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EFFECT OF DIFFERENT DOSES OF NITROGEN FERTILIZER (UREA) ON THE YIELD PERFORMANCE OF MUSTARD (*Brassica* sp.)

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ABSTRACT

An experiment was conducted at the agriculture research field of Noakhali Science and Technology University, Noakhali-3814, Bangladesh during the period 1st November 2021 to 30 January 2022 to observe the effect of different levels of nitrogen (N) fertilizer on growth and yield of mustard. The experiment comprised four levels of nitrogenous (N) fertilizer viz; control (N_0) 0 kg ton ha^{-1}, (N_1) 90 kg ton ha^{-1}, (N_2) 140 kg t ha^{-1}, (N_3) 190 kg t ha^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Application of different levels of nitrogen significantly influenced the Plant height (cm), branches $plant^{-1}$ (no.), effective siliqua $plant^{-1}$ (no.), seeds siliqua (no.), 1000-seed weight (g), grain yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}), harvest index (%) content of mustard. Application of 190 kg ha-1 nitrogen gave the maximum plant height (77.83 cm), Branches plant-1 (5.80), Effective siliqua plant-1 (23.60), Siliqua length (6,17 cm), Seeds siliqua (33.87), 1000-seed weight (3.57 g), grain yield (1.53 t ha-1), Stover yield (3.90 t ha-1), Biological yield (5.43 t ha-1) and the lowest yield was found from control (N_0) 0 kg ton ha-1. Consequently, 'BARI SARISHA-14' may be suggested to grow for higher yield with N_3 treatment.

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INTRODUCTION

Bangladesh, a country in South Asia with a large population, is 1,47,570 square kilometres in size and is located between 20°34' and 26°38' north latitude and 88°01' to 92°42' east longitude (Rashid, 2001). It shares borders with India on the West, North and East, Myanmar on the Southeast, and the Bay of Bengal on the South. Of the total geographic place of Bangladesh, agricultural land makes up 59.8% (BBS, 2018). Bangladesh is predominantly an agrarian country in the world. It has very fertile land and favourable weather, so varieties of crops grow abundantly in this country. Agricultural sector contributes about 13.02 % (P) FY 2019-20 to the Country’s Gross Domestic Product (GDP) and employs about 40.60 % of total labour force (BBS, 2021). The cultivation of mustard (*Brassica spp*. L) dates back to 1200 B.C. and is a crop that was first grown in Asia, Europe, and maybe Africa. About 97% of the world's exports of mustard seed come from Canada, which is the top producer in the world (Man and Weir, 2009). During 2007–2008, Bangladesh produced 431078 and 153588 metric tonnes, respectively, of rapeseed and mustard. Brassica oilseed production in Bangladesh typically yields 356 kg/acre (BBS, 2008). In 2008 to 2009, the world is expected to produce 50 million tonnes of mustard seeds, up from 49 million tonnes in 2007, when 20 million tonnes of mustard oil were produced (SMDC, 2009). Bangladesh is home to a large number of edible oil seed crops. However, the country's acute edible oil shortage is getting worse every year as a result of population expansion. The majority of Bangladeshis are malnourished due to a severe protein and calorie scarcity. The seed contains up to 46–48% oil, while seed meal contains 43.6%.The protein content of mustard is 24.94 g (USDA, 2005). The family is home to many economically significant species that produce a significant portion of the world's winter vegetables. Mustard is a cool-season crop with a condensed growing period. The yield of mustard seed per acre is significantly lower than that of other emerging nations' key oil-producing crops. Omega-3 fatty acids, manganese, and selenium are all nutrients that can be found in abundance in mustard seeds. Additionally, they are a good source of vitamin B1, cobalt, phosphorus, and magnesium.

Post predicts rapeseed or mustard planting area at 630 thousand hectares and production at 820 thousand MT for MY 2022-2023 based on DAE agricultural production data. Post projects that the MY 2021–2022 mustard crop will cover 610 thousand hectares and produce 800 thousand MT, increasing by 144% and 248%, respectively (USDA 2022). Due to a lack of market transparency and Russia's invasion of Ukraine, edible oil prices have been rising and are currently becoming more erratic. When compared to local soybean production, Post predicts that MY 2022–2023 soybean imports will reach 2.8 million MT. Both India and Nepal are receiving soybean meal exports from Bangladesh. Post updated its figures for rapeseed to include information on both rapeseed and mustard's production, marketing, and consumption (FA0, 2022). Mustard is the principal oilseed crop of Bangladesh that covers more than 60% of the total oil seed area. At present, the local production of edible oil meets only 25% of the country’s requirement. When compared to other mustard-growing nations throughout the world, Bangladesh's average output is quite poor at only 700 kg/ha (BBS, 2006). They typically control their own fertilizer usage while growing native cultivars, primarily Tori-7. Farmers generally apply lower amount of NPK. But these nutrient elements are crucial for plant growth and development.

