IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 4, Issue 6 (Sep. - Oct. 2013), PP 39-46
www.iosrjournals.org

Effect of lime on yield contributing characters of Wheat in Barind tract of Bangladesh

Md.Kamaruzzaman[1], Sikdar Mohammad Marnes Rasel[2] , Md Nurul Islam[3]
[1]*(Soil Resources Development Institute, Rajshahi, Bangladesh)*
[2]*(Soil Resources Development Institute, Dhaka, Bangladesh)*
[3]*(Soil Resources Development Institute, Rajshahi, Bangladesh)*

Abstract : (11Bold) : *There were six lime treatments viz.T1: Control, T2 : 0.5 t lime ha-1 , T3 : 1.0 t lime ha-1, T4 : 1.5 t lime ha-1, T5 : 2.0 t lime ha-1, and T6 : 2.5 t lime ha-1. Dolochun($CaCO_3$) was used as the liming material. The design of the experiment was Randomized Complete Block Design (RCBD)with three replications. Every plot received 140.0 kg N, 25.0 kg P, 106.0 kg K, 3.06 kg S, 3.6 kg Zn and 0.6 kg B ha-1 from urea, TSP, MoP, gypsum, zinc sulphate (monohydrate) and boric acid, respectively. Available K, P, Ca and Mg were significantly increased due to application of lime which was mainly associated with increased wheat yields. The different characters of wheat viz. plant height, tillers plant-1, spike length, grains sipke-1 and grain yield were significantly increased by the application of lime. The application of 0.5 t lime ha-1 significantly increased most of the growth parameters of wheat compared to that without any lime application. The application of lime had significant effect on the grain yield of wheat. The highest grain yield was found in T4 (4.73 t ha-1), which was statistically identical with the grain yields obtained in T5 and T6 treatments but superior to those found in T1, T2, T3 treatments. Thus, the application of 1.50 t lime ha-1 is enough for satisfactory yield wheat.*

Keywords*: Wheat, Lime, Yield, Spike, Panicle, Grain*

I. INTRODUCTION

Nutrient availability in soil depends on the pH value of soils. On the basis of pH, soil are classified as alkaline, neutral and acidic having pH range 6.6 to 7.4. (Hausenbuiller, 1972). Most of the plant nutrients are highly available in neutral soil having pH 6.6 to 7.4. But soil acidity is a major growth-limiting factor for plants in many parts of the world (Adams, 1980).

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. The sandy soil has low cation exchange capacity. These soils have high content of aluminum, iron and manganese and deficiencies of nitrogen, calcium, magnesium, potassium, phosphors and boron are common. Aluminum toxicity is responsible for the poor yield of crops in acid soils.

Among the cereal crops, wheat is next to rice in Bangladesh. Although, rice is the staple food of Bangladesh but its total production is not sufficient enough to feed her population. Wheat can be a good supplement of rice and it can play a vital role to feed her population. From the nutritional point of view, wheat is preferable to rice for its higher protein content. In Bangladesh about 3.58 lac hectare of land is covered by wheat producing 9.95 lac metric ton with an average yield of 2.78 t ha-1 during the year 2011-2012 (BBS, 2012). The cultivation of wheat needs only one or two supplementary irrigation while a boro rice crop needs about 15-20 irrigation during the growth period. It is a future challenge for Bangladesh to better exploit the potential of the production of wheat crop to meet the country's grain food requirement without endangering the environment.

