Effects of nitrogenous fertilizer on growth and yield of Mustard Green

Shagata Islam Shorna1, Mohammed Arif Sadik Polash1, Md. Arif Sakil2, Moshtari Afrin Mou3, Md. Abdul Hakim1, Akash Biswas1 and Md. Alamgir Hossain1*

1Plant Physiology Lab, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202
2Food Biochemistry Lab, Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh-2202
3Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202

*Corresponding Author: alamgir.cbot@bau.edu.bd [Accepted: 15 February 2020]

Abstract: Nitrogenous fertilizer is a good source of nutrients for soil that implies a positive effect on growth, development and yield of vegetables when applied at optimal doses. Considering this fact, the present research was designed to study the effect of different levels of nitrogenous fertilizer (from urea source) on the growth and yield of mustard Green. A split-plot layout within randomized complete block design (RCBD) with 4 treatments and 3 replications was used. The analysis of variance (ANOVA) showed T3 (150 kg urea ha⁻¹) and T2 (100 kg urea ha⁻¹) was statistically insignificant. However a significant difference was noticed with T1 (50 kg urea ha⁻¹) and T0 (control) in shoot height, leaf area, shoot fresh weight, number of primary branches per plant, number of secondary branches per plant, number of siliqua per plant, number of seeds per siliqua and finally seed yield per hectar. The results revealed that the application of 100 kg urea ha⁻¹ were judicial for commercial mustard green production at Bangladesh Agricultural University experimental farm.

Keywords: Nitrogenous fertilizer - Mustard green - Leaf area - Shoot fresh weight - Yield.

INTRODUCTION

Cultivation of vegetables has been a ritual for centuries throughout the world. Vegetables are very crucial food commodity, playing a significant role in meeting vitamins, minerals, fiber and protein requirements as well as assist as a steady source of income generation for farmers (Torrefiel 2006, Gonzales et al. 2015). Actually, growing vegetables is comparatively profitable than other field crops, because growers can harvest more vegetables from a small area in a very short period of time.

In this context, a newly introduced foliar type Mustard green (Brassica juncea L.), rather than Oleiferous type could be the fittest vegetable in Bangladesh (Burton et al. 1999). The foliage type Mustard green is believed to originate in the Himalayan region of India and has been consumed for more than 5,000 years ago. Recently in Africa and many parts of Asia, the fully expanded tender leaves are eaten as vegetables; they are often shredded, cooked and served as a side dish with the staple food. Aside, higher production appends more income to farmers (Gonzales et al. 2015). So it can play a significant role in the economy of Bangladesh along with meeting the nutritional requirements of its people.

Fertilizers are indispensable to attain commercial vegetable production and most common cultural practices in the globe. Masarirambji et al. (2010) reported that the commercial and subsistence farming has been and is still bank on the use of inorganic fertilizers. This is in favor of, they are easy to apply, promptly absorbed and utilized by crops. Among inorganic fertilizers, nitrogenous fertilizers are the most commonly used by the farmers. In addition to supply nutrients, it also able to improve the physical, chemical and biological properties of the soil which could considerably boost the growth, development and yield of plants (Allen & Morgan 1972,
Nitrogen is an important nutrient element that provides lush green color in crop (due to increase in chlorophyll), development of canopy (Cheema et al. 2001a), thus increasing total leaf area and leaf area index (LAI) up to an optimal value (Allen & Morgan 1972, Scott et al. 1973, Cheema et al. 2001b). Plant height and above-ground biomass are focal contributing factors to crop lodging rates, which can be intensified by nitrogen application (Conley et al. 2004, Kausar et al. 2017). Oilseed rape has a strong exigency for nitrogen because of the high level of nitrogen in leaves, stems, siliqua, and seeds (Rathke et al. 2005, Svečnjak & Rengel 2006). Besides, the production is usually enhanced by applying nitrogen to the Brassicaceae family (Asare & Scarisbrick 1995, Patel et al. 1996, Wang et al. 2014, Ferguson 2015). However, excess application of nitrogenous fertilizers beyond a certain limit induced lodging and eventually lessened grain yield and its components. Therefore, the present research work was designed to determine the optimal doses of nitrogen fertilizers for commercial production of mustard green in Bangladesh.