Nitrogen is a crucial nutrient that contributes to the development of the canopy and rich green colour of the crop (owing to an increase in chlorophyll) (Ali et al., 2023; Ali et al., 2022a Ali et al., 2022b; Cheema et al*.,* 2001a), bringing the leaf area index (LAI) and total leaf area to their ideal levels (Allen and Morgan, 1972; Scott et al*.* 1973; Cheema et al. 2001b). Crop lodging rates are primarily influenced by plant height and above-ground biomass, which can be exacerbated by excessive nitrogen application (Conley et al., 2004; Kausar et al., 2017). Because of the high levels of nitrogen in its leaves, stems, siliques, and seeds, oilseed rape has a substantial demand for nitrogen (Rathke et al. 2005; Svečnjak and Rengel, 2006). In addition, nitrogen is frequently added to the Brassicaceae family to increase yield (Asare and Scarisbrick, 1995; Patel *et al.* 1996, Wang et al., 2014, Ferguson, 2015). However, overuse of nitrogenous fertilisers caused lodging after a certain point and finally reduced grain production and its constituent parts. Therefore, the goal of the current research project was to establish the ideal nitrogen fertiliser dosages for Bangladesh's commercial mustard green production. There is several research works has done all over the world in different aspects but not specifically done in that coastal region of Bangladesh. Therefore, the main goal of the research is to determine the optimum dose of nitrogenous fertilizer on yield performance of mustard cv. BARI-14 of mustard.

METHODOLOGY

Description of the Experimental Site

Duration

The experiment was conducted at the agriculture research field of Noakhali Science and Technology University, Noakhali-3814, Bangladesh during the period last week of October 2021 to mid-January 2022.

Location

The research had been carried out at Agriculture research field of Noakhali Science and Technology University, Noakhali-3814, Bangladesh. Geographically the experimental field was located in between 22°07’ and 23°08’ north latitudes and in between 90°53’ and 91°27’ east longitudes.

Soil

The experimental field belongs to the agro ecological zone of the AEZ-18: Young Meghna Estuarine Floodplain. This area is located on young alluvial ground that borders and is adjacent to the Meghna estuary. With very low ridges and wide depressions, it is nearly level. The predominant soils are deep, calcareous silt loams and silty clay loams that range in colour from grey to olive and are stratified throughout or at shallow depths.

Climate

The experimental area is under a subtropical climate characterized by a hot season with high humidity from April to June, a hot humid monsoon season with heavy rainfall from June to October, and a relatively cool and dry winter season from November to March.

Experimental Treatments

Four levels of nitrogen (Urea) were used as a treatment in this experiment. The treatment is as follows: N_0=0 kg ha-^{1}, N_1=90 kg ha-^{1}, N_2=140 kg ha-^{1}, N_3=190 kg ha-^{1}

Seed collection

Seeds of mustard variety (BARI Sarisha14) were collected from Bangladesh Agricultural Development Corporation (BADC), Noakhali. Healthy seeds were selected by following the standard method.

Preparation of experimental land

The soil of the experimental land was first opened on 18 October 2021 with the help of a tractor-drawn disc plough; later on, 22 October 2021, the land was irrigated and prepared by three successive ploughing and cross ploughing. After ploughing and laddering, all kinds of uprooted weeds and previous crop residues were removed from the field. After the final land preparation, the field layout was made on 23 October 2021.

Fertilizer application

The plots were fertilized with triple super phosphate (TSP), muriate of potash (MOP), and gypsum at the rate of 120, 60, and 60 kg ha-^{1}, respectively. The whole amount of TSP, MOP, and gypsum were applied at the time of final land preparation. The urea was applied according to treatment of the experiment at the rate of 30, 47.6, 63.3 kg ha^{-1} in the equal installments at 15, 30 and 45 DAS.

