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ROOT GROWTH, YIELD AND PROTEIN CONTENT OF SUMMER MUNGBEAN IN RESPONSE TO LIME

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ABSTRACT

A field experiment was carried out to investigate the root growth, yield potential and seed protein content of summer mungbean under different levels of lime. The lime levels were as 0, 500, 1000, 1500, 2000, 2500, 3000, 3500 kg ha^{-1} for T1, T2, T3, T4, T5, T6, T7 and T8 treatments, respectively. The highest number of leaves $plant^{-1}$ (23.4) was found in T_6 followed by T5, T3, T4, T7, T2 and T8 plants at 50 days after sowing (DAS). The lowest number of leaves $plant^{-1}$ (17.5) was recorded in T1 treatment. The tallest plant (38.23 cm) was found in T8 at 50 DAS followed by T4 as the lowest (28.47 cm) was in T2 at 40 DAS. The maximum leaf area (71.5 cm^2) was observed in T6 plant while the minimum (52 cm^2) was found in T1 plant at 45 DAS. The T7 plant had significantly greater root dry weight and root length while the lowest was in T1 (control plant). Root weight, length and root volume markedly variable and increased under different levels of lime. The number of root nodule $plant^{-1}$ and number of seed pod^{-1} were found significantly different under liming. The highest number of seed pod^{-1} (12.3) was found in T6, T4, T5, T7 and T8 plants which was statistically similar. The lowest number of seed pod^{-1} (9.5) was found in T1 treatment. The highest seed yield (1635.3 kg ha^{-1}) was recorded in T5 similar to that of T7 and T8. The lowest grain yield (1505.8 kg ha^{-1}) was found in T2 treatment. The protein content in seed ranged from 25.05 to 26.35% which was not statistically different. The study inferred that lime application at the rate of 2000 kg ha^{-1} was beneficial for the root growth and higher seed yield in summer mungbean cv. BARI mung-6 in the Northwest Bangladesh. More root growth of summer mungbean might be helped to add net organic carbon and nitrogen by biological nitrogen fixation in acid piedmont soil in Northwest Bangladesh.

Key words: lime, mungbean, root growth, seed protein, yield

INTRODUCTION

Mungbean is the important pulse crops of Bangladesh that supplies a major source of protein. Pulse crops are an important component of subsistence cropping systems because of their ability to form nodules, which offer a renewable source of energy through biological nitrogen fixation. Mungbean was found to be an accommodative crop between wheat and rice, and its recycling stover of yield (brown manuring) reduced negative balance of N and K (Timsina *et al.* 2002). It contains about 26% protein, 51%, carbohydrate, 4% minerals and 3% vitamins (Kaul 1982). Daily consumption of pulse bean is 13.29 g $head^{-1}$ in Bangladesh. The World Health Organization (WHO) suggested 45 g $head^{-1}$ daily intake is required for balanced diet. Increased yield and sustained soil productivity may not be possible without organic matter in the cropping systems (Saha *et al.* 1998).

Mungbean grows well all over the Bangladesh but yield is not satisfactory (BBS 2001). The production area of mungbean is declining (BBS 2005). This trend of pulses cannot compete with HYV cereals in terms of production and economic return and are thus being pushed to marginal lands where plant nutrient deficiencies are severe. Plant root growth chiefly affected by soil nutrient, soil moisture as well as soil pH but liming is directly. Regarding root systems, mungbean root nodulation helps in nitrification. Summer mungbean also helps to improve the soil fertility and productivity by fixing atmospheric nitrogen through rhizobium bacteria that lives in root nodules. Some mungbean varieties can be profitably used as brown manure for soil health improvement and hay for cattle. Suhartatik (1999) indicated that