The wheat yield in this country is low. There are several reasons that can explain the yield variation, which cover both biotic and abiotic factors. Among the biotic factors, unavailability of high yielding varieties (Rerkasem et al., 1993), incidence of diseases and pests (Hossain et al., 1995) and abiotic factors such as high temperature (Orakwue, 1984), moisture stress (Bingham, 1966) and nutrient deficiency (Rerkasem et al., 1991; Jahiruddin et al., 1992; Islam et al., 1999) are responsible for lower productivity of wheat in the tropics and sub-tropics. Among these factors, the most dominating factor that is a vital barrier for crop productivity is problem soil like acidic soil, saline soil etc.There are different types of problem soils in Bangladesh. These soils restrict the growth of plants and make crop production difficult and sometimes impossible. Special management practices need to be applied in such soils for economic crop production. Acid soil in Bangladesh is one of the problematic soils. The potential of acid soil for crop production is limited due to less availability of phosphorus and toxicity of aluminum. For example, the soils of Northwest part of Bangladesh are light textured, low in organic matter and strongly acidic to moderately acidic (pH ranges from 4.5 to 5.5) in nature (BARC, 2005). The status of available P, Ca and Mg of these soils are low. The sandy soil has low cation exchange capacity. These soils have high content of aluminum, iron, and manganese (Breemen, 1973), and deficiencies of nitrogen, calcium, magnesium, potassium, phosphorus and boron are common. Aluminum toxicity is responsible for poor yields in acid soils (Lierop, 1984). There are some reclamation process for acid soils, for instance liming that 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 plants may have a better nutrition and the crop may produce a good yield. Farmers in the Northern part of Bangladesh are applying a large amount of fertilizers for wheat production but they do not get good yields. Unless the soil pH is raised to around neutrality, the availability of nutrient elements will limit the growth of plants.

Liming also 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.

Infertility of Acid soil is a major limitation to crop production on highly weathered and leached soil throughout the world (Mokolobate and Haynes, 2004) and research project deal with soil management practices to sustain high yield through fertilization and liming to improve soil quality at a high level to meet plant requirements.

In respect of the northern part of Bangladesh, farmers are applying a large amount of fertilizer for wheat production but they do not get good yields. Unless the soil pH is raised to around neutrality, the availability of nutrient elements will limit the growth of plants. So it is urgent need to mitigate the shortage of wheat production, lime application is a crop sustainable production technology for better soil fertility management of acidic soil. In these regard a study in highly acidic soil using optimum level of lime is urgently needed. It is a future challenge for Bangladesh to better exploit the potential of the production of wheat crop to meet the country's grain food requirement without endangering the environment. Last of all through the application of lime, soil pH might be increased and yield gap of wheat grain can be minimized in North region. Therefore, an intensive study has been designed for the acidic soils of Northwest / 26 AEZ to evaluate the changes in chemical properties of soil due to lime in wheat field. Therefore, a study was undertaken in a highly acidic soil of Barind area, with the following objective:

- To evaluate the effect of lime on yield and yield contributing characters of wheat

II. MATERIALS AND METHODS

2.1. Study area

The experimental field is located at 25009'58.0" N latitude and 88o 28' 32.6"E longitude at a height of 28.0 m above the mean sea level. The experiment was conducted at Mouza Tiloni, Village Boikanthapur under Sapahar Upazila in Naogaon District during the period from October 2011 to April 2012.

2.2. Soil

Within total land surfaces of Bangladesh, terrace constitutes about 8% namely The Barind tract and The Madhupur Tract. The Barind tract has mainly level, poorly drained highland though it has a small area of dissected hilly lands at the western fringe and a small well drained highland area at the eastern fringe. The experimental field belongs to the AEZ No. 26, Barind Tract Soil. Amnura (Soil series of Bangladesh) soils are developed in deeply weathered Madhupur clay. The soils are mixed yellowish brown and grey to light grey silt loams to silty clay loams grading into grey, mottled yellowish brown, weathered Madhupur clay below about 2 feet, a member of hyperthermic Aeric Haplaquept under the order Inceptisol having only few horizons, developed under aquic moisture regime and variable temperature conditions, Agro ecological Appraisal of Bangladesh, (UNDP and FAO, 1988). According to BARC 'Fertilizer Recommendation Guide (2005) general characteristics of the soil and chemical characteristics of initial composite soil sample (0-15 cm depth) which were collected on October 2011 for initial status and tested, are presented in Table 1 and Table 2.