MATERIALS AND METHODS
Seed of mustard green and urea were the experimental materials. Mustard green seeds were collected from Department of Crop Botany, Bangladesh Agricultural University and urea from local market in Mymensingh.

Details of the experimentation
The experiment was conducted at Plant Physiology field laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh from December 2016 to March 2017. Twelve plots (4 m² each) were used in this experiment, laid out in Randomized Complete Block Design (RCBD) with four treatments and three replications. The treatments were T0= control (0 kg urea ha⁻¹), T1= 50 kg urea ha⁻¹, T2= 100 kg urea ha⁻¹ and T3= 150 kg urea ha⁻¹. 50 percent urea was applied as a basal dose (except control plot) during land preparation and seed were shown manually at a spacing 25 cm × 30 cm. Rest urea was applied at 20 DAS. Crop(selected and tagged) was harvested twice, once at 30 DAS (vegetable production) and another at during maturity (Seed production). Relevant data were taken when required.

Shoot height (SH)
Randomly selected and tagged plants was assessed by measuring SH from shoot base to the leaf tip at 30 DAS and from shoot base to the tip of the main inflorescence at maturity by a meter scale.

Leaf area (LA)
Randomly selected and tagged plants were used for measuring LA by LI-3100 Area Meter at 30 DAS.

Shoot fresh weight (SFW)
SFW was recorded at 30 DAS and maturity as well. Randomly selected and tagged plants were uprooted and cut at shoot base position and then SFW was taken by electric weight machine at both harvest.

Number of branches per plant
The number of primary and secondary branches from selected and tagged plants of each treatment and replications were counted manually at maturity.

Number of siliqua per plant
The number of siliqua per plant from selected and tagged plants of each treatment and replications were counted manually at maturity.

Number of seeds per siliqua
The number of seeds per siliqua from selected and tagged plants of each treatment and replications were counted manually at maturity.

Seed yield (SY)
SY was calculated at maturity by the following equation

\[ Seed \ yield \ (kg \ ha^{-1}) = \frac{Plants}{Unit \ area} \times \frac{Branches}{Plants} \times \frac{Siliqua}{Branches} \times \frac{seeds}{Siliqua} \times \frac{weight}{seeds} \]

Statistical analysis
The collected data were statistically analyzed by using Minitab 17. Tukey’s LSD test was applied to compare the treatments means at 0.05 level of confidence. Significant differences among treatments means were determined using the Duncan Multiple Range Test (DMRT).

www.tropicalplantresearch.com
RESULTS

Shoot height (SH)

Figure 1. Effects of nitrogenous fertilizer (urea) on shoot height of Mustard green at: A, 30 DAS; B, Maturity. [T0= Control (0 kg urea ha\(^{-1}\)); T1= 50 kg urea ha\(^{-1}\); T2= 100 kg urea ha\(^{-1}\); T3= 150 kg urea ha\(^{-1}\). The vertical bars represent the mean ± SE (Standard Error)]

Shoot height (SH) showed a significant difference among the treatments at 30 DAS and maturity as well (Fig. 1A & 1B). The tallest shoot was found at T3 in both 30 DAS (46.33±2.03 cm) and at maturity (136±5.57 cm) followed by T2 at 40.67±1.76 and 126.67±3.35 cm respectively. The shortest was observed in T0 in both 30 DAS (25.67±1.86 cm) and at maturity (57±1.15 cm).

Leaf area (LA)

Figure 2. Effects of nitrogenous fertilizer (urea) on leaf area of mustard green at 30 DAS. [T0= Control (0 kg urea ha\(^{-1}\)); T1= 50 kg urea ha\(^{-1}\); T2= 100 kg urea ha\(^{-1}\); T3= 150 kg urea ha\(^{-1}\). The vertical bars represent the mean ± SE (Standard Error)]

Being a leafy vegetable, leaf area (LA) of mustard green is an important parameter. LA at 30 DAS showed a significant difference among the treatments (Fig. 2). Here, T3 showed the highest LA (203±7.11 m\(^2\)) followed by T2 (200.77±12.4 m\(^2\)). The result also revealed the significant drop of LA at 41% and 61% in T1 and T0 respectively, in contrast to T3.

