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EFFECT OF NITROGEN ON DIFFERENT GENOTYPES OF MUNGBEAN AS AFFECTED BY NITROGEN LEVEL IN LOW FERTILE SOIL

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Abstract

A pot experiment was conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during kharif- II season (August to November) of 2010 to find out the nitrogen acquisition and yield of mungbean genotypes affected by different levels of nitrogen fertilizer in low fertile soil. Ten mungbean genotypes viz. IPSA-12, GK-27, IPSA-3, IPSA-5, ACC12890053, GK-63, ACC12890055, BARI Mung-6, BUmug- 4 and Bina moog- 5 and six nitrogen fertilizer levels viz. 0, 20, 40, 60, 80 and 100 kg N ha^{-1} were included as experimental treatments. Results indicated that increasing applied nitrogenous fertilizer in low fertile soil increased nitrogen acquisition of mungbean which increased number of pods plant^{-1} and seeds pod^{-1} and finally increased yield of mungbean upto 60 kg N ha^{-1} irrespective of genotype and thereafter decreased. Genotype IPSA -12 produced the highest seed yield (14.22 g plant^{-1}) at 60 kg N ha^{-1}. The lowest yield (7.33 g plant $^{-1}$) was recorded in ACC12890053 in control. From regression analysis, the optimum dose nitrogen for mungbean cultivation in the low fertile soil is 54 kg ha^{-1}.

Keyword: Yield, Nitrogen level, Nitrogen acquisition, Low fertile soil.

Introduction

Mungbean (*Vigna radiata* (L.) Wilczek) is an ancient and widely cultivated crop in many Asian countries including China, India, Pakistan, Philippines, Indonesia and Bangladesh (Akbari *et al.,* 2008). Mungbean is a short duration crop and very effective for intensive cropping system. Mungbean can be easily fitted in mungbean - T. aus - T. aman (southern region), mungbean -T. aman wheat (north western region) and mungbean - aus - aman - potato (northern region) cropping systems without considering the fertility status of the soil (Haque, 2001). One of the reasons of ignoring soil fertility in mungbean cultivation is its ability to fixation of atmospheric nitrogen (Hardarson and Danso, 1993). However, amount of nitrogen fixed by microbial association varies over many soil and environmental factors which might not be sufficient for proper growth and yield formation of mungbean. Most of the researchers evaluated mungbean genotype in optimum soil

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condition but they ignored low nutrient environments for evaluation of mungbean (Anjum, *et al.*, 2006; Akbari, *et al.*, 2008 and Malik *et al.*, 2002). There exists ample scope to evaluated mungbean genotypes that have inherent capability for producing higher yield under nutrient poor conditions. Therefore, the present study was undertaken with view to yield and nitrogen acquisition behavior of mungbean under low nitrogen condition in different nitrogen level.

Materials and Method

The pot experiment was conducted at Bangbandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during kharif II season (August to November) of 2010. The soil was used in this experiment belongs to Codda series, under Madhupur tract. The soil is called low fertile soil because nutrient content in soil below the critical limit in the fertilizer recommendation guide (FRG, 2005). The experimental pots were filled with 12 kg soil. Ten mungbean genotypes (IPSA-12, GK-27, IPSA-3, IPSA-5, ACC12890053, GK-63, ACC12890055, BARI Mung-6, BUmug- 4 and Bina moog- 5 and six nitrogen levels (0, 20, 40, 60, 80 and 100 kg N ha^{-1}) were used as treatment variables.. Four (4) seeds per pot were sown on 31 August 2010. The treatments were factorial combination of the two factors and the experiment was conducted using a completely randomized design with four replication. One plant pot^{-1} was considered as one replication. Nitrogen fertilizers were top dressing at 15 days after sowing. All agronomic practices like two weeding (15 days and 30 days after emergence), three irrigation (12, 25 and 40 days after emergence) and one mulching was done at pod developing stage. Insect pest was controlled by spraying admire 0.5 ml $litre^{-1}$ of water during the entire growth period of the crop. Genotypes differed in attainment of maturity and then the harvesting was done twice one on 31 October and another on 13 November, 2010.

Table 1. Chemical properties of the experimental soil before sowing.