Table 1. Morphological, physical and chemical characteristics of the soil

AEZ	: High Barind Tract (AEZ 26)
General Soil Type	: Deep Grey Terrace soils and Grey Valley soil
Parent material	: Madhupur clay
Drainage	: Imperfectly drained
Topography	: High land
Flood level	: Above flood level

Table 2 Physical characteristics of soil

Sand (%)	:	42.0
Silt (%)	:	32.0
Clay (%)	:	26.0
Textural class	:	Silt loam to Silty clay loam

2.3 Crop

The test crop was wheat. Certified seeds were collected from the Regional Wheat Research Centre,BARI,Shampur, Rajshahi. The variety used was Prodip.

2.4 Treatments

There were six different rates of lime application in wheat as follows-

T_1 : Control
T_2 : 0.5 t lime ha^{-1}
T_3 : 1.0 t lime ha^{-1}
T_4 : 1.5 t lime ha^{-1}
T_5 : 2.0 t lime ha^{-1}
T_6 : 2.5 t lime ha^{-1}

The liming material had 20% Ca and 10% Mg. The liming material was applied to the soil on 07 November 2011.

2.5 **Land preparation**

Repeated ploughing with power tiller and country plough was done on 07 November 2011 and the layout of the experiment was done as per statistical design. Liming was done and the liming material was incorporated to soil by spading. Final land was prepared on 27 November 2011. Ploughing was followed by laddering in order to break clods as well as level the land. All weeds, stubbles and crop residues were removed from the experimental field.

2.6 Experimental design

The experiment was laid out in a Randomized Complete Block Design. All the treatments were replicated three times. There were altogether 18 (6×3) unit plots, each plot measuring 2. 5m × 4 m. Inter-block and Inter-plot spacing were 0 .7/m and 0.5/m respectively.

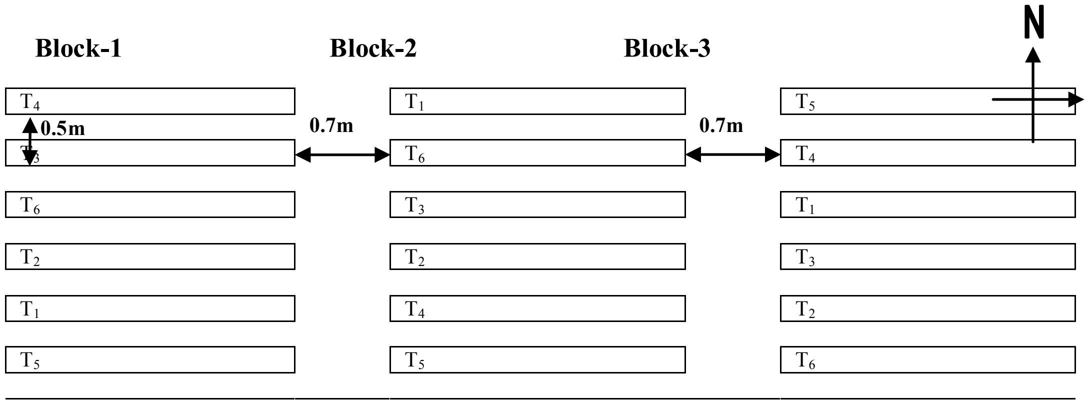

Figure 01. Layout of the experimental plot.

2.6 Treatment

T_1 : Control, T_2 : 0.5 t lime ha^{-1} , T_3 : 1.0 t lime ha^{-1}, T_4 : 1.5 t lime ha^{-1}, T_5 : 2.0 t lime ha^{-1}, T_6 : 2.5 t lime ha^{-1}

2.7 Fertilizer application

The total amount of urea, TSP, MOP, gypsum, zinc sulphate (monohydrate) and boric acid were applied on the basis of Soil Test value during final land preparation. Nitrogen was applied @ 140 kg ha^{-1} from urea, P @ 5 kg ha^{-1} from TSP, K @ 106 kg ha^{-1} from MOP, S @ 3.06 kg ha^{-1} from gypsum, Zn @ 3.6 kg ha^{-1} from zinc sulphate (monohydrate) and B @ 0.6 kg ha^{-1} from boric acid . Urea was applied in two splits, 2/3 was applied during final land preparation and rest 1/3 was applied 20 days after sowing. The fertilizers were incorporated to soil by spading one day before sowing.

