among the treatments were observed foe K content in soil but higher concentration of available K was obtained with treatment T_4 (1.5 t ha^{-1}). The supply of exchangeable potassium in the soil is low in acid soils, due to the formation of soluble K salt by acid soils and their loss by leaching from the soil. Sulpher content changes in the soil due to lime application were not significant. The effect is only addition.

Among the doses the highest value for each micro elements were obtained with treatment T_1 for Mn only; T_2 for Fe only; T_4 for K, Mg, N, S, B, and Cu; T_5 for Zn only; T_4 for Ca& P only and T_5 for pH & OM only. On the other hand, the smallest value were obtained in T_1 for pH, OM, Ca, and Mg; T_5 for Cu only; T4 for S & Zn only and T_5 for K, N, P, B, Fe and Mn.

A significant and positive correlation between the pH status and available Ca, Mg and B was observed with increased rate of lime application. The treatment T_3 showed better where pH value changed from 5.82 to 7.1 and supply more available plant nutrients by increasing the concentration of K, Ca, Mg, N, P, S, B, Cu and Mn. Though, with treatment $T_{4,}$ the content of OM and soil Zn decreased slightly along with the excessive concentration of Fe decreased slightly and lowered within the range of optimum to very high interpreted level. From the above discussion treatment T_3 i.e., liming with 1.5 t ha^{-1}, total content of available nutrients was increased. The different yield attributing characters of mungbean were significantly increased by the application of lime. The application of 1.5 t lime ha^1 significantly increased the yield of summer Mungbean compared to control.

The highest grain yield was found in T_3 (1.50 t ha^{-1}), which was statistically identical with the grain yields obtained in $T_{4,}$ treatments but superior to those found in $T_{1,}$ T_2 treatments. Thus, the application of 1.5 t lime ha^{-1}is beneficial for higher yield of summer Mungbean. Thus, the application of 1.5 t lime ha^{-1} appears to be optimum for desired soil pH (> 6.5 but < 7.0) which increased availability of nutrient and ultimately increased yield of mungbean.

In conclusion, for the acidic soils of North West Bangladesh, 1.5 ton h^{-1} of lime application is beneficial to sustain high yield. Thus, liming may be an important management practice to tailoring the soil to meet plant needs by improving the soil pH that increases the availability of plant nutrients and can play major roll in yielding potentials to plant.

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