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Effects of Different Nitrogen Levels on the Morphology and Yield of Blackgram

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Abstract: This study was conducted to evaluate the performance of blackgram (*Vigna mungo* L) under various levels of nitrogen at the Agronomy Research Site of Bangabandhu Sheikh Mujibur Rahman Agricultural University during March to June 2002. Two varieties of blackgram- BARI mash 3 and BINA mash 1 and six levels of nitrogen i.e., 0, 20, 40, 60, 80 and 100 kg N ha^{-1} were the treatment variables. Different morphological characters including grain yield were affected significantly by the nitrogen levels. The longest plant was measured with 100 kg N ha^{-1} whereas largest leaf area was obtained with 80 kg N ha^{-1}. BINA mash 1 was longer than BARI mash 3. Yield and yield contributing characters were affected significantly by different levels of nitrogen. The highest grain yield was obtained with 60 kg N ha^{-1} in both the varieties, thereafter the grain yield declined. Application of 60 kg N ha^{-1} favored most of the yield contributing characters that contributed the maximum grain yield production at this level of N. Between the two varieties of blackgram, BARI mash 3 out yielded BINA mash 1 at all levels of nitrogen. It was obvious that grain yield of blackgram can be increased substantially with the judicious application of N.

Key words: Morphology, yield, nitrogen level and blackgram

INTRODUCTION

An essential element of agricultural sustainability is the effective management of N in the environment (Rao *et al*., 2005). Nitrogen deficiency constrains leaf area expansion, enhances leaf senescence after canopy structure and subsequently reduces crop yield (Wolfe *et al*., 1988). Blackgram is one of the main edible pulse crops of Bangladesh. It ranks fourth among the pulses with an area of about 70,000 ha (BBS, 2000). As an excellent source of plant protein it is cultivated extensively in the tropics and subtropics. Soils of Bangladesh are mostly deficient in nitrogen. Nitrogen increases the dry matter and protein percentage of grain as well as methionine and triptophen contents in seed with increases of levels of applied nitrogen (Vidhate *et al*., 1986). The yield of blackgram is very poor as compared to many other legume crops (Rahman, 1991). Slow rate of dry matter accumulation during pre-flowering phase, on-set of leaf senescence during the period of pod development and low partitioning efficiency of assimilates to grain are identified as the main physiological constraints for increasing yield. Adequate supply of N may minimize the yield reduction through reduced those constraints. Probably that is why blackgram is highly responsive to nitrogen. Leaf area is made up of the total green lamina area of emerged leaves (Keating and Carberg, 1993). Greater leaf area is necessary to have superior yield and yield components in grain legumes (Muchow, 1985). Saini and Thakur (1996) stated that moderate doses of nitrogen (60 kg N per hectare) significantly increased the plant height, branches $plant^{-1}$ and leaf area index of grain legumes compared to no N. The higher grain yield of blackgram is associated with significantly superior yield attributes e.g. effective number of pods per plant and 1000 seed weight (Singh *et al*., 1993).

Flower and pod formation being the major sink during the reproductive phase. Little attention has been paid to exploit maximum N use efficiency and productivity of blackgram through judicious application of N. This study was therefore undertaken aimed to evaluate the beneficial effects of different levels of N alone and in combination with variety on plant height, leaf area development, yield and yield contributing characters of blackgram. The study was also initiated to furnish the information on the nature of combination among different morphological and yield attributes to choose a suitable selection criteria for predicting the grain yield of blackgram.

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MATERIALS AND METHODS

A field experiment was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during Kharif -1 season (from March to June 2002). The soil of the experimental field was silty clay under salna series with pH 6.5. The experimental soil contains 0.159% total N, 0.619% organic carbon, 0.312 meq exchangeable P/100 g soil, 0.38 meq exchangeable K/100 g soil and CEC 22.54 meq/100 g soil. The experimental site is situated in a subtropical environment having frequently rainfall during March to June. The experiment was laid out in a factorial RCBD with 3 replications.

Treatment combination: Two varieties of blackgram with six level of nitrogen fertilizer constituted the following treatment combinations.