2.8 Sowing of seeds

Seeds were sown in 28 November 2011, the seed rate being 125 kg/ha. Sowing was done continuously in 20 cm apart lines covered by soil manually.

2.9 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. The following intercultural operations were followed:

2.10 Irrigation

Three irrigations were applied, the first irrigation after 18 days of sowing , second irrigation after 29 days of sowing at crown root initiation stage and the third after 62 days of sowing at heading stage.

2.11 Weeding

Weeding was done twice during the whole growing period, the one after 19 days of sowing and the other after 38 days.

2.12 Insect and pest control

During maturation, four plots were slightly infested by field rat and the pest was controlled instantly by using mechanical control measures and application of zinc phosfide.

2.12 Harvesting

The crop was harvested at maturity after about four months of sowing (March 25, 2012). For data collection, ten plants from each plot were sampled randomly. The crop was cut at the ground level. Threshing, cleaning and drying of grain were done separately for every plot. Then plot- wise weights of grain and straw were recorded.

2.13 Data collection

Data were collected on the following yield and yield components.

2.14 Plant height

The plant height was measured from the ground level to top of the spike. From each plot, height of 10 plants were measured and averaged.

2.15 Number of tillers plant^{-1}

Ten plants were selected from each plot randomly. The number of effective and non-effective tillers plant^{-1} was counted and averaged.

2.16 Spike length

Length of spike of ten plants per plot was recorded and averaged.

2.17 Grains spike^{-1}

Ten spikes were selected and the filled and unfilled grains spike^{-1} were recorded and averaged.

2.18 Thousand grain weight

Thousand grains were randomly selected from each plot and the weight of grains was recorded after sun drying by an electrical balance.

2.19 Grain yield

Grains from each unit plot were dried and then weighed carefully. The results were expressed as kg ha^{-1} on 14% moisture basis.

2.20 Shoot and Root weight

Like grain yield, biomass and dry weight of **s**hoot and root for individual plot were recorded and expressed as kg ha^{-1}.

2.21 Harvest Index

I. About 15 percent moisture in grain.

II. Grains in hard dough stage.

III. Yellowing of spikelets.

2.22 Statistical analysis

The data were analyzed statistically (Gomez and Gomez, 1984) by F-test to examine whether the treatment effects were significant. The mean comparisons of the treatments were evaluated by DMRT (Ducan's Multiple Range Test). The analysis of variance (ANOVA) for different parameters was done by a computer package programme "MSTATC.

III. RESULTS AND DISCUSSION

3.1 Effect of liming on growth and yield contributing characters of wheat

Table3. Effect of lime on growth and yield contributing characters of wheat.

Treatment	Plant height (m)	Tillers/ Plant (no.)	Spike length (m)	Grains/ Spike (No)	1000 grain wt. (g)	Yield (t/ha)
T_1: Control	0.88	1.88	6.35	28.33	29.00	2.71
T_2: 0.5 t lime ha^{-1}	0.98	2.03	7.57	30.67	45.00	3.41
T_3: 1.0 t lime ha^{-1}	1.10	2.99	9.15	33.00	57.00	3.89
T_4: 1.5 t lime ha^{-1}	1.10	4.77	11.82	42.33	72.67	4.73
T_5: 2.0 t lime ha^{-1}	1.08	3.86	10.08	36.00	53.00	4.49
T_6: 2.5 t lime ha^{-1}	1.03	4.20	9.26	35.67	57.67	4.29
LSD	-	-	-	-	-	-
CV %	-	-	-	-	-	-

The figures having common letter(s) in a column are not significantly different by DMRT at 1% level.
LSD= Least Significant Difference, C. V. = Coefficient of variation.