Shoot fresh weight (SFW)

Figure 3. Effects of nitrogenous fertilizer (urea) on shoot fresh weight of mustard green at both 30 DAS and maturity. [T0= Control (0 kg urea ha\(^{-1}\)); T1= 50 kg urea ha\(^{-1}\); T2= 100 kg urea ha\(^{-1}\); T3= 150 kg urea ha\(^{-1}\). The lines represent the mean ± SE (Standard Error)]
The graph (Fig. 3) showed that shoot fresh weight (SFW) was the highest (166.66±10.92 g) at T3 whereas the lowest at T0 (46.33±8.14 g) at 30 DAS. The SFW of T2 and T1 was at 161.33±10.17 and 101.66±20.83 g respectively. In case of mature plant the maximum (79.97±6.38 g) SFW was obtained at T3 followed by T2 (76.5±10.41 g). Same as before T0 showed the lowest (26.62±1.08 g) value.

Number of primary branches per plant

Apparently, there was no significant difference in the number of primary branches per plant among the treatments (Table 1). Table 1 showed the maximum primary branches per plant at both T3 (9±0.57) and T2 (9±1.52) followed by T1 (8±0.57). On the other hand, T0 demonstrated the minimum (7±1) primary branches per plant.

Table 1. Number of primary and secondary branches, number of siliqua per plant, number of seeds per siliqua and seed yield at different treatments.

| Treatments | No. of primary branches | No. of secondary branches | No. of siliqua per plant | No. of seeds per siliqua | Seed yield (kg ha⁻¹) |
|------------|-------------------------|---------------------------|--------------------------|--------------------------|---------------------|
| T0         | 7±1.00b                 | 1.33±.33a                 | 537.67±11.78b            | 18.67±.67b              | 140.00±4.93c        |
| T1         | 8±.57ab                 | 1.33±.33a                 | 601.00±5.86b             | 19.67±.88b              | 270.67±5.21b        |
| T2         | 9±1.52 a                | 1.66±.33a                 | 803.33±8.82a             | 22.67±.33a              | 327.33±3.71a        |
| T3         | 9±.57 a                 | 2.33±.33a                 | 878.00±38.16a            | 23.00±.58a              | 340.67±5.81a        |

Note: Values are presented as mean ± SE; Values marked with the same letter within the same columns do not differ significantly @ 5% level of probability. Here, T0= Control (0 kg urea ha⁻¹); T1= 50 kg urea ha⁻¹; T2= 100 kg urea ha⁻¹; T3= 150 kg urea ha⁻¹; SE= Standard Error.

Number of secondary branches per plant

The number of secondary branches per plant had no significant difference (Table 1). T3 showed the maximum (2.33±0.33) value followed by T2 (1.66±0.33). Both T1 and T0 showed the minimum (1.33±0.33) number of secondary branches per plant (Table 1).

Number of siliqua per plant

The number of siliqua per plant was the lowest (537.67±11.78) at T0. Siliqua per plant was increased at 11, 33 and 39% in T1, T2 and T3 respectively, when compared to the control (Table 1).

Number of seeds per siliqua

The lowest (18.67±0.67) number of seed per siliqua was observed at T0. The number of seed per siliqua was increased at 5, 18 and 19% in T1, T2 and T3 respectively, over the control (Table 1).

Seed yield (kg ha⁻¹)

The effects of nitrogen on seed yield (SY) showed a significant difference among the treatments (Table 1). SY was the maximum (340.67±5.81 kg) at T3 followed by the SY of T2 (327.33±3.71 kg). The lowest SY was obtained at T0 (140±4.93 kg). SY was increased at 48, 57 and 59% in T1, T2 and T3 respectively, in contrast of T0 (Table 1).

