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ORIGINAL RESEARCH ARTICLE



Optimization of nitrogen requirement for better growth and yield of brinjal (*Solanum melongena* L.)

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ABSTRACT

A field experiment was conducted at the College of Agriculture Sciences, Agriculture Research Field of International University of Business Agriculture and Technology (IUBAT), Uttara, Dhaka, to optimize nitrogen requirements for growth and yield response of brinjal (*S. melongena*). There were six treatments of urea viz., 0, 275, 300, 325, 350 and 375 kg ha⁻¹ and the experiment was laid out in randomized complete block design (RCBD) with four replications. The texture of the experimental soil was sandy loam and fertility status was very low. Parameters measured include: plant height, number of leaves plant⁻¹, leaf area, number of branches plant⁻¹, number of flower clusters plant⁻¹, number of flowers plant⁻¹, fruit diameter, fruits length, number of fruits plant⁻¹, fruit weight and yield. Present study results revealed that application of the highest dose of urea showed positive significant influence on growth and reproductive characters of brinjal (*S. melongena*). Similarly, yield and yield contributing characters of brinjal (*S. melongena*) increased with the increasing rates of urea. The highest yield (18.0 ton ha⁻¹) was obtained from the application of 375 kg ha⁻¹ urea, while the lowest yield (10.1 ton ha⁻¹) was found from the control treatment. Thus, the overall study results suggested that 375 kg ha⁻¹ urea performed the best in context Agriculture Research Field soils of IUBAT, Uttara, Dhaka. The study concluded that before final recommendation of the application dose, further study is needed in different agro-ecological zones of Bangladesh.

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INTRODUCTION

Eggplant or brinjal (*S. melongena*) is a native crop of subtropical areas of south-eastern Asia and was introduced into Europe by early Arab traders. It is a member of the *Solanaceae* family. It has been widely grown in southern Europe, the Middle East, Africa and Asia for hundreds of years (Ullio, 2003). It is a long duration vegetable crop with high yield which removes large quantities of different nutrient elements from the soil. Brinjal (*S. melongena*) is familiar throughout the world for its low calories and high mineral contents, which is beneficial for human health. It is rich source of potassium, sodium, magnesium, calcium and iron (Kowalski et al., 2003; Raigón et al., 2008) as well as dietary fiber (Sanchez-Castillo et al., 1999). It is consumed almost on a regu-

larly basis by the both rural and urban peoples of Bangladesh. Brinjal (*S. melongena*) is the second most important vegetable crop in Bangladesh in respect of acreage and production (BBS, 2018). It is cultivated all over the country in two seasons viz. *rabi* and *kharif*. In 2016-17, it is cultivated in 80195 and 45665 acres of land with an annual production of 347541 and 159891 tons in *rabi* and *kharif* seasons, respectively (BBS, 2018). But average yield of the crop in Bangladesh is very low compared to those obtained in some advanced countries of the world. The low yield of brinjal (*S. melongena*) in Bangladesh is primarily due to the lack of high yielding varieties, inadequate and imbalanced use of manure and fertilizers especially the nitrogenous ones. As because nitrogen is the most deficient nutrient element in the soils of Bangladesh. Thus brinjal (*S. melongena*) requires a large

quantity of nitrogenous fertilizer for its proper growth, development and yield (Aminifard *et al.*, 2010).

In Bangladesh, the farmers use huge amount of different chemical fertilizers injudiciously for crop production especially for vegetables and among that urea is the top most. Nitrogenous fertilizer often have mobility in soils, which leads to soil pollution and ground water contamination, ultimately causing health hazards to the people (Begum *et al.*, 2014; Giannakoula *et al.*, 2010). Therefore, management of nitrogen fertilizers such as rate, type and application time is very important (DePascale *et al.*, 2006). Nutritional stress is one of the main factors limiting crop productivity; this may occur due to an excess or a deficit of nutrients (Souza *et al.*, 2018). Thus, judicious application of nitrogenous fertilizer with appropriate rate is essential. Considering this fact, the study was planned to optimize nitrogen requirement for cultivation of brinjal (*S. melongena*) at Agriculture Research Field condition of International University of Business Agriculture and Technology, Uttara, Dhaka.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Agriculture Research Field of International University of Business Agriculture and Technology, 4 Embankment Drive Road, Sector 10, Uttara Model Town, Dhaka 1230, Bangladesh during the period from May 10 to Aug 10, 2016 in *Kharif* season. Geographically the experimental field is located at 23.8883°N latitude and 90.3909° E longitude. The experiment was set up on the medium high land in an open and sunny area. The texture of the soil was sandy loam and the pH was 7.6. The climate of the area is characterized by high temperature and medium rainfall with an annual rainfall of 119-145 cm during April to August and little or no rainfall during September to March.