3.1.1 Plant height

Liming effect on plant height of wheat was found statistically significantly different and the application of different rates of lime significantly increased the plant height of wheat (Table 3 and Fig. 02). Plant height of wheat progressively increased with increase in lime rates. The plant height ranged from 0.88 m in T_1 (control) treatment to 1.10 in T_4 treatment. The highest plant height recorded in T_4 was significantly comparable to those obtained in T_5 and T_6, but T_4 and T_5 treatments are statistically identical. All the treatments T_1, T_2, T_3 and T_6 differed statistically from each other in terms of plant height. On the otherhand, another observation of this result where plant height was highest in the treatment T_4 (1.1m) and grain yield also highest was found in same treatment T_4 (4.73 t/ha). The grain yield of wheat was positively correlated with number of tillers plant-1 character.

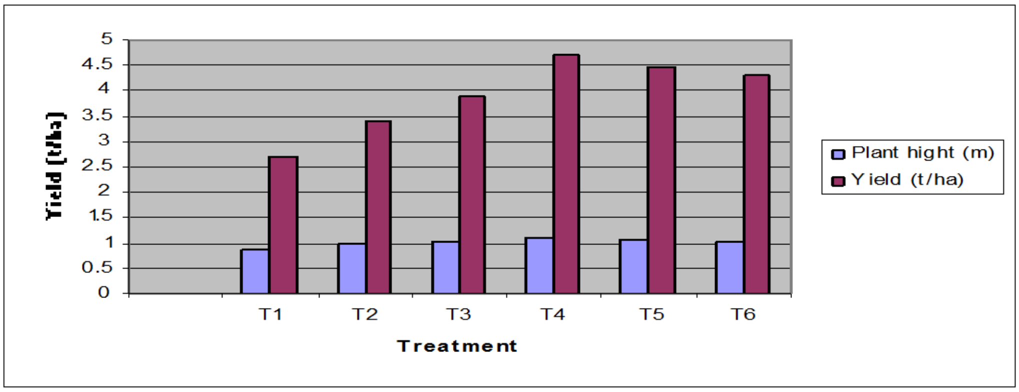

Figure 2. Relationship between plant height and yield with different lime rates.

Plate 01.Measurement of wheat plant height with scale after harvest.

3.1.2 Tillers plant-1

Liming effect on number of tillers plant-1 was found statistically highly significant (Table 3). The highest number of tillers plant-1 (4.77) was found in T_4 . The lowest number of tillers plant-1 (1.88) was found in T_1..The number of tillers plant-1 in T_5 was identical to those found in T_6, and also identical was found in T_1 and T_2. The treatment was superior to T_4, T_5 and T_6 in recording the number of tillers plant-1. The number of tillers plant-1 in T_4 and T_6 was statistically superior to tillers plant-1 recorded in T_1, T_2, T_3 and T_5 treatments. The number of tillers plant-1 of wheat was affected due to changes in soil properties through liming. The grain yield of wheat was also found in highest in the treatment of T_4 (4.77 t/ha). The grain yield of wheat was positively correlated with number of tillers plant-1 characters.

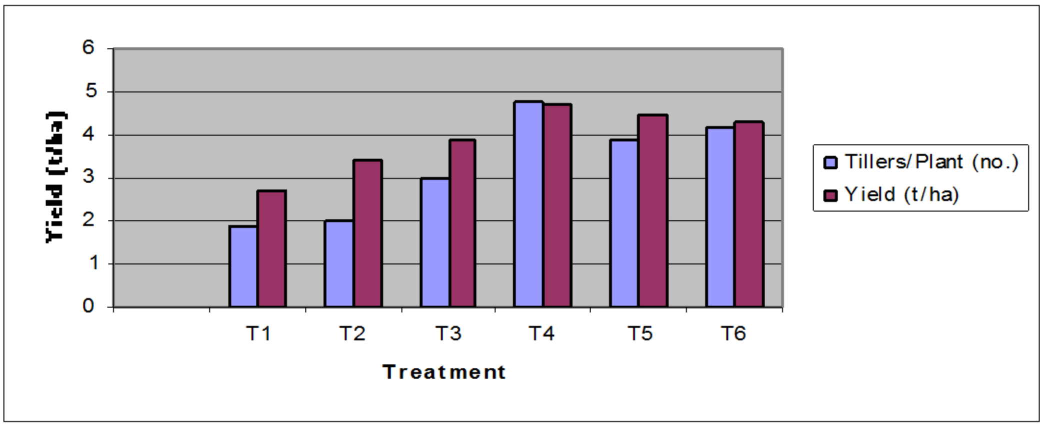

Figure 3. Relationship between tillers plant-1 and yield with lime rate.