Soil properties	Present value	Critical level
Organic matter (%)	0.536	-
Total N (%)	0.05	0.10
Available P (ppm)	0.16	8.00
Exchangeable K meg 100^{-1}g soil	0.85	0.08
Available S (ppm)	7.00	8.00
Available B (ppm)	0.15	0.16
Available Zn (ppm)	0.25	0.50
Exchangeable Ca meg 100^{-1}g soil	14.83	2.00
Exchangeable Mg meg 100^{-1}g soil	1.76	0.50
CEC meg 100^{-1}g soil	6.90	3-7.5

Data on yield, yield components and nitrogen content of mungbean genotypes were recorded. Total nitrogen contents in plant were determined by modified

Kjeldahl digestion colorimatric method (Cataldo *et al.,* 1974). Nitrogen uptake by plant (shoot) of ten genotypes determined at maturity stage. The data on different parameters were subjected to statistical analysis Microsoft Excel and MSTAT C software programs were used wherever appropriate to perform statistical analysis.

Results and Discussion

Plant height

Genotype and nitrogen interacted significantly in plant height of mungbean (Table 2). Although plant height of mungbean increased with the increase of nitrogen levels but it attained peak differently in different genotypes treated by different nitrogen levels. Thus, the tallest plant (63.66 cm) of IPSA 12 was observed at 60 kg N ha^{-1} , GK 27 (43.00 cm) at 40 kg N ha^{-1}, IPSA 3 (65.33 cm) at 80 kg N ha^{-1}, IPSA 5 (78.33 cm) at 80 kg N ha^{-1}, ACC 12980053 (75.00 cm) at 40 kg N ha^{-1}, BU mug 4 (60.06 cm) at 40 kg N ha^{-1}, BARI Mung 6 (57.00 cm) at 60 kg N ha^{-1} and Binamoog 5 (68.33 cm) at 60 kg N ha^{-1}. The lowest plant height was obtained at o kg ha-1 irrespective of genotypes. The results revealed that genotypes itself are responsible for variation in plant height while applied nitrogen enhanced the growth of mungbean. Increase in plant height of mungbean at higher nitrogen levels may be ascribed to increase of N in chlorophyll which increased photosynthesis and enhanced meristematic activity of plant (Sawwar *et al*., 1989). Besides, nitrogen is essential component of amino acids which are vital building blocks for development of tissues and consequently increased plant height. This result is an agreement with the findings of Rahman *et al*. (1992) of French bean at higher level of nitrogen (120 kg ha^{-1}).

Table 2. Plant height (cm) of mungbean genotypes as affected by nitrogen level.

Genotypes	Nitrogen levels (kg ha^{-1})					
	0	20	40	60	80	100
IPSA -12	50.00cC	54.66bB	56.66bC	63.66aB	57.00bC	48.66cC
GK -27	40.00bC	42.66aC	43.00aD	42.66aC	42.66aC	40.00bC
IPSA- 3	63.00abA	64.66aAB	62.40bC	63.00abB	65.33aB	63.00abB
IPSA -5	58.30cB	63.44cAB	69.00bB	63.00bbB	78.33aA	69.66bA
ACC12890055	61.56bcA	63.00bAB	65.66bB	62.00bB	78.66aA	58.61cBC
GK -63	44.96bC	47.37aC	47.00aD	43.00bcC	41.66bcC	41.00cC
ACC12890053	56.64cB	68.66bA	75.00aA	71.33abA	70.65abA	70.00abA
BUmug -4	43.66bcC	46.06cC	60.60aC	59.00aC	42.66cC	43.00bcC
BARI Mung -6	41.66cC	44.12cC	54.00abC	57.00aC	53.66aC	51.33abC
Binamoog -5	54.33cBC	65.00abA	65.0abB	68.33aAB	60.33bcB	58.33bcBC

Means followed by same small letter (row) and capital letter (column) did not differ significantly at 5% level of probability.

Yield components and yield

Pods plant^{-1}

Number of pods plant^{-1} of mungbean genotypes significantly influenced by the N levels. Increasing nitrogen level led to increase pod plant^{-1} up to 60 kg N ha^{-1} irrespective of genotypes and thereafter decreased due to increase in N rates (Table 3). These results are agreed with the findings of Peter and Patel (1991) they reported that number of pod plant^{-1} of mungbean increased with application of nitrogen fertilizer and excess application reduced pod number of mungbean. There were genotypic variations in pod development where the genotype IPSA 12 produced the highest pods plant^{-1} (30.16) with 60 kg N ha^{-1} and it was statistically similar to IPSA 5 at same N level (Table 3). The lowest number of pods plant^{-1} (16.16) was recorded in genotype GK- 63 which was identical with pods plant^{-1} (16.83) with Binamoog-5 with 100 kg N ha^{-1}. Control plant (no fertilizer with N) produced lower number of pods in all the mungbean genotypes. Plant absorbed nutrient from the soil which is required in the formation of seed is not sufficient in control condition. Increased nitrogen level in the no fertile soil were increased nutrient availability and increased number of pod plant^{-1} up to 60 kg N ha^{-1}.Further increased nitrogen levels nutrient toxicity occur and decreased pod plant^{-1}. These results are supported by Ashraf (2001) that number of pods plant^{-1} was significantly affected by application of N fertilizer. These means that mungbean genotypes require additional N for better pod development although it is capable to fix atmospheric N through rhizobium species living in root nodules (Anjum *et al*., 2006).