B1 N0: BARI mash-3 with 0 kg ha^{-1} level of nitrogen fertilizer; B1 N20: BARI mash-3 with 20 kg ha^{-1} level of nitrogen fertilizer; B1 N40: BARI mash-3 with 40 kg ha^{-1} level of nitrogen fertilizer; B1 N60: BARI mash-3 with 60 kg ha^{-1} level of nitrogen fertilizer; B1 N80: BARI mash-3 with 80 kg ha^{-1} level of nitrogen fertilizer; B1 N100: BARI mash-3 with 100 kg ha^{-1} level of nitrogen fertilizer; B2 N0: BINA mash-1 with 0 kg ha^{-1} level of nitrogen fertilizer; B2 N20: BINA mash-1 with 20 kg ha^{-1} level of nitrogen fertilizer; B2 N40: BINA mash-1 with 40 kg ha^{-1} level of nitrogen fertilizer; B2 N60: BINA mash-1 with 60 kg ha^{-1} level of nitrogen fertilizer; B2 N 80: BINA mash-1 with 80 kg ha^{-1} level of nitrogen fertilizer and B2 N100: BINA mash-1 with 100 kg ha^{-1} level of nitrogen fertilizer.

The well-prepared soil was fertilized at the rate of 50 and 36 kg P and K per ha. Nitrogen are six levels of 0, 20, 40, 60, 80, 100 kg ha^{-1}. Half dose of N and full dose of P and K were applied as basal at the time of seed sowing. Seeds were sown on 9 March, 2002 with 10×30 cm^2 spacing; light irrigation was given to establish the seedlings properly. Excess seedlings were removed on March 20 to retain one seedling per hill. The crop was top-dressed with rest half of N on April 6, 2002.

Leaf Area Index (LAI): Leaf Area Index (LAI) was calculated using the following formula

$$LAI = \frac{\text{Surface area of sampled leaf}}{\text{Ground area occupied by the sampled plants}}$$

Yield parameters of blackgram was determined from a sampled area of 1.8 m^2 and converted in t ha^{-1} at 11% moisture content. For yield attributes of blackgram ten plants were selected at random from each treatment and pods per plant, seeds per pod, pod length and seed size were recorded.

Statistical analysis: The data recorded on different plant characters were statistically analyzed with the help of MSTAT program. The differences between the treatment means were compared by Least Significant Difference (LSD) test (Gomez and Gomez, 1983).

RESULTS AND DISCUSSION

Morphological characters

Plant height: Plant height is an important morphological character that acts as a potent indicator of availability of growth resources in its vicinity. The height of a plant depends on nutrient especially on nitrogen (Ferdous, 2001). Irrespective of nitrogen treatments, plant height increased over time (Fig. 1). Plant height increased progressively over time and attaining the highest at physiological maturity. In the beginning (between pre-flowering and pod filling stage) the rate of increase in plant height was not statistically significant and thereafter tended to flatten off regardless of nitrogen treatment differences. The effect of N on plant height was statistically significant from pod filling stage to maturity stage. Among the two blackgram varieties the increasing rate of plant height was more pronounced between the two stages in BINA mash 1 than BARI mash 3

The highest plant height was recorded with 100 kg N ha^{-1} and the lowest with N0 at all the growth stages. This trend was similar to the result reported for pea (Naik, 1989), for mungbean (Akhtaruzzaman, 1998) and for edible podded pea (Ferdous, 2001).

Leaf area development: Crop growth depends on adequate formation of leaf area for efficient interception of light (Wilson, 1981). Leaf area m^{-2} as influenced by variety and N fertilizer application is shown in Fig. 2. Leaf area m^{-2} increased sharply after emergence reaching peak at pod filling stage and then decreased especially in BINA mash 1. The reduction of leaf area m^{-2} at later part of growth might be due to senescence of older leaves associated with the remobilization of the stored metabolites from the leaf to the developing pods of blackgram (Prasad *et al*., 1978). Similar trends were reported by Matsunaga *et al.* (1989) and Singh *et al.* (1985) in mungbean, Ferdous (2001) in edible podded pea, Hossain (1999) and Misa *et al.* (1994) in groundnut. Among the varieties, BINA mash 1 consistently produced more leaf area m^{-2} than BARI mash 3 N levels significantly influenced leaf area development upto pod