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lime residue had effectively increased mungbean yield and improved soil productivity for two croppings. Sharma *et al.* (2000) compared rabi mungbean with summer one followed by rice in the rainy season and wheat in winter. Timely sown summer mungbean increased seed yield by 0.4-1.3 t ha^{-1} and, on average, increased rice yields by 0.5-0.9 t ha^{-1} and the yields of the succeeding wheat by 0.4-0.7 t ha^{-1}. A production system with high yield goals can't be sustainable unless balanced nutrient are supplied to soil against nutrient removal by crops (Bhuiyan *et al*. 1991). Again, unless the organic matter factor is adequately considered in the cropping systems, increased yield and sustained soil productivity may not be possible (Saha *et al.*, 1998). In spite of the many advantages of mungbean, the area coverage and the production are in declining trend. More than 3 t ha^{-1} of seed yield have been reported in many trials in pulse growing countries but in Bangladesh, the average yield is about 0.89 M t ha^{-1}**.** The yield difference indicates wide scope to increase the production of mungbean by horizontal expansion of yield. This goal can be achieved by using improved variety and proper soil and nutrient management.

Soil calcium (Ca) deficiency appears to affect absorption of water and nutrients but liming contain Ca that enhance the root development and its nodulation. Thus, it helps water absorption, nitrification and organic carbon sequestration in soil. Most legume proteins are deficient in methionine (Pant *et al.* 1968) but it contains amino acid lysine, which is rare in most cereals. The combination of cereals and legumes thus provides good balanced amino acids since cereals supply adequate methionine (Chavan and Duggal 1978; Mariseal *et al.* 2002). About 30 percent of protein calories consumed in the world from legumes (Aykroyd and Doughty 1964).

Mungbean has small root systems but its root nodulation helps a part of nitrogen nutrition. Thus it helps water absorption by increased root growth and nitrogen nutrition by symbiosis. On the other hand increased root growth supplies more organic matter to soil resulting more organic carbon in soil.

The soil Ca is required for the pulse production but agricultural soil of Dinajpur, Rangpur and Panchagar districts contain low Ca. So, proper application of lime is a commercially alternative and ecologically sound tool for supplying Ca might yield higher and quality of mungbean. Moreover, the hypothesis is that soil liming promotes root growth and root nodulation in mungbean and helps for better pulse production and deposit more carbon and nitrogen in soil. Therefore, the present investigation was undertaken to evaluate the root growth, yield and seed protein of summer mungbean cv. BARImung-6 in response to different levels of lime in Dinajpur, Northwest Bangladesh.

MATERIALS AND METHODS

A field experiment was conducted at the Agricultural farm in Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from April 2009 to June 2009. The soil belongs to the Old Himalayan Piedmont plain, Agro-ecological Zone-1 (AEZ-1) (UNDP and FAO, 1988). The soil was sandy loam with pH 5.6, available soil Ca 1.16 meq 100 g^{-1}, total nitrogen 0.07%, organic matter 1.17%, available P, K, S and boron were 13.77, 0.225, 38.59 and 0.56 ppm, respectively. The seed of BARImung-6 was collected from BARI (Bangladesh Agricultural Research Institute) Rajshahi, Bangladesh and used as planting materials for the study. The seeds were used for cultivation following wheat-summer mungbean-T-aman rice cropping pattern. The experiment was laid out in a randomized complete block design (RCBD). There were eight treatments with three replications. The total number of plots was 24 and the plot size was 4×5 m. The lime treatments were as- 0 (no lime), 500, 1000, 1500, 2000, 2500, 3000, 3500 kg ha^{-1} for T1, T2, T3, T4, T5, T6, T7 and T8, respectively. The land was prepared thoroughly by ploughing and cross-ploughing three times followed by laddering. The stubbles and weeds were removed from the field. The experimental plot was fertilized with urea (45 kg ha^{-1}), triple super phosphate (100 kg ha^{-1}) and muriate of potash (55 kg ha^{-1}) following Afzal *et al.* (1999). The mungbean seeds were sown in rows by hand on 12 April 2009. Weeding followed by thinning was done at 20 and 40 days after sowing (DAS). The experimental plots were irrigated as and when necessary due to low soil moisture. Insecticide was also used for controlling insects.