Table 3. Number of pods per plant of mungbean genotype as affected by nitrogen level.

Genotype	Nitrogen levels (kg ha^{-1})					
	N_0	N_{20}	N_{40}	N_{60}	N_{80}	N_{100}
IPSA 12	22.00cA	24.83bcA	27.50bA	30.16aA	26.16bA	22.66cA
GK 27	20.00bA	22.50abAB	23.60aB	23.50aC	22.33abB	19.66bB
IPSA 3	19.66cAB	22.16bAB	23.16bB	25.16aB	22.50bB	20.33bcB
IPSA 5	21.83bcA	25.33aA	26.33aA	27.50aB	26.00aA	23.16bA
ACC12890055	20.16cA	23.00abAB	23.16abB	25.00aB	21.66bB	20.83bcB
GK 63	16.83cC	21.33bB	21.63bC	23.33aC	22.33abB	17.16cC
ACC12890053	20.33cA	22.00bcAB	22.66bC	25.83aB	22.00bB	22.16bA
BU mug 4	19.00cAB	22.00bAB	24.16aAB	25.16aC	21.83bBC	21.00bcAB
BARI Mung 6	18.93cB	20.50bB	22.50abC	23.33aC	22.33aB	20.83bBC
Binamoog 5	16.83dC	19.83cC	23.33aB	24.83aC	21.50bB	17.66dC

Means followed by same small letter (row) and capital letter (column) did not differ significantly at 5% level of probability.

Seeds pod^{-1}

Interaction effect of genotype and nitrogen was not significant but genotype had significant effects on seeds pod^{-1} of mungbean (Table 4.). The highest seed pod^{-1} (12.40) was obtained in IPSA 12 and the lowest seed pod^{-1} (10.20) was recorded in BUmug 4 at o kg N ha^{-1}. Seed pod^{-1} was highest in IPSA 12 in control condition because lower number of pod plant^{-1} were obtained in this condition and more nutrient were available in formation in seed but not significantly different with other nitrogen level. These findings are agreed with Asaduzzaman *et al.* (2008) where they reported that nitrogen level and irrigation had no significant effect on seeds pod^{-1}. The number of seeds pod^{-1} is mostly genetically controlled but its number may be regulated by canopy photosynthesis during pod developing stage. Seed number also may be limited by the activity of the source (Akther, 2005). During seed filling, the ability of the individual seed to utilize assimilate determines number of seeds pod^{-1} and limitation of assimilate reduce the seeds pod^{-1} (Jenner *et al.* 1992). This results however contrasting with the findings of Rashid *et al.* (1999) who reported that application of N fertilizer increases seeds pod^{-1} significantly.

Table 4. Number of seeds per pod of mungbean genotype as affected by nitrogen levels.

Genotypes	Nitrogen levels (kg ha^{-1})					
	0	20	40	60	80	100
IPSA 12	12.40A	12.33A	12.13A	12.03A	11.66A	11.83A
GK-27	10.93A	11.11A	10.85A	10.76B	10.76B	10.66B
IPSA 3	11.65A	11.20A	11.91A	11.08A	11.38A	11.05A
IPSA 5	11.46A	12.15A	11.98A	11.96A	11.60A	11.86A
ACC12890055	10.60B	11.20A	11.16A	11.20A	11.00A	11.05A
GK-63	10.83B	11.23A	11.20A	11.36A	10.83A	10.23A
ACC12890053	10.40B	11.65A	11.25A	10.66B	11.23A	10.40B
BU mug 4	10.20B	10.84A	10.65B	11.15A	11.06A	11.20A
BARI Mung 6	10.30B	10.76A	10.75B	11.01A	11.40A	11.11A
Binamoog 5	11.40A	11.28A	10.73B	11.13A	11.10A	11.54A

Means followed by same capital letter (column) did not differ significantly at 5% level of probability.