Sowing of seeds

Seeds of mustard were sown as (25 cm apart rows at the rate of 11 kg ha^{-1}) on the 25th October 2021 in 2-3 cm deep furrows made by hand rake keeping. After placement of seeds in furrow, seeds were covered with soil followed by a light pressure by hand.

Emergence of seedlings

Seedling emergence started after 3 days and completed within 7 days of sowing.

Intercultural operations

Gap filling

After emergence of seedlings, a minor gap filling was done as and where necessary using the seedling from where densely populated or separated tillers from the previous source as per treatment.

Weeding

The crop was infested with some weeds during the early stage of crop establishment. Two hand weeding were done at 20 DAS and 35 DAS.

Irrigation and Drainage

Irrigation was applied three times at 15, 25 and 45 DAS for all experimental plots equally. Besides, the drainage of extra water was done during heavy rainfall.

Plant protection measures

Plants were infested with leaf rust (*Alternaria Brassicae*) to some extent which was successfully controlled by applying Robral (0.2%) @ 10 ml / 10 litres of water for 5 decimal lands. The crop was protected from birds during the grain-filling period. Controlling the bird's watchman was deep-laid, especially during morning and afternoon.

Harvesting and post-harvest operation

The maturity of the crop was determined when 90% of the grains became ripen. Harvesting was done on 30 January 2022. Five hills per plot were preselected randomly from which different growth and yield attribute data were collected and 1m² areas from a middle portion of each plot were separately harvested and bundled, properly tagged, and then brought to the threshing floor for recording grain and straw yield. Threshing was done by hand beating or using a pedal thresher. The grains were cleaned and sun-dried to a moisture content of 12- 14 % approximately. Straw was also sun-dried properly.

Sampling and data collection

During the experiment, data on the following parameters were collected from the sample plants. For data collection, five plants were chosen at random from each plot unit. Observations were recorded for 10 different characteristics related to vegetative, yield and quality attributing traits.

Statistical analysis

The resulting data was analyzed by using IBM SPSS statistical software, version 26 and the figures were produced by Microsoft Excel, 2020. The means of all studied parameters were adjusted by Duncan’s Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Effect of nitrogen on plant height

Plant height was found to be increased significantly with the increase in nitrogen level up to 190 kg N ha^{-1}. The maximum plant height (77.83 cm) was observed with the application of N_3 treatment where which was statistically identical with N_2 treatments. The shortage plant height (39.4 cm) was found in control treatment. The result showed that nitrogen boosts mustard growth, resulting in the longest plants (Figure 1). Similar results were found by some researcher in their experiment. They used T_3 (150 kg N ha^{-1}), T_2 (100 kg N ha^{-1}), T_1 (50 kg N ha^{-1}) and T_0 (0 kg N ha^{-1}) treatments. They noticed the highest plant height with the application of T_3 (150 kg N ha^{-1}) and T_2 (100 kg N ha^{-1}) treatments (Shorna et al., 2020).

Effect of nitrogen on branch plant^{-1}

Application of nitrogen significantly increases the production of branch plant^{-1}. The application of nitrogen in treatment N_3 (190 kg ha^{-1} N) resulted in the maximum number of branches 5.80 by application of N_2 (140 kg ha^{-1} N) treatment which was 5.06 and N_1 (90 kg ha^{-1} N) treatment which was 4.50 respectively. The minimum number of branches was found at N_0 treatment which was 1.17. According to the observation, the number of branches increase as the degree of nitrogen application increased. Because nitrogen fertilizer promotes mustard growth, the maximum number of branches plant^{-1} was recorded for the highest quantity of nitrogen (Figure 2). Similar findings were observed by a group of researcher from their experiment. They used five doses (0, 50, 100, 150, and 200 kg N ha^{-1}) and they indicated that 100 and 150 kg N ha^{-1} rate increased significantly the number of branch, yield and quality traits with regard to other N treatments (Mir et al., 2010).