DISCUSSIONS AND CONCLUSION

Application of nitrogen is indispensable for crop production as it is an integral component of plant constituents such as proteins, amino acids, nucleotides, nucleic acids and chlorophyll content (Grant & Bailey 1990), which are involved in several metabolic processes influencing growth, yield and quality (Reddy & Reddy 1998, Dinesh et al. 2000). In the present study, we observed that the higher amount of nitrogenous fertilizer produces higher yield (Table 1) and growth (Fig. 1A, 1B, 2 & 3) as well.

Shoot height, leaf area and shoot fresh weight increased with the increasing of nitrogenous fertilizer both at 30 DAS and maturity (Fig. 1A, 1B, 2 & 3). The possible reason for increase in shoot height, leaf area and shoot fresh weight due to nitrogen, it induces cell division and multiplication, enhances cell elongation that strength the sink capacity which favors to acquire more photosynthesis (Evans 1983, Almaliotis et al. 1996, Danesh et al. 2008, Hunková et al. 2009). These results are alien with the findings of Kumar et al. (1997), Singh & Meena (2004), Kumar & Kumar (2008) and Ghodrat et al. (2012).

The number of branches per plant increased with the increasing amount of nitrogenous fertilizer (Table 1). It could be, increased nitrogen eventually improves protein availability and protoplasm formation thus helps in the mitotic division. Our findings justify the results of Imtiaz et al. (1992), Muse et al. (1994) and Danesh et al. (2008).

A higher rate of nitrogenous fertilizer increased the number of siliqua per plant (Table 1) which is similar to the findings of Bajpai et al. (1984), Bhatti et al. (1986) and Siadat et al. (2010). A number of seeds per siliquas
directly proportional to the increase of nitrogenous fertilizers. We found the highest seed per silique in T3 (table 1). The possible reason could be an increase in seed per silique due to nitrogen. This result is also consistent with that of Basak et al. (1990) and Singh & Meena (2004).

With each successive increment of nitrogen up to 150 kg urea ha$^{-1}$, the increase in seed yield was significant (Table 1). The possible reason for increase in seed yield is, to produce more number of branches per plant, siliqua per plant, seeds per siliqua and 1000 seed weight which could be positive effect of nitrogen as nitrogen is believed to help in cell division and expansion, strength sink capacity and acquire more photosynthate (Kumar et al. 2001, Awodun et al. 2007, Danesh et al. 2008, Ghodrat et al. 2012). A similar increase in seed yield with an increase in nitrogen doses was reported by Yadav et al. (2007).

From the analysis of variance (ANOVA) we found, T3 (150 kg urea ha$^{-1}$) and T2 (100 kg urea ha$^{-1}$) was statistically insignificant in all stated data while the rest T1 (50 kg urea ha$^{-1}$) and T0 (control) were showed significant difference. Apart from this result, excess nitrogen may volatile and/or leach out which is detrimental to the environment (Roosta & Schjoerring 2007, Gao et al. 2012). So the application of 100 kg urea ha$^{-1}$ is judicial for commercial mustard green production instead of other treatments.

Based on results 100 kg urea ha$^{-1}$ may be cost-effective and better for higher growth (vegetable purpose) and commercial seed production of mustard green among other treatments.

ACKNOWLEDGEMENTS

The authors are thankful to the Head, Department of Crop Botany, field assistances for immense support.

REFERENCES

Allen EJ & Morgan DG (1972) A quantitative analysis of the effects of nitrogen on the growth, development and yield of oilseed rape. The Journal of Agricultural Science 78(2): 315–324.

Almaliotis D, Therios I & Karatassiou M (1996) Effects of nitrogen fertilization on growth, leaf nutrient concentration and photosynthesis in three peach cultivars. In: II International Symposium on Irrigation of Horticultural Crops. pp. 529–534.

Asare E & Scarisbrick DH (1995) Rate of nitrogen and sulphur fertilizers on yield, yield components and seed quality of oilseed rape (Brassica napus L.). Field Crops Research 44(1): 41–46.

