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Research article

Effects of nitrogenous fertilizer on growth and yield of Mustard Green

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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 hector. 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.

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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 indispensible to attain commercial vegetable production and most common cultural practices in the globe. Masarirambi *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,

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Sylvester-Bradley *et al*. 1990, Ramah 2019, Tanari *et al.* 2019).

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 m^2 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).

RESULTS

Shoot height (SH)

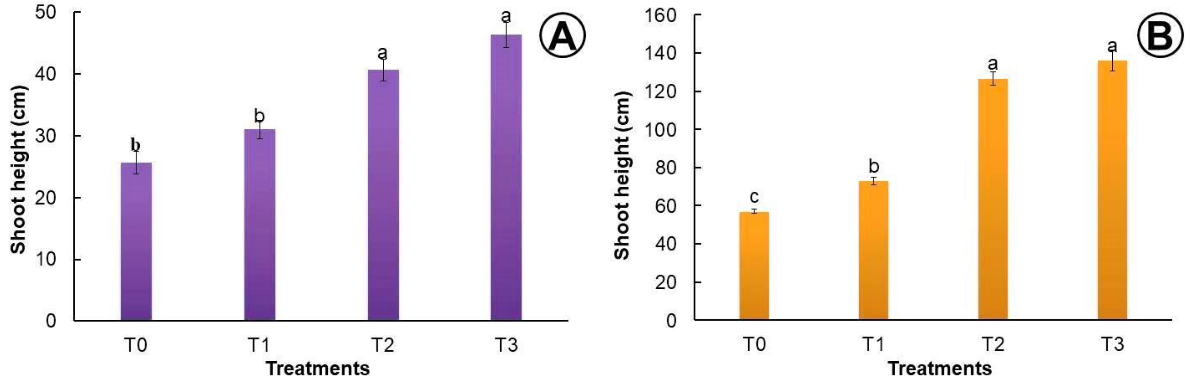

Figure 1. Effects of nitrogenous fertilizer (urea) on shoot height of Mustard green at: **A**, 30 DAS; **B**, Maturity. [T0= Control (0 kg urea ha^{-1}); T1= 50 kg urea ha^{-1}; T2= 100 kg urea ha^{-1}; T3= 150 kg urea ha^{-1}. The vertical bars represent the mean ± SE (Standard Error)]

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)

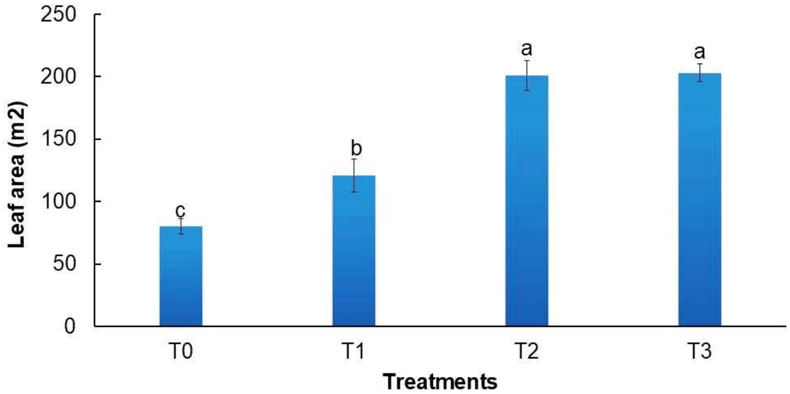

Figure 2. Effects of nitrogenous fertilizer (urea) on leaf area of mustard green at 30 DAS. [T0= Control (0 kg urea ha^{-1}); T1= 50 kg urea ha^{-1}; T2= 100 kg urea ha^{-1}; T3= 150 kg urea ha^{-1}. The vertical bars represent the mean ± SE (Standard Error)]

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)

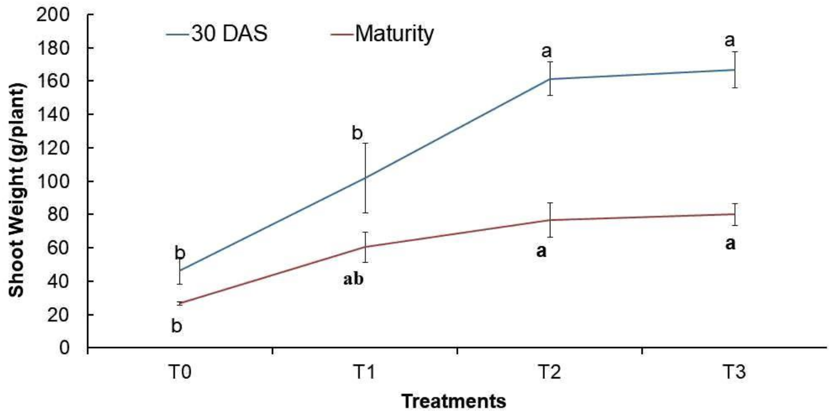

Figure 3. Effects of nitrogenous fertilizer (urea) on shoot fresh weight of mustard green at both 30 DAS and maturity. [T0= Control (0 kg urea ha^{-1}); T1= 50 kg urea ha^{-1}; T2= 100 kg urea ha^{-1}; T3= 150 kg urea ha^{-1}. The lines represent the mean ± SE (Standard Error)]

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).

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 siliquaper 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 siliquais directly proportional to the increase of nitrogenous fertilizers. We found the highest seed per siliqua in T3 (table 1). The possible reason could be an increase in seed per siliqua 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.

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