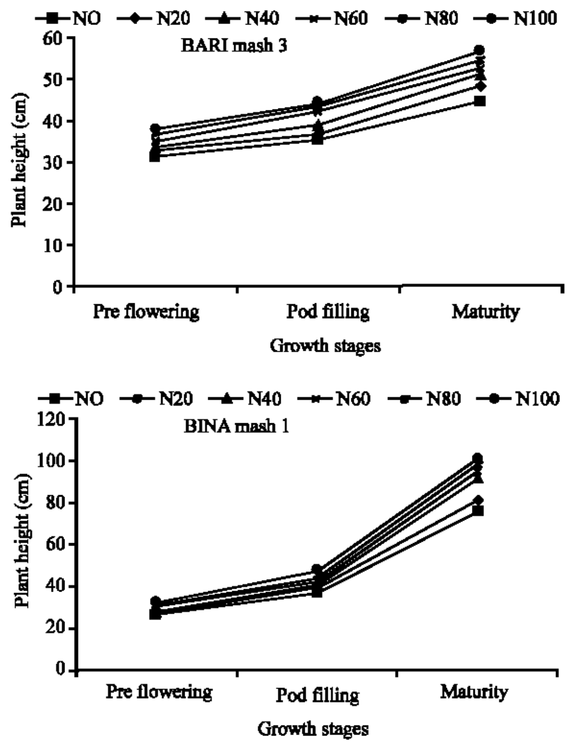

Fig. 1: Plant height of two blackgram varieties at different growth stages as affected by different N levels

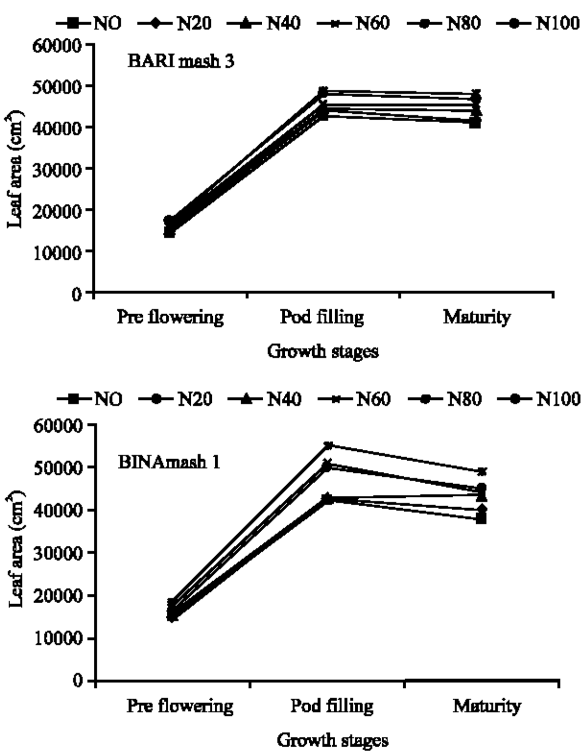

Fig. 2: Leaf area of two blackgram varieties at different growth stages as affected by different N levels

filling stage (Fig. 2). Leaf area development responded upto 80 kg N ha^{-1} and then decreased. Maximum leaf area was obtained at pod filling stage with 80 kg N ha^{-1} followed by plants with 60 kg N ha^{-1} which was statistically at par with 100 kg N ha^{-1}. This treatment (80 kg N ha^{-1}) also maintained higher leaf area throughout the crop growth period. Plants grown without N gave the lowest leaf area. Enhanced leaf area development with high dose of N also reported for mungbean (Santos *et al*., 1993). Borde *et al.* (1983) concluded that increase in N uptake increased nuclic acid, amides and amino acids and hence cell multiplication, which increased leaf area. However, it is evident from Fig. 2 that despite the magnitude of differences in leaf area due to treatment differences, the trend of leaf area development m^{-2} remain identical for both the varieties used.

Yield and yield attributes

Number of branch per plant: No of branch per plant of two blackgram varieties was measured, were influenced by levels of N (Table 1). It is clear that number of branch was increased with the increase of N levels. Highest number of branch per plant (about 8) was found with 60 kg N ha^{-1}, irrespective of varieties. Further increase of N levels did not show any advantage. Among the varieties, BARI mash 3 always produced higher branches per plant than BINA mash 1, though the differences were not conspicuous.

Number of pods plant^{-1}: Both remobilization of N and biological N_2 fixation during reproductive growth are important sources of N for developing pods (Neves *et al.*, 1982). Number of pods per plant depends on the number of flowering nodes per plant, branches per plant and number of flowers per node and its retention. Greater photosynthesis enhanced by more nutrient uptake helps to initiate more flowering buds, which ultimately developed as pods. Nitrogen requirement of a plant depends on its demand and is controlled genetically or by the nutrient status present in soil. The number of pods per plant significantly increased with the increasing levels of nitrogen (Table 1). Plants treated with 60 kg N ha^{-1} produced the highest number of pods per plant (59.43) and the lowest number of pods per plant (42.8) was recorded from the plants treated with 0 kg N ha^{-1}. Application of above 60 kg N ha^{-1} did not show any advantage in relation to pod setting. This result was similar to those reported by Singh *et al.* (1992) and Ferdous (2001).