Treatments and layout

There were six treatments of urea viz. T₀ (control), T₁ (275 kg ha⁻¹), T₂ (300kg ha⁻¹), T₃ (325kg ha⁻¹), T₄ (350kg ha⁻¹) and T₅ (375kg ha⁻¹). Urea was applied to the plot in three equal splits at 20, 40 and 60 days after transplanting. The experiment was laid

out as randomized complete block design (RCBD). The experimental area is divided into 4 blocks representing the 4 replications and each replication was divided into 6 plots which were equal in size i.e. 0.25m² (0.5m × 0.5m). Thus, total number of plots was 24 (6×4). Within each replication, 6 plots were assigned with six nitrogen (urea) treatments which were randomly distributed. There were 40 cm and 30 cm gaps from block to block and plot to plot for intercultural operations, respectively (Figure 1).

Application of fertilizers

Fertilizers applied in the plots as recommended for high yield goal and very low soil fertility status as described in Fertilizer Recommendation Guide (FRG, 2012). The recommended doses of phosphorus, potassium, sulphur, zinc and cow dung were 42, 105, 18, 2.5 kg ha⁻¹ and 5 ton ha⁻¹, respectively. Nutrient elements were applied from triple superphosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate fertilizers, respectively. Potassium was applied in three equal splits at 20, 40 and 60 days after transplanting along with the treatments of urea as mentioned in FRG (2012).

Test crop and intercultural operations

Brinjal (*S. melongena*) variety BARI Begun-8 was used for the experiment. Seeds of this variety were collected from the Horticulture Division of Bangladesh Agriculture Research Institute, Joydebpur, Gazipur. After collection, seedlings were grown in pots and then 30 days old brinjal (*S. melongena*) seedlings were transplanted on the experimental field. Intercultural operations viz. weeding, irrigation, disease and pest management were done using traditional methods as and when necessary. Sex pheromone trap was used in the experimental field for controlling brinjal shoot and fruit borer.

Data collection and processing

Data on growth, yield and yield contributing characters were recorded from each plot and total yield was calculated through average plant yield by multiplying plant population. Then collected data were analyzed statistically using Minitab 17.

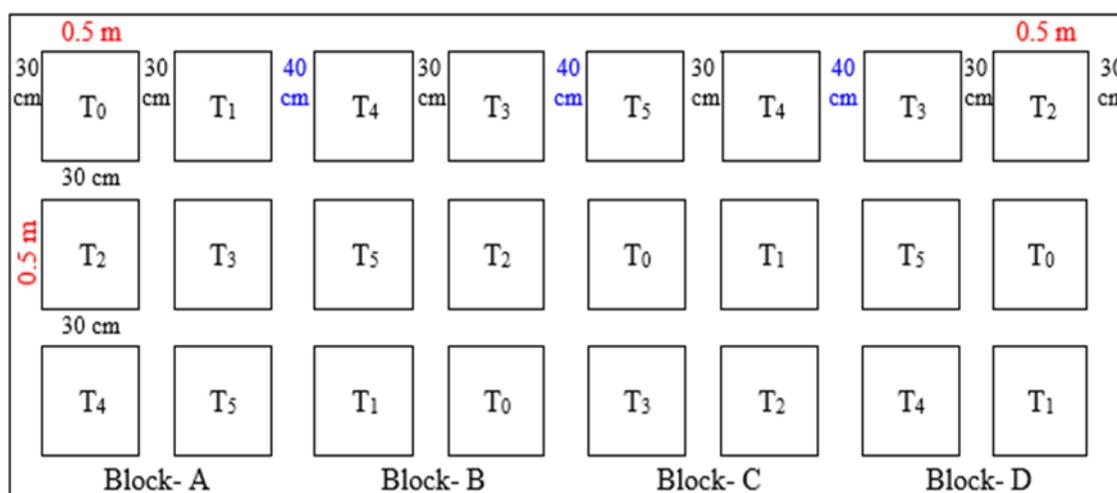


Figure 1. Experimental design and layout.