The pod was collected twice manually from 11 to 30 June 2009 at maturity stage (about 95% pods became brown to black in colour). Ten sample plants (excluding border ones) were selected randomly from the central 3×1 m area of each unit plot and were uprooted for recording necessary data on yield contributing characters. After sampling, the crop was threshed and sun-dried for three consecutive days. Seeds were then cleansed and sun dried for the purpose. Data on plant height (cm), number of leaves $plant^{-1}$ were collected during experiment period. The dry root weight (g), root volume (cm^3) and number of root nodule were collected five times at 15 days interval. The number of seeds pod^{-1}, 1000 seed weight (g), biomass yield $plot^{-1}$, grain yield $plot^{-1}$, seed yield (kg ha^{-1}) were measured at harvesting time. Total N content in seed was determined by kjeldahl method (Page *et al.* 1982). Protein content of summer mungbean seed was calculated by multiplying the total N with a factor 6.25. The data were analyzed by using MSTAT-C computer program. The least significant differences were evaluated followed by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The leaf number

The lime had stimulatory effects on leaf production in summer mungbean. Leaf number increased gradually with the advancement of the growth of the plants in all treatments. The data revealed that lime at 2500 kg ha^{-1} produced the higher number of leaf at all growth stages. Table 1 shows that the number of mungbean leaves produced during the experiment period. The leaf number was increased gradually from seedling to maturity and declined after 45 DAS. The highest leaf number plant^{-1} (23.4) was found in T6 and the lowest (17.1) was in T1 treatment. After 50 DAS, the leaf number was decreased due to aging and leaf senescence. A general sigmoid growth pattern in leaves number was observed for summer mungbean which was also supported by Sarker *et al.* (2012).

Table 1. The leaves number of mungbean at different times of experiment under different levels of lime

	Days after sowing (DAS)												
Treatments	10	15	20	25	30	35	40	45	50	55	60	65	70
T1	2.0	6.7	10.0	11.0	13.3	15.5	15.7	17.6	17.5	16.0	16.0	16.0	14.0
±	0.0	0.3	0.9	0.0	1.3	0.5	1.8	1.9	0.3	2.0	2.0	2.0	2.0
T2	2.0	6.7	9.6	11.2	14.2	16.6	15.6	16.4	19.3	16.0	16.0	16.0	14.0
±	0.0	0.3	1.1	0.4	0.6	0.2	0.8	2.3	2.2	1.0	1.0	1.0	1.0
T3	2.0	6.5	9.5	11.0	14.5	15.6	16.0	18.2	22.0	16.0	16.0	16.0	13.0
±	0.0	0.5	0.9	0.0	0.8	0.7	1.3	3.0	2.0	1.5	1.5	1.5	1.5
T4	2.0	6.1	9.3	11.6	14.8	16.0	16.4	15.3	21.4	17.0	17.0	17.0	13.0
±	0.0	1.0	1.1	1.1	0.5	0.5	2.9	0.3	1.2	2.0	2.0	2.0	2.0
T5	2.0	6.5	8.7	11.0	15.0	14.9	14.1	17.7	23.2	15.0	15.0	15.0	14.0
±	0.0	1.3	0.8	0.0	0.8	0.8	4.1	2.2	1.4	2.0	2.0	2.0	2.0
T6	2.0	5.5	9.0	10.2	13.6	16.0	14.3	17.3	23.4	17.0	14.0	14.0	4.0
±	0.0	0.5	0.9	1.4	2.5	1.7	2.4	2.7	1.1	3.0	3.0	3.0	3.0
T7	2.0	6.3	8.7	11.0	13.9	15.6	16.1	16.3	21.8	15.0	15.0	16.0	15.0
±	0.0	0.3	0.8	0.0	0.4	1.7	1.5	0.9	1.2	2.0	2.0	2.0	2.0
T8	2.0	6.6	9.2	11.2	14.9	16.2	15.8	18.2	21.2	16.0	16.0	16.0	14.0
±	0.0	1.3	1.0	0.7	2.7	1.3	3.0	1.3	1.3	2.0	2.0	2.0	2.0

Note: ± means standard deviation; n=10

Plant height

Mungbean plant height increased gradually with the advancement of the growth of the plants in all treatments. A marked difference was observed in summer mungbean plant height (Figure 1). The tallest plant (38.88 cm) was found in T8 treatment followed by T7 and the smallest (25.78 cm) was observed in T2 plant. The average tallest plants (38.88 cm) was recorded in T4 treatment. The height was increasing upto 50 DAS and then tended to decline subsequently upto final harvesting. Therefore, the growth was increased in regard to plant height due to application of lime in acid soils which was similar to agreement with Sarker *et al.* (2012).