1000 - seed weight

Thousand seeds weight was not significantly affected by N fertilizer application as it is largely governed by genetic factors. Thus, 1000- seeds weight varied in among the mungbean genotypes where maximum 1000 -seed weight (50.2 g) was recorded in GK -27 which was similar (50.1 g) to GK 63 and the lowest seed size (34.2 g) was recorded in ACC12890053 (Table 5). In present study although, soil N fertilizer failed to enhanced 1000 -seed weight but it increased in faba bean (Elsheikh and Elzidany, 1997) and groundnut (Chetti *et al.,* 1995) due to soil N fertilizer application.

Table 5. Effect of nitrogen fertilizer on 1000 -seed weight (g) of mungbean genotypes.

Genotypes	Nitrogen levels (kg ha^{-1})					
	0	20	40	60	80	100
IPSA 12	41.5	38.8	38.7	39.2	40.7	40.3
GK-27	50.2	49.4	49.9	49.9	49.7	49.8
IPSA 3	47.1	47.7	46.5	47.8	45.5	46.1
IPSA 5	38.5	38.1	39.5	41.5	41.0	36.8
ACC12890055	43.7	46.2	45.7	43.9	45.9	42.9
GK-63	49.8	50.1	49.9	49.4	49.6	49.7
ACC12890053	34.7	34.2	35.8	34.9	37.7	34.5
BU mug- 4	46.1	43.4	41.6	40.3	43.5	40.8
BARI Mung -6	49.3	48.9	48.9	50.0	49.0	48.6
Binamoog -5	39.0	40.3	37.2	37.0	40.7	41.1

Seed yield $plant^{-1}$

Seed yield $plant^{-1}$ was significantly affected by the interaction of mungbean genotypes and N fertilizer applications. Seed yield of mungbean varied from 7.33 g to 14.22 g $plant^{-1}$ and it was the highest in IPSA 12 (14.22 g $plant^{-1}$) grown with 60 kg N ha $^{-1}$ and the lowest in ACC12890053(7.33 g $plant^{-1}$) under control condition (Table 6). The genotype IPSA 12 however respond well (11.32 g $plant^{-1}$) under control condition. There was general trend of increase seed yield with the increase of N fertilizer up to 60 kg N ha^{-1} and thereafter decreased. Increase nitrogen fertilizer in low fertile soil gradually increased seed yield upto 60 kg N ha^{-1} due to increase pod $plant^{-1}$. These findings agreed with Biswas and Hamid (1989) and Mitra and Ghildiyal (1988) that seed yield of mungbean is limited by nitrogen supply. Application of N fertilizer upto 60 kg N ha^{-1} enhanced leaf area, dry matter production and consequently improved number of pods $plant^{-1}$ and seeds pod^{-1} of mungbean genotypes and hence increased the yield. Plants grown without added nitrogen or lower levels of fertilizer produced the lowest seed yield $plant^{-1}$ irrespective of genotypes. the negative response of higher N doses (beyond 60 kg N ha^{-1}) might be the toxic effect or produced some barriers on nutrition of mungbean plants. Yield of mungbean decrease in beyond 60 kg N ha^{-1} may be explained by quadratic equation $y = 9.37 + 0.101x - 0.001x^2$ as illustrated in Fig. 1. This equation states that seed yield of mungbean is maximum (11.92 g plant^{-1}) at 54 kg N ha^{-1} and thereafter, yield decrease at the rate of $0.001x^2$ for each unit of applied N fertilizer. The value of R2 (0.97) indicates that the nitrogen rates can account for 97% of the total variable in each yield.

Table 6. Seed yield (g plant $^{-1}$) of mungbean genotype as affected by nitrogen fertilizer.

Genotypes	Nitrogen levels (kg ha^{-1})					
	0	20	40	60	80	100
IPSA 12	11.32Ac	11.87Ac	12.87Ab	14.22Aa	12.41Ab	10.80Ac
GK-27	10.97Ab	12.34Aa	12.80Aa	12.61Ba	11.94Ab	10.43Ab
IPSA 3	10.78Abc	11.83Ab	12.82Aa	13.32ABa	11.65Ab	10.35Ac
IPSA 5	9.60Bc	11.72Ab	12.45Aa	13.64Aa	12.36Aa	10.10Abc
ACC12890055	9.33Bc	11.90Aab	11.81Bab	12.29Ba	10.93Bb	9.87ABb
GK-63	10.06Bb	12.00Aa	12.20Ba	13.09Ba	11.99Aa	9.23ABb
ACC12890053	7.33Dcd	8.49Db	9.12Cab	9.60Ca	9.31BCab	7.95Cc
BU mug 4	8.93Bbc	10.35Bab	10.85Ba	11.14Ba	10.40Bab	9.59ABbc
BARI Mung -6	8.55Bbc	10.78Bb	11.82Bab	12.84Aa	12.40Aa	11.24Aab
Binamoog 5	7.48Dc	8.61Cb	9.31BCab	10.23Ca	9.71Cab	8.37Cbc