Effect of nitrogen on effective siliqua plant $^{-1}$

The effective siliqua plant^{-1} varied significantly to the application of different nitrogen levels. The highest siliqua plant^{-1} was 23.13 recorded in N_3 (190 kg ha^{-1} N) treatment and 18.40 which was recorded in N_2 (140 kg ha^{-1} N) treatment and 8.33 which was recorded in N_1 (90 kg ha^{-1} N). The maximum siliqua plant^{-1} was recorded 23.13 in N_3 treatment. The lowest siliqua plant^{-1} was recorded 4.63 recorded in N_0 (0 kg N ha^{-1}) treatment (Figure 3). Similar kind result found by a group of researcher from their study. The N and S were used together. The increase in N uptake under (40, 60, and 80 kg N ha^{-1}) the siliqua plant^{-1} increased. Nitrogen @80 kg ha^{-1} and S @60 kg ha^{-1} significantly increase siliqua plant^{-1} (Singh et al., 2004).

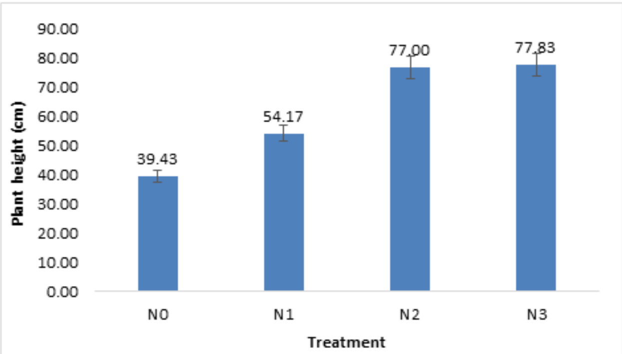

Figure 1. Effect of nitrogen on plant height of mustard. (Legends: N0=0 kg N ha-1 , N1=90 kg N ha-1,N2=140 kg N ha-1, N3=190 kg N ha-1)

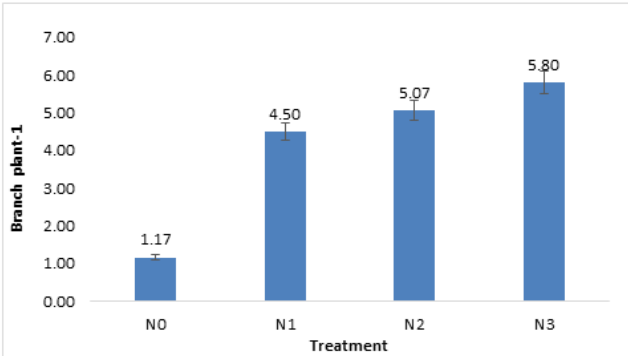

Figure 2.: Effect of nitrogen on branch plant-1 of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

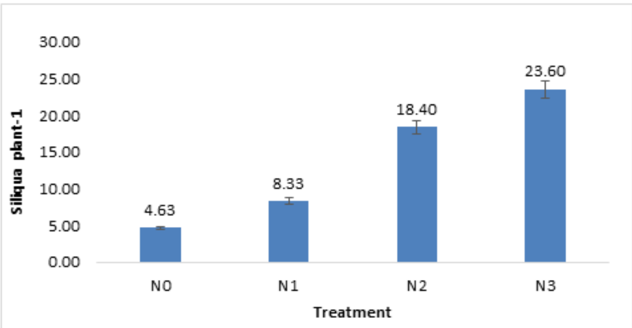

Figure 3. Effect of nitrogen on effective siliqua-1 of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

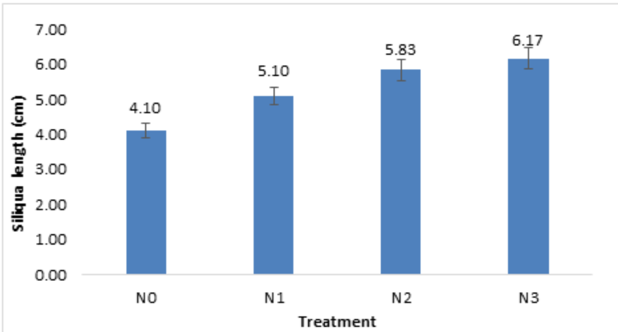

Figure 4. Effect of nitrogen on Siliqua length (cm) of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

Effect of nitrogen on Siliqua length (cm)

The result found non-significant from the statistical analysis. Siliqua length observed 4.10 cm by application of N_0 (control), 5.10 cm from N_1 (90 kg N ha^{-1}), 5.83 cm found from N_2 (140 kg N ha^{-1}) and 6.17 cm found from N_3 (190 kg N ha^{-1}). Siliqua length (cm) increased by the application of N fertilizer (Figure 4).