Awodun MA, Omonijo IJ & Ojeniyi SO (2007) Effect of goat dung and NPK fertilizer on soil and leaf nutrient content, growth and yield of pepper. International Journal of Soil Science 2(2): 142–147.

Bajpai RK, Pandey S & Patel JK (1984) Effect of irrigation and nitrogen fertilizer on grain yield of mustard. Advance Plants Science 5: 129–133.

Basak NC, Karim MMA & Zaman MW (1990) Performance of some rapeseed lines under two different fertilizer levels. Bangladesh Journal of Agricultural Research 15(1): 70–74.

Bhatti AU, Gurmani AH, Rehman H & Khattak JK (1986) Response of sarson to alone and combined application of N, P and K under DI Khan conditions [Pakistan]. Sarhad Journal of Agriculture 2(1): 251–256.

Burton WA, Pymer SJ, Salisbury PA, Kirk JTO & Oram RN (1999) September. Performance of Australian canola quality Brassica juncea breeding lines. In: 10th International Rapeseed Congress. pp. 113–115.

Cheema MA, Malik MA, Hussain A, Shah SH & Basra SMA (2001a) Effects of time and rate of nitrogen and phosphorus application on the growth and the seed and oil yields of canola (Brassica napus L.). Journal of Agronomy and Crop Science 186(2): 103–110.

Cheema MA, Saleem M & Malik MAA (2001b) Effect of row spacing and nitrogen management on agronomic traits and oil quality of canola (Brassica napus L.). Pakistan Journal of Agricultural Sciences 38: 15–18.

Conley SP, BordovskyD, Rife C & Wiebold WJ (2004) Winter canola survival and yield response to nitrogen and fall phosphorus. Crop Management 3(1): 1–8.

Danesh SA, Kashani A, Mesgarbashi M, Nabipour M & Koohi DM (2008) The effect of plant densities and time of nitrogen application on some agronomic characteristic of rapeseed. Agronomy and Horticulture 21(2): 10–17.

Dinesh K, Surendra S, Sharma SN & Shivay YS (2000) Relative efficiency of urea and dicyandiamide-blended urea on mustard (Brassica juncea) varieties. Indian Journal of Agronomy 45(1): 179–183.

Evans JRL (1983) Nitrogen and photosynthesis in the flag leaf of wheat (Triticum aestivum L.). Plant Physiology 72(2): 297–302.

Ferguson BT (2015) Spring nitrogen and cultivar effects on winter canola (Brassica napus L.) production in western Oregon. (Thesis). Oregon State University. Weed Science 54: 743–748.
Gao Y, Yu G, Luo C & Zhou P (2012) Groundwater nitrogen pollution and assessment of its health risks: a case study of a typical village in rural-urban continuum, China. PloS One 7(4): 33982.

Ghodrat V, Rousta MJ, Tadaion MS & Karampour A (2012) Yield and yield components of corn (Zea mays L.) in response to foliar application with indole butyric acid and gibberellic acid. American-Eurasian Journal of Agricultural & Environmental Sciences 12(9): 1246–1251.

Gonzales LMR, Caralde RA & Ahan ML (2015) Response of Pechay (Brassica napus L.) to Different Levels of Compost Fertilizer. International Journal of Scientific and Research Publications 5(2): 1–4.

Grant CA & Bailey LD (1990) Fertilizer management in canola production. In: Proceedings of National Canola Conference. Atlanta, Georgia, USA, April 2–6, 1990, pp. 122–159.

Hunková E, Živčák M, Brestič M & Malovcová L (2009) The leaf area index relation to production potential of winter oilseed rape genotypes (Brassica napus subsp. napus). Acta Fytotechnicaet Zootecnica 12(3): 76–80.

Imtiaz M, Raiz H, Anwar KH, Gulzar A & Ghulam CA (1992) Response of Brassica cultivars to fertilizer level under rain-fed condition. Pakistan Journalof Soil Science 11: 60–63.

Kausar S, Faizan S & Haneef I (2017) Nitrogen level affects growth and reactive oxygen scavenging of fenugreek irrigated with wastewater. Tropical Plant Research 4(2): 210–224.