RESULTS AND DISCUSSION

Effect of nitrogen on different growth parameters of brinjal

Plant height of brinjal (*S. melongena*) varied significantly among the different treatments of nitrogen. The tallest plant was found from T₁ treatment (47.50 cm) at 20 DAT, but at 40 and 60 DAT the highest plant heights were obtained from T₅ treatment (80.08 and 87.08 cm, respectively). On the other hand, the smallest plants were found from control treatment both at 20 and 60 DAT (37.50 and 68.25 cm, respectively) but at 40 DAT the minimum plant height was obtained from T₄ treatment (61.89 cm). It can be inferred from Figure 2 that at later stage of growth (i.e. 60 DAT) nitrogen levels showed remarkable change in plant height compared to the initial stage of growth of brinjal (*S. melongena*). This result is in agreement with Wange and Kale (2004) who reported that significant improvement in plant height of eggplant occurred due to over recommended rate of nitrogenous fertilizers. Similarly, increase in plant height with increasing level of fertilizer application; have been reported by Bar-Tal *et al.* (2001) and Prabhu *et al.* (2003). Ge *et al.* (2008) observed that nitrogen application increased plant height at vegetative, flowering and reproductive stages. Devi *et al.* (2002) reported better growth of brinjal (*S. melongena*) by the application of 260 kg ha⁻¹ urea. Hussain *et al.* (2009) reported plant height of brinjal

(*S. melongena*) at harvesting varied from 115.2-131.0 cm by the application of different types of nitrogenous fertilizers.

The application of different levels of nitrogen significantly affected the number of leaves plant⁻¹, leaf area and number of branches plant⁻¹ of brinjal (*S. melongena*) (Figure 3). The maximum number of leaves plant⁻¹ (90) was found from T₅ treatment while the minimum (67) was obtained from T₀ treatment at 60 DAT (Figure 3). Thus it can be inferred from this result that brinjal (*S. melongena*) required higher amount of nitrogen for its better growth and development. Similar result was also stated by Wange and Kale (2004), and they reported that over recommended rate of nitrogenous fertilizer significantly increased number of leaves in eggplant. Jilani *et al.* (2008) stated that application of nitrogen at the rate of 150 kg ha⁻¹ increased number of leaves of brinjal (*S. melongena*). Mohammad *et al.* (2010) stated that nitrogen is found to promote growth and increases biomass production, and nitrogen fertilization has been used to increase growth of eggplants.

Effect of different levels of nitrogen on leaf area of brinjal (*S. melongena*) was statistically significant at 1% level of probability. The maximum leaf area was obtained from the treatment T₅ (43.0 cm²), while the minimum was found from the control treatment (35.0 cm²). The increase in leaf area index could be attributed to increased cell division and elongation resulting in increased leaf expansion, more numbers of leaves due to beneficial influence of additional nitrogen. This result is at par with the report published by Kumar *et al.* (2018). The highest number of branches plant⁻¹ (11.00) was also found from the T₅ treatment and the lowest (7.33) was obtained from T₀ treatment at 60 DAT. Present study results revealed that application of the highest dose of urea showed positive influence to increase leaf area and total number of branches of brinjal (*S. melongena*). Takebe *et al.* (1995) reported that increments in the leaf dry weight may be due to a combination of nitrogen with plant matter produced during photosynthesis. Hussain *et al.* (2009) reported number of branches plant⁻¹ of brinjal (*S. melongena*) varied from 11.96-15.64 by the application of different types of nitrogenous fertilizers. Tanko and Yusuf (2015) reported that the highest numbers of branches were found at all the sampling stages of brinjal (*S. melongena*) when 200 kgN ha⁻¹ of fertilizer was applied.

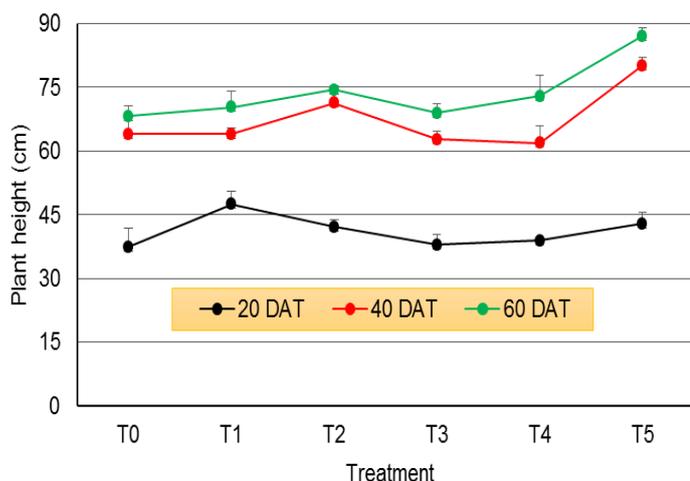


Figure 2. Effect of different levels of nitrogen on plant height of brinjal (*S. melongena*) at different days after transplanting.