The result is in agreement with Sharma et al. (2000), they reported that limes application significantly increased yield of mungbean. Samia(2007) also agreed with this result, she found that Liming effect on number of tillers plant-1 was significantly influenced by the different treatments of lime. The number of tillers per plant by different treatments varied from 2.09 to 4.03.

3.1.3 Spike length

Spike length of wheat was found significantly different due to the increasing amount of lime application (Table 3). Spike length of wheat ranged from 6.35 to 11.82 cm, tallest spike was found in T_4 treatment which is not statistically similar to others treatment. The treatment T_5 recorded the spike length of 10.08 cm which was comparable to those found in T_3 and T_6 treatments. The treatment T_4 was statistically superior to T_3, T_5 and T_6 treatments in terms of spike length. The grain yield of wheat was positively correlated with spike length characters.

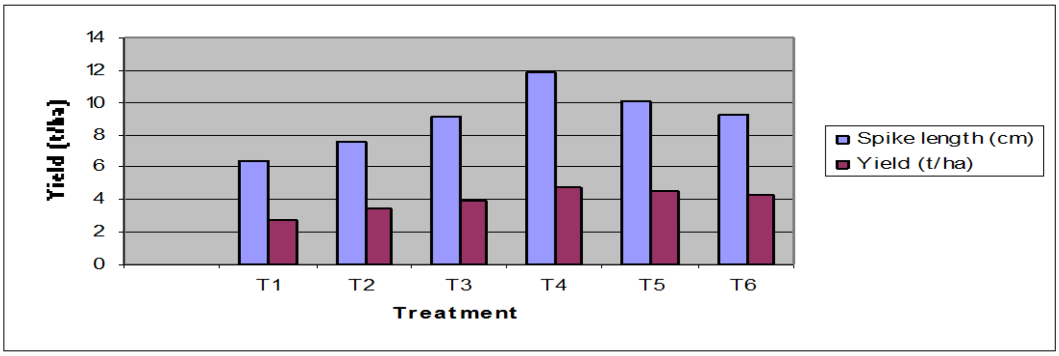

Figure 4. Relationship between spike length and yield with lime rate.

Plate 02. After harvesting of wheat plant spike length measured with scale.

The result is in agreement with Sharma et al. (2000) and Samia(2007.

3.1.4 Grains spike-1

The number of grains spike-1 was also shown significantly variation due to different liming treatments (Table 3). The number of grains spike-1 of wheat ranged from 28.33 to 41.33. The highest number of grains was found in T_4 treatment which is not statistically similar to all the treatments. The treatments T_2 and T_3, and T_5 and T6 recorded identical number of grain spike-1. Again the treatment T_3 recorded higher number grains spike-1 over T_2 treatment but they were statistically alike. The grain yield of wheat was positively correlated with the number of grains spike-1 characters Samia (2007) also agreed with this result, she found that liming effect of the number of grains spike-1 was significantly influenced by the different treatments of lime.