Root weight

Figure 2 shows the dry root weight of mungbean plants during the experiment period. Dry root weight was significantly increased by the application of different doses of lime. After 30 DAS the highest dry root weight (3.91 g) was found in T7 and the lowest (1.88 g) was in T1 treatment. The lime application increased the soil physical properties and pH which might help to increase root growth.

Root volume

A marked difference was observed in summer mungbean root volume (Table 2). Liming effect on mungbean root volume was found statistically significant at 15 to 60 DAS. At 60 DAS the highest root volume (8.3 cm^3) was found in T7 and the lowest root volume (7.03 cm^3) was in T1.

Root nodule of mungbean

There was a significant variation in root nodule production that was observed in the present study. The number of root nodule produced in summer mungbean cv. BARImung-6 was presented in Figure 3. The number of nodule in summer mungbean roots was higher at early growth stages while it began to

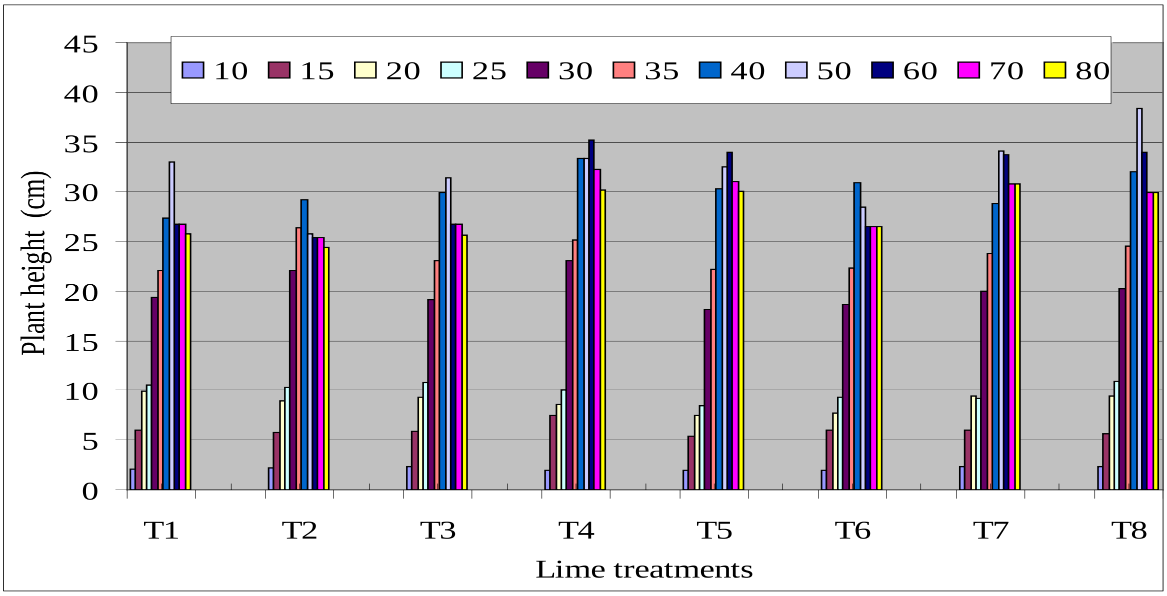


Figure 1. Plant height of mungbean grown under different lime conditions at different days after sowing.