Means followed by same small letter (row) and capital letter (column) did not differ significantly at 5% level of probability.

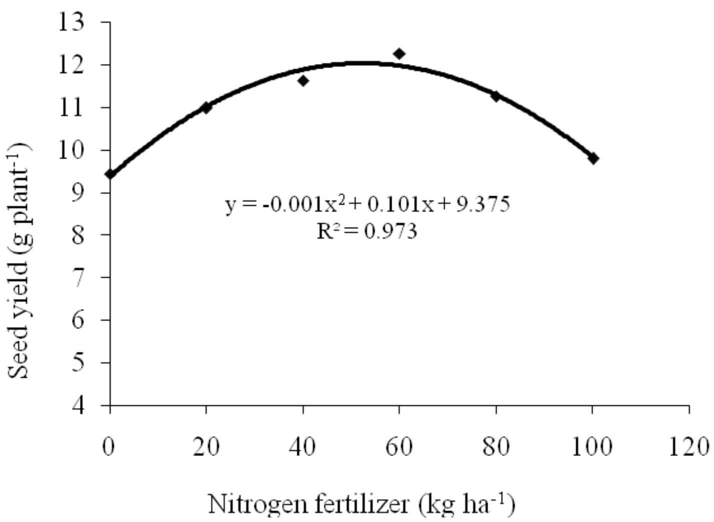

Fig. 1. Relationship between nitrogen fertilizer and seed yield of mungbean genotypes.

Nitrogen acquisition

As nitrogen deficiency in soil of Bangladesh is common (FRG, 2005), the ability of the plants to acquire nitrogen and their efficient use is important for crop adaptation to soils with low fertility. Genotypic differences in nitrogen acquisition revealed that the genotype IPSA 12 acquired maximum amount of nitrogen (0.767 g plant^{-1}) under 60 kg N ha^{-1} and it was the lowest in Binamoog 5 (0.381 g plant^{-1}) at control condition (Table 7). It was observed that most of the mungbean genotype acquired maximum nitrogen at 40 or 60 kg N ha^{-1} except ACC12890053. This genotype needs even 80 kg N ha^{-1} to acquire maximum nitrogen which supposed to be very expensive. Nitrogen regulates soil pH through NH+ and increases P availability (Havlin *et al.*, 2006), and phosphorus enhances nodulation and subsequently accumulates more N in mungbean plants (Marschner *et al.*, 1997).

Table 7. Plant nitrogen acquisition (g plant^{-1}) of mungbean genotypes as affected by different nitrogen levels.

Genotypes	Nitrogen levels (kg ha^{-1})					
	N_0	N_{20}	N_{40}	N_{60}	N_{80}	N_{100}
IPSA 12	0.536	0.639	0.710	0.767	0.662	0.591
GK -27	0.437	0.495	0.533	0.531	0.531	0.483
IPSA 3	0.480	0.506	0.530	0.604	0.555	0.506
IPSA 5	0.430	0.537	0.650	0.676	0.643	0.541
ACC12890055	0.472	0.614	0.674	0.601	0.579	0.510
GK -63	0.402	0.481	0.508	0.525	0.480	0.446
ACC12890053	0.412	0.527	0.584	0.630	0.620	0.526
BUmug 4	0.420	0.516	0.565	0.531	0.517	0.484
BARI Mung -6	0.433	0.492	0.560	0.595	0.554	0.501
Bina moog 5	0.381	0.443	0.534	0.556	0.519	0.46

Conclusion

The results revealed that nitrogen is necessary to ensure better growth and productivity of mungbean with low fertile soil. Increased N level mungbean production increased up to 60 kg N ha^{-1} in low fertile soil irrespective of genotypes. The genotype IPSA 12 performed the best in low fertile soil. The optimum dose of nitrogen for mungbean cultivation in the low fertile soil is 54 kg ha^{-1}.

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