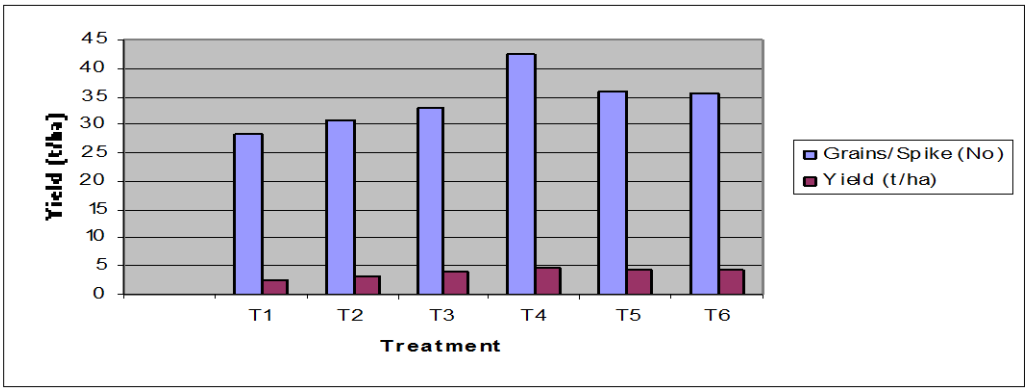

Figure 05. Relationship between grains spike-1 and yield with lime rate.

3.1.5 1000-grain weight

Liming had also shown significant effect on the 1000-grain weight of wheat (Table 3). The 1000- grain weight of wheat varied from 29.0 g to 72.67 g. The 1000 grain weight for T4 was highest (72.67 g) and the lowest was in T1 (29.0 g). The 1000 grain weight for T6 was in 2nd highest (57.67 g). The 1000 seeds weight and grain yield of wheat was affected due to changes in soil properties due to liming. This result is agreed with Samia (2007) and Basak (2010), they reported that liming increased soil pH and availability of nutrients which increased the yield components of wheat and mungbean finally higher yields of wheat and mungbean.

3.1.6 Grain yield

Grain yield of wheat (var. Prodip) was significantly responded due to application of different rates of lime (Table 3). The highest grain yield was found in T_4 (4.73 t ha-1) while the lowest was in T_1 treatment (2.71 t ha-1). The rate of lime application 0.5 t ha-1 (T_2) significantly increased the grain yield of wheat compared to control treatment. Application of lime increased grain yield of wheat to a considerable extent but application of lime at the rate of 1.5 t ha-1 was optimum for desired yield of wheat in the study area. The application of 0.5, 1.0, 1.5, 2.0 and 2.5 t lime ha-1 recorded 3.41, 3.89, 4.73, 4.49 and 4.30 t ha-1 compared to lime control treatment (Table 3). The grain yield of wheat was positively correlated with different plant characters like plant height. The grain yield of wheat was affected by changes in soil properties due to liming. It appeared that liming increased soil pH and availability of nutrients which increased the yield components as well as yields of wheat. Caires et al. (2006) reported that surface liming caused increases up to 140% in the grain yield of wheat. Kisic et al. (2002) found that besides mineral and organic fertilization, liming also rendered significantly higher yields compared to the control and relatively higher yields than treatments involving mineral fertilizers. Jovanovic et al. (2006) found that liming considerably influenced the yields of the field crops and single application of high rates was the better choice compared with repeated use of low rates. Similar observations were also reported by Miller (2000), Donahue (1981), Samia (2007) and Basak (2010).

IV. Conclusion

The different characters of wheat viz. plant height, tillers plant-1, spike length, grains sipke-1 and grain yield were significantly increased by the application of lime. The application of 0.5 t lime ha-1 significantly increased most of the growth parameters of wheat compared to that without any lime application. The application of lime had significant effect on the grain yield of wheat. The highest grain yield was found in T_4 (4.73 t ha-1), which was statistically identical with the grain yields obtained in T_5 and T_6 treatments but superior to those found in T_1, T_2, T_3 treatments. Thus, the application of 1.50 t lime ha-1 is enough for satisfactory yield wheat.

The results from this experiment showed that liming is necessary for wheat cultivation in the Amnura soil series of Sapahar Upazila of Naogaon District. The application of lime had positive impact on yield components resulted in higher yield of wheat. The application of 1.5 t lime ha-1 appears to be optimum for wheat cultivation in the study area. However, further research may be carried out on the effects of lime on crops in different cropping patterns for a sustainable food production.