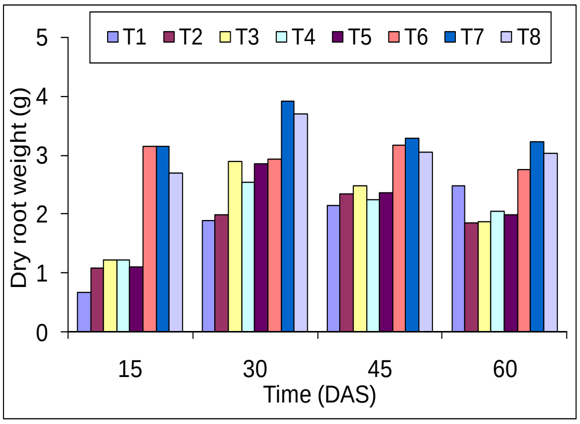


Figure 2. Total dry root weight during growth period under different lime conditions.

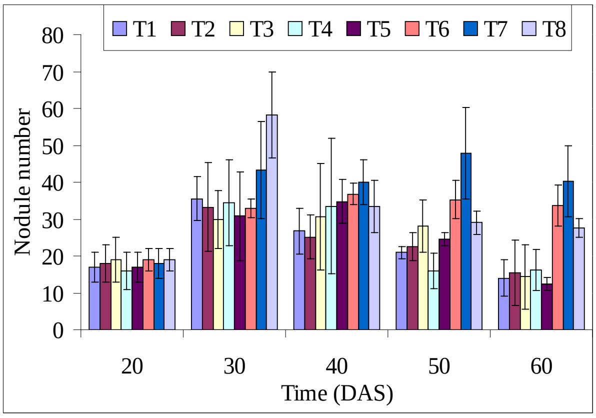


Figure 3. Root nodule number during growth period under different levels of lime.

decrease after 30 DAS. At harvesting stage, the highest number of nodule was 40.22 found in T7 and the lowest number of nodule was 14 in T1 roots. It indicated that early vegetative stage might be suitable for nodule formation in mungbean plant. Lime application in acid piedmont soil encourages the nodule formation which is important for atmospheric N_2 fixation to soil resulted in soil health improvement.

Yield and yield contributing character

Number of seed pod^{-1}

A significant variation was observed in number of seed pod^{-1} of summer mungbean. Table 3 shows the number of seed pod^{-1} in summer mungbean under different levels of lime. The highest number of seed pod^{-1} (12.3) was found in T8 treatment that was statistically similar to that of T6 and T7 plants. The lowest number of seed pod^{-1} 9.5 in mungbean was obtained from T1 plants. The results were in agreement with Sharma *et al.* (2000) that lime application significantly increased of 58% of mungbean seed pod.

Fresh and dry biomass plot^{-1}

The fresh and dry biomass plot^{-1} in summer mungbean under different levels of lime has been shown in Table 3. The highest fresh biomass plot^{-1} (6.2 kg) was found in T6 and the lowest (5.3) was in T3 treatment. Dry biomass plot^{-1} of summer mungbean showed a marked variation at harvesting time. The highest amount of dry biomass plot^{-1} (330.0 g) was recorded in T5 treatment which was similar to those of all treatments except T1 (Table 3).

Table 2. Root volume of summer mungbean under different levels of lime at different times of experiment.

Treatment	Days after sowing (DAS)			
	15	30	45	60
T1	1.17	4.33	6.83	7.03
±	0.29	1.26	1.53	1.53
T2	1.17	5.00	7.13	7.03
±	0.15	0.50	1.26	1.60
T3	1.67	5.00	7.33	7.03
±	0.47	0.50	1.15	1.15
T4	1.40	4.17	8.50	8.05
±	0.30	1.89	2.60	2.16
T5	1.23	4.83	8.67	8.17
±	0.21	0.29	3.06	3.06
T6	1.50	4.83	7.50	6.95
±	0.50	0.29	1.80	1.48
T7	1.67	4.33	8.33	8.30
±	0.21	1.26	1.04	1.04
T8	1.53	5.00	7.83	7.41
±	0.76	0.5	2.36	2.06