Kumar A & Kumar S (2008) Crop growth rate and developmental characteristics of Indian mustard varvadan to varying levels of nitrogen and sulphur. Indian Journal of Agricultural Research 42(2): 112–115.

Kumar A, Singh DP & Singh B (2001) Effect of nitrogen application on partitioning of biomass, seed yield and harvest index in contrasting genotypes of oilseed brassicas. Indian Journal of Agronomy 46(1): 162–167.

Kumar S, Singh J & Dhingra KK (1997) Leaf-area index relationship with solar-radiation interception and yield of Indian mustard (Brassica juncea) as influenced by plant population and nitrogen. Indian Journal of Agronomy 42(2): 348–351.

Masarirambi MT, Hlawe MM, Oseni OT & Sibiya TE (2010) Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce (Lactuca sativa L.) ‘Veneza Roxa’. Agriculture and Biology Journal of North America 1(6): 1319–1324.

Muse M, Aadal NK, Shahzad MA, Chaudhry GA & Khalid AH (1994) Yield potential and co-relation studies of mustard as effected by varying fertilizer doses and row spacing. Pakistan Journalof Soil Science 11: 91–94.

Nekha T, Suma R, Anusree T & Manjunatha G (2019) Effect of fertilization of primary nutrients on pomegranate (Punica granatum L.) fruit productivity and quality. Tropical Plant Research 6(3): 424–432.

Patel RH, Meisher TG & Patel JR (1996) Analysis of growth and productivity of Indian mustard (Brassica juncea) in relation to FYM, nitrogen and source of fertilizer. Journal of Agronomy and Crop Science 177(1): 1–8.

Ramah K (2019) Enhancing the productivity of Maize - Blackgram cropping system through drip fertigation. Plants and Environment 1(1): 1–4.

Rathike GW, Christen O & Diepenbrock W (2005) Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (Brassica napus L.) grown in different crop rotations. Field Crops Research 94(2–3): 103–113.

Reddy CS & Reddy PR (1998) Performance of mustard varieties on alfisols of Rayalaseemaa region of Andhra Pradesh. Journal of Oilseeds Research 15: 379–380.

Roosta HR & Schjoerring JK (2007) Effects of ammonium toxicity on nitrogen metabolism and elemental profile of cucumber plants. Journal of Plant Nutrition 30(11): 1933–1951.

Scott RK, Ogunremi EA, Ivins JD & Mendham NJ (1973) The effect of fertilizers and harvest date on growth and yield of oilseed rape sown in autumn and spring. The Journal of Agricultural Science 81(2): 287–293.

Siadat SAE, Sadeghipour O & Hashemidezfouli AH (2010) Effect of nitrogen and plant density on yield and yield component of rapeseed. Journal of Crop Production 2(1): 49–62.

Singh A & Meena NL (2004) Effect of nitrogen and sulphur on growth, yield attributes and seed yield of mustard (Brassica juncea) in eastern plains of Rajasthan. Indian Journal of Agronomy 49(3): 186–188.

Svečnjak Z & Rengel Z (2006) Nitrogen utilization efficiency in canola cultivars at grain harvest. Plant and Soil 283(1-2): 299–307.

Sylvester-Bradley R, Stokes DT, Scott RK & Willington VBA (1990) A physiological analysis of the diminishing response of winter wheat to applied nitrogen - Theory. Aspects of Applied Biology 25: 227–287.

Torrefiel DB Jr (2006) Growth and yield performance of pechay (Brassica napus L.) as influenced by biogas digester effluent and rice hull ash application, (Undergraduate Thesis). Visca, Baybay. Leyte.
Wang Y, Liu B, Ren T, Li X, Cong R, Zhang M, Yousaf M & Lu J (2014) Establishment method affects oilseed rape yield and the response to nitrogen fertilizer. *Agronomy Journal* 106(1): 131–142.

Yadav R B, Singh R K & Singh H (2007) Response of Indian mustard (*Brassica juncea* L.) to nitrogen and sulphur in mid-western plain zone of Uttar Pradesh. *Indian Journal of Crop Science* 2: 243–244.