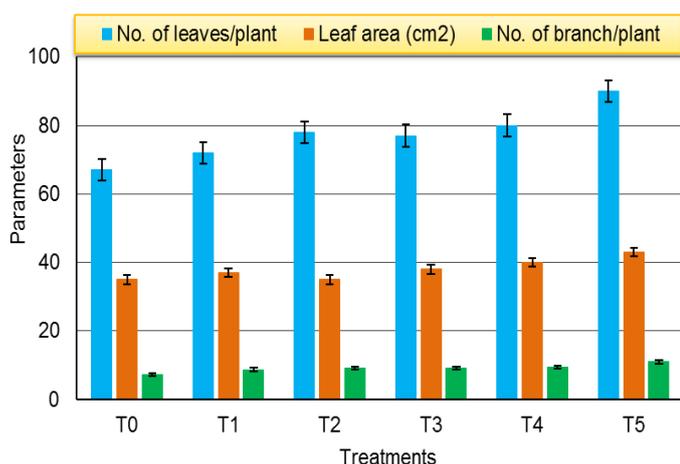


Figure 3. Effect of different levels of nitrogen on different growth parameters of brinjal (*S. melongena*).

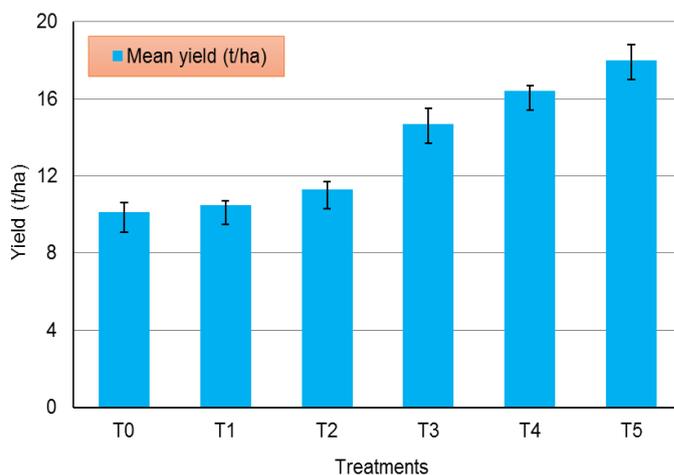


Figure 4. Effect of different levels of nitrogen on yield of brinjal (*S. melongena*).

Effect of nitrogen on reproductive and yield characteristics of brinjal

Effect of different levels of nitrogen on number of flower cluster plant⁻¹, number of flowers plant⁻¹, number of fruits plant⁻¹, fruit length and fruit weight of brinjal (*S. melongena*) were statistically significant at 1% level of probability, while the fruit diameter was significant at 5% level of probability (Table 1).

The maximum number of flower cluster plant⁻¹ (12.33) was recorded from the treatment T₄, which was statistically at par with the treatment T₅. On the other hand, the minimum number of flower cluster plant⁻¹ (7.25) was obtained from the treatment T₁. Similarly, the highest number of flowers plant⁻¹ (17.05) was found from the T₅ treatment but the lowest number of flowers plant⁻¹ (11.25) was found from the control treatment. The present study results illustrate that the significant highest mean values of number of flowers plant⁻¹ was obtained by application of urea at the rate of 375 kg ha⁻¹. This result is in agreement with the report of Mirdad (2011), who stated that the eggplant plants responded well to fertilization by using high levels of nitrogen, and gave the most favorable performances for all studied characters.