References

[1]. Adams, F. 1981.Nutritional imbalance and constraints to plant growth on acid soil. J. Plant Nutrition, 4:81-87.

[2]. BARC (Bangladesh Agricultural Research Council) 2005. Fertilizer Recommendation Guide-2005. Soil Pub. No. 45. Farmgate, Dhaka.

[3]. BBS (Bangladesh Bureau of Statistics). 2012. Statistical Yearbook of Bangladesh. Bangladesh Bur. Stat. Ministry of Planning. Govt. of the People's Republic of Bangladesh. Dhaka.

[4]. Basak,V.2010. Nutrient Dynamics and Chemical Properties of Acid soil under different liming conditions in Mungbean field followed by Transplanted aman. MS Thesis Student No. 0905046,HSTU, Dinajpur.

[5]. Buoyoucos, G. J. 1927. Hydrometer method improved for making particle size analysis of soils. Agron. J. 54: 4661-4665.

[6]. Charles A. Black, C.A.1992. Soil Fertility Evaluation and Control. Lewis Publishers, London, 647-718

[7]. Clark, R. B., Zeto, S. K., Baligar V. C. and Richey K. D.. 1997. Growth traits and mineral concentrations of maize hybrids on unlimed and limed soil. J. of Plant Nutrition 20(12): 1795.

[8]. Hausenbuiller, R.L. 1972. Soil Science: Principle and Practices. W.M.C. Brown Company, Pub. USA.

[9]. Haynes, R. J. 1984. Lime and phosphorus in the soil plant system. Adv. Agron. 37: 249-315.

[10]. Islam M. R., Islam, M. S., Jahiruddin, M. and Hoque, M. S. 1999. Effects of sulphur, zinc and boron on yield, yield components and nutrient uptake of wheat. Pakistan J. Sci. Ind. Res. 42: (8), 137-140.

[11]. Islam, A.K. M.S., Edward, D.G. and Asher, C.J. 1980. pH optima for crop growth; Results of a following solution culture experiment with six species. Plant Soil 54:339-357

[12]. Jackson, M.L. 1962. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd. New Delhi. pp. 10-14.

[13]. Jahiruddin, M., Ali, M. S., Hossain, M. A., Ahmed, M. U. and Hoque, M. M. 1995. Effect of boron on grain set, yield and some other parameters of wheat cultivars. Bangladesh J. Agril. Sci 22(1): 179-184.

[14]. Jahiruddin, M. Hoque, M. S., Haque, A. K. M. M. and Roy, P. K. 1992. Influence of boron, copper and molybdenum on grain formation on wheat. Crop Res. 5: 35-42.

[15]. Luthra, V.K. 1978. Liming and leaching of acid sulphate soils, M. Sc. Thesis No. AE-78-3, AIT, Bangkok, Thailand.

[16]. Sahai, V. N. 1990. Fundamental of Soil Science. Kalyani Publishers, Ludhiana, New Delhi. P 76-84.

[17]. Samia, B.S. 2007. Effect of liming on soil properties and yield of wheat .MS Soil Sci. Thesis student no. 0605015,HSTU, Dinajpur.

[18]. Sharma, S.N. Prashed, R. and Singh, R.K. 2000. Influence of summer legumes in rice *(Oryza sativa)*-Wheat *(Triticum aestivum)* cropping system on soil fertility. *Indian J. Agric. Sci.* **70**(16): 357-359.

[19]. Shah, W. A., Bakht, J., Ullah, T., Khan A. W. and Zubair, M. 2006. Effect of sowing dates on the yield and yield components of different wheat varieties. J. Agron. 5(1): 106-110.

[20]. Sharma, S. N; Prasad, Singh, R. and. Singh, S. P. 2000. On-farm trials of the effect of introducing a summer green manure of mungbean on the productivity of a rice-wheat cropping system. J. Agric. Sci. Vol: 134(2) 169-172

[21]. UNDP and FAO. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development. Report 2, Agroecological Regions of Bangladesh. UN Dev. Prog. Food and Agric. Org.: 212-221.