Pod length (cm): Pod length of two blackgram varieties were significantly influenced by nitrogen levels (Table 1).

Table 1: Yield components of two blackgram varieties as influenced by different levels of N

Variety	Fertilizer doses ($N\ kg\ ha^{-1}$)	No. of branch/plant	No. of pods/plant	Pod length (cm)	No. of seeds/pod	1000 seed wt.	Yield ($kg\ ha^{-1}$)
BARI mash 3	0	5.77	42.80	4.75	7.17	31.09	868.23
	20	6.17	49.83	4.80	7.27	32.13	1205.50
	40	6.77	52.10	4.88	7.33	32.62	1234.83
	60	7.30	59.43	5.00	7.93	34.39	1768.00
	80	7.17	58.17	4.98	7.50	33.58	1499.93
	100	6.97	55.43	4.93	7.43	33.31	1308.67
BINA mash 1	0	5.27	27.00	4.33	6.50	20.18	640.70
	20	5.73	31.10	4.45	6.87	22.83	821.00
	40	6.23	32.50	4.51	7.00	26.54	898.50
	60	7.17	42.30	4.78	7.47	30.92	1050.18
	80	6.94	36.87	4.70	7.23	29.05	945.36
	100	6.60	34.47	4.62	7.10	27.43	908.74
LSD (0.05)		0.63	5.51	0.11	0.25	2.26	139.90
CV (%)		5.64	7.44	1.27	2.05	4.47	11.44

Irrespective of varieties and N levels, with the increasing N levels pod length increased upto 60 kg N ha^{-1}. Again with the increasing N level pod length decreased. Among the varieties, maximum pod length was always recorded in BARI mash 3 compared to the cultivar BINA mash 1. The highest pod length (5.0 cm) was recorded where plants were treated with 60 kg N ha^{-1} and the lowest pod length was observed in plants treated with 0 kg N ha^{-1}. Nitrogen induced increase in pod length also reported for blackgram and green gram (Singh *et al.*, 1993).

Number of seeds pod^{-1}: Insufficient nutrient supply to the pod during pod development stage may cause lesser number of seeds per plant. During pod development the supply of sufficient nutrient and photo assimilates are essential for increasing pod length as well as grain number in pod. Seeds pod^{-1} was significantly influenced by nitrogen levels (Table 1). Irrespective of varieties and N levels seeds pod^{-1} increased with the increasing N levels. Maximum no of seeds pod $^{-1}$ was obtained in plants treated with 60 kg N ha^{-1} and the minimum number of seeds plant^{-1} was obtained with 0 kg N ha^{-1}. Both the varieties had similar number of seeds pod^{-1}. Beyond 60 kg N ha^{-1} number of seeds pod^{-1} was reduced. This might be due to the fact that larger canopy created shading effect that reduced of photosynthates to the developing grain. Roy *et al.* (1995) got the highest seeds pod^{-1} at moderate level of nitrogen and beyond it number of seeds pod^{-1} were reduced in pea and sesame, respectively.

1000-seed weight (g): Seed size i.e. seed weight contributes greatly to seed yield. Seed size varies with the variation in N levels. The quality of seed of a crop depends on the translocation of photosynthates from photosynthesizing organ to seeds during the period from pod setting to pod maturity. Seed weight depends on protein synthesis in it and seed protein increases by nitrogen fertilization (Klalan and Berger, 1963). Among the different N levels significant variation in 1000-seed weight was observed (Table 1) and it varied from 20.18 to 34.39 g. The highest 1000-seed weight was observed at 60 kg N ha^{-1} that was statistically identical with the treatment of 80 and 100 kg N ha^{-1}. Singh *et al.* (1993) in blackgram and greengram, Ferdous (2001) in edible podded pea and Roy *et al.* (1995) in sesame also got the highest seed weight with moderate level of nitrogen.