Note: ± means standard deviation; n=10

Seed yield

Seed yield of summer mungbean cv. BARRImung-6 was significantly responded due to application of different levels of lime. The highest seed yield (1635 kg ha^{-1}) was found in T_5 plants while the lowest (1505.78 kg ha^{-1}) was found in T2 plants. The T4, T6, T7 and T8 plants produced statistically similar amount of seed of mungbean. Marzuki (1991) observed that the seed yield of mungbean varied from 1500 to 1700 kg ha^{-1} by the application of lime in different levels with compared to the control plot which produced only 1300 kg ha^{-1} seed. On the contrary, Sarker *et al.* (2012) revealed that seed yield of summer mungbean was 1365 kg ha^{-1} by using lime while only 900 to 960 kg ha^{-1} mungbean seed yield was obtained without lime (Mollah *et al.* 2009). Such results was consistent with Sultana *et al.* (2009) The 2000 kg lime ha^{-1} application significantly increased the seed yield of summer mungbean cv. BARRImung-6 compared to that of control in the study area.

Protein content in mungbean seed

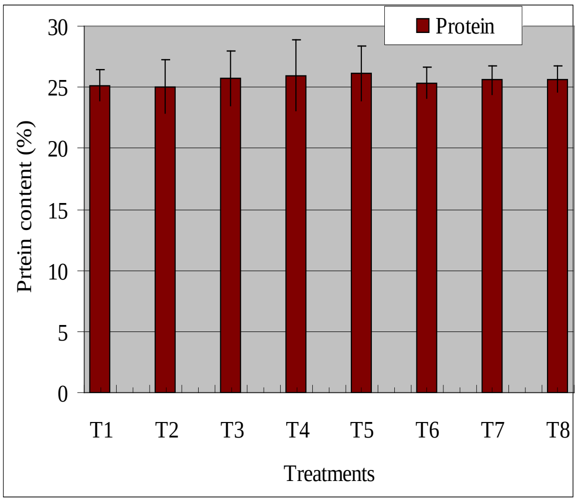
The highest seed protein content (26.16%) was found in T5 while the lowest (25.05%) in T_2 treatment. The protein content under different lime treatments was statistically similar for all the lime treated fields. Roy (2004) observed that the protein content ranged from 25.35-26.15% in four different varieties of BINAmug. The values were consistent with the results of Khan *et al.* (1955).

Table 3. Yield and yield contributing characteristics of summer mungbean

Treatment	No of seeds pod^{-1}	1000 seed wt. (g)	Fresh biomass (kg plot^{-1})	Dry biomass (g plot^{-1} m^{-2})	Seed yield (kg ha^{-1})
T1	9.5	54.4	5.8	240	1575
±	1.2	5.5	1.2	31	112
T2	10.3	53.3	5.7	280	1506
±	2.1	4.7	1.0	44	221
T3	10.5	53.7	5.3	270	1599
±	1.6	7.3	1.9	27	201
T4	12	54.7	5.8	303	1163
±	2.1	6.9	1.0	53	302
T5	11.3	54.7	5.9	330	1635
±	2.8	6.9	2.1	34	275
T6	11.7	55.8	6.2	330	1621
±	1.7	5.9	1	44	254
T7	12.3	55.9	6.1	324	1632
±	1.9	5.4	1.4	40	233
T8	12.3	55.5	6.1	322	1622
±	2.4	4.5	1.5	30	187
lsd	0.3	6.11	0.3	5.7	8.6
CV%	7.5	6.11	4.4	10.0	11.27

Note: ± means standard deviation; n=10

Figure 4. Seed protein content (%) of summer mungbean under different levels of lime.



CONCLUSION

It is concluded that leaf number, plant height and root growth in regard to weight and volume of summer mungbean plants were enhanced due to lime application in the acid piedmont soil. The root nodule number which might be fixed atmospheric nitrogen to soil that was markedly increased the growth of plants at vegetative stage by liming. More root growth along with nodule formation are utmost important for organic carbon sequestration and atmospheric nitrogen fixation in soil. The research suggested that the application of lime (dolochune) at the rate of 2000 kg ha^{-1} would be suitable dose for the cultivation of summer mungbean in Dinajpur, Northwest Bangladesh.

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