The application of different levels of nitrogen significantly affected the numbers of fruits plant⁻¹ and fruit length of brinjal (*S. melongena*) (Table 1). The highest numbers of fruits plant⁻¹ and fruit length (10.00 and 25.05 cm, respectively) was recorded from the highest dose of urea (i.e. T₅ treatment) while the lowest numbers of fruits plant⁻¹ and fruit length (6.33 and 20.25 cm, respectively) was obtained from the control treatment. It is apparent from Table 1 that numbers of fruits plant⁻¹ and fruit length of brinjal (*S. melongena*) increased with the increasing rates of nitrogen. Thus, it can be inferred from the present study that the productivity of brinjal (*S. melongena*) is highly responsive to the additional added nitrogen. Furthermore, it has been reported that a sufficient supply of various nitrogenous compounds is required in each plant cell for its proper functioning (Mengel and Kirkby, 1987). On the other hand, fruit diameter and fruit weight of brinjal (*S. melongena*) ranged from 5.75-8.10 cm and 78.00- 98.05 g, respectively, and the highest fruit diameter and weight were recorded from the T₅ treatment. This result is concomitant with Aujla *et al.* (2007) who also reported

that increasing the rate of nitrogen fertilizer increased the average fruit weight and fruit volume. Similarly, Mirdad (2011) reported that increasing the application of nitrogen to the grown plants, irrespective of the used amount up to 300 kg N ha⁻¹, significantly increased all reproductive and yield components of brinjal (*S. melongena*). Akanbi *et al.* (2007) reported that nitrogen fertilizer affected seed number, fruit pH, crude protein, total solid and ascorbic acid of eggplant and nitrogen deficiencies reduced both physical and chemical properties of fruits.

Effect of nitrogen on yield of brinjal

The application of different levels of nitrogen significantly affected the yield of brinjal (*S. melongena*). The highest yield (18.0 ton ha⁻¹) was obtained from the application of T₅ treatment, while the lowest yield (10.1 ton ha⁻¹) was found from the control treatment (Figure 4). It is apparent from Figure 4 that similar to different yield contributing characters, yield of brinjal (*S. melongena*) increased with the increasing rates of urea. Thus, it can be inferred from the present study that the productivity of brinjal (*S. melongena*) is highly responsive to the additional added nitrogen. The response of additional nitrogen may be due to the fact that plant produce more leaves would have increased photosynthetic area and hence better performance in terms of yield. This result is in agreement with Wange and Kale (2004) who reported that significant improvement in yield (74%) of eggplant occurred due to over recommended rate of N fertilizer. Pal *et al.* (2002) reported that eggplant fruit yield increased with increase in nitrogen up to 187.5 kg ha⁻¹. Results concerning the fruits yield of brinjal (*S. melongena*) obtained by the present study, are in general agreement with the reports published by Mirdad (2011) and Aujla *et al.* (2007), and they also revealed that fruits yield increased significantly with increasing nitrogen levels. Similar observation was also reported by Mohammad *et al.* (2010), who stated that nitrogen is found to promote growth and increases biomass production, and nitrogen fertilization has been used to increase growth and yield of eggplant. On the other hand, Devi *et al.* (2002) found better fruit girth, fruit weight and fruit yield level of eggplant with the application of 120 kg N ha⁻¹.

Table 1. Effect of different levels of nitrogen on reproductive and yield characteristics of brinjal (*S. melongena*).

Treatment	No. of flower cluster plant ⁻¹	No. of flowers plant ⁻¹	No. of fruits plant ⁻¹	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
T ₀	8.10	11.25	6.33	20.25	6.00	78.00
T ₁	7.25	13.00	6.50	21.33	5.75	80.10
T ₂	7.50	12.75	7.00	21.50	6.05	81.33
T ₃	10.05	14.00	7.25	22.05	6.50	84.67
T ₄	12.33	16.10	9.33	23.10	7.00	83.33
T ₅	12.25	17.05	10.00	25.05	8.10	98.05
CV (%)	6.70	6.80	6.15	4.26	6.49	2.85
SE (mean)	0.67	0.53	0.43	0.63	0.31	1.40
Level of significance	**	**	**	**	*	**

** = Significant at 1% level of probability; * = Significant at 5% level of probability.

Conclusion

This investigation concluded that the brinjal (*S. melongena*) fruit yield and yield contributing characters showed significant positive influence with the increasing rates of urea. The highest fruit yield of brinjal (*S. melongena*) was recorded from the application of 375 kg ha⁻¹ urea, while the lowest yield was found from the control treatment. Hence, the present study results suggested that 375 kg ha⁻¹ urea performed the best in context Agriculture Research Field soils of IUBAT, Uttara, Dhaka. However, fertilizer recommendation in future should be site, location and variety specific. The study finally concluded that before final optimization of the application dose, further study is needed in different seasons and agro-ecological zones of Bangladesh.

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