Seed yield ($kg\ ha^{-1}$): Seed yield area^{-1} is attributed to the number of pods plant^{-1}, number of seeds plant^{-1}, seed weight and number of plants area^{-1}. All these yield contributing characters were significantly influenced by the increasing level of N fertilizer in blackgram varieties (Table 1). From the Table 1 it is clear that seed yield hectare^{-1} increased upto 60 kg N ha^{-1} and thereafter it decreased. The highest grain yield (1760.00 kg ha^{-1}) was observed at 60 kg N ha^{-1} in BARI mash 3 and the lowest grain yield was observed at 0 kg N ha^{-1} in BINA mash 1. The highest seed yield at 60 kg N ha^{-1} may be attributed due to greater partitioning of dry matter into the economic portion i.e., to seed and favorable growth nutrient uptake, higher number of seeds plant^{-1} and heavier seed weight. Among the varieties BARI mash 3 always produced highest seed yield than BINA mash 1. This is mainly due to better canopy structure that facilitate more light interception and more dry matter production that translocated to the developing grain in BARI mash 3. Whereas in BINA mash 1, shading canopy influenced distribution of photo-assimilates to the parasitic leaves rather to developing grains. Dry seed yield showed a best-fit linear positive relationship with LAI and N levels (Fig. 3 and 4). Where the R^2 values are 0.619 (BARI mash 3), 0.838 (BINA mash 1) and 0.791 (BARI mash 3), 0.934 (BINA mash 1). These

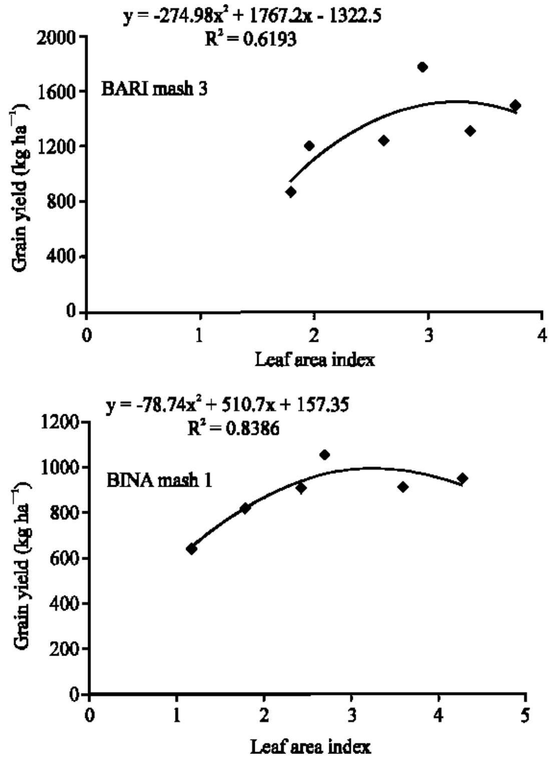

Fig. 3: Functional relationship between grain yield and leaf area index of two blackgram varieties

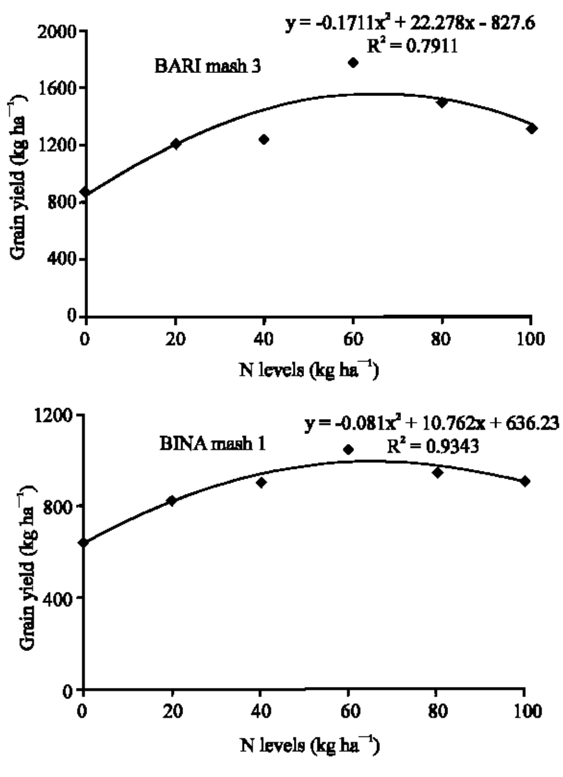

Fig. 4: Functional relationship between levels of N fertilizer and grain yield of two blackgram varieties

relationships indicated that incase of BARI mash 3, over 61% and 79% variation can be explained from the variation in LAI and N levels and incase of BINA mash 1, over 83% and 93% variation can be explained from the variation in LAI and N levels, respectively.

Vidhate *et al.* (1986) also explored the response of blackgram to nitrogen fertilizer and observed that an increase in the doses of fertilizer N increased the grain yield over control. The report of Singh *et al.* (1993) revealed that the higher grain yield of blackgram was mainly owing to significantly superior yield attributes like effective number of pods plant^{-1} and 1000-seed weight.

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