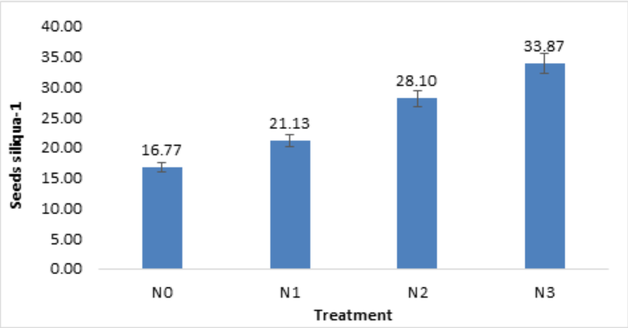

Figure 5. Effect of nitrogen on seeds siliqua-1 of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

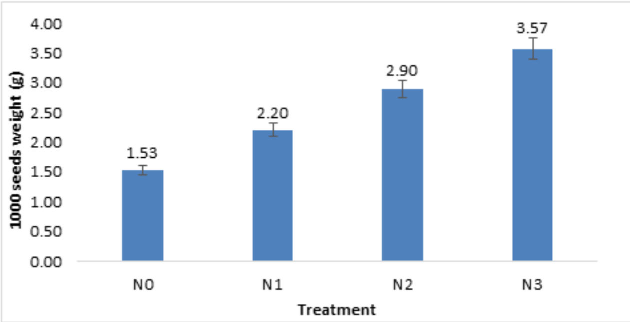

Figure 6. Effect of nitrogen on 1000-seeds weight (g) of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

Effect of nitrogen on seeds siliqua^{-1}

Application of nitrogen significantly increases the production of seeds siliqua^{-1}. The application of nitrogen in treatment N_3 (190 kg ha^{-1} N) resulted in the maximum number of seeds siliqua^{-1} 33.87, N_2 (140 kg ha^{-1} N) treatment which was 28.10 and N_1 (90 kg ha^{-1} N) treatment which was 21.13 respectively. The minimum number of seeds siliqua^{-1} were found at N_0 treatment which was 16.77. According to the observation, the number of seeds siliqua^{-1} increase as the degree of nitrogen application increased. Because nitrogen fertilizer promotes mustard growth, the maximum number of seeds siliqua^{-1} was recorded for the highest quantity of nitrogen (Figure 5). Similar findings were observed by some researcher from their experiment. They used different levels (40, 80 and 120 kg N ha^{-1}). Almost similar results were obtained in case of siliquae/plant, siliquae length, number of seed siliqua^{-1}, harvest index, oil and protein content in seed with the application of (120 kg N ha^{-1}) (Mahipat et al., 2014).

Effect of nitrogen on 1000-seeds weight (g)

The 1000 seeds weight 3.57 g was measured by N_3 (190 kg ha^{-1} N) and 2.90 g was counted by N_2 (140 kg ha^{-1} N) and 2.20 g was counted by (90 kg ha^{-1} N) and 1.53 g was counted by N_0 (control) treatment. The lowest weight was found from N_0 treatment. This finding show that nitrogen promotes growth, resulting in a high weight of grains than lower and control dose of nitrogen (Figure 6). The similar result was obtained a group of researchers. The thousand-seed weight (g) was significantly affected by nitrogen fertilization. The highest thousands seed weight were obtained for the crop utilized with (200 kg N ha$^{-1)}$ in plots with 80 plant m^{-2} (Keivanrad et al., 2012).

Effect of nitrogen on grain yield (t ha^{-1})

The different level of nitrogen application influence on the grain yield (t ha^{-1}) of mustard. The yield range of the present study varied from (1-1.53 t ha^{-1}). The maximum grain yield (1.53 t ha^{-1}) was observed from N_3 (190 kg N ha^{-1}) treatment followed by 1.30 t ha^{-1} from N_2 (140 kg N ha^{-1}) and (1.10 t ha^{-1}) from N_1 (90 kg N ha^{-1}) treatment respectively .The possible reason for such yield due to increase in the nitrogen level because nitrogen possess the vegetative growth which resulting the better yield (Figure 7). This finding is in partial or fully agreement with a group of researchers. The increase in N uptake under (40, 60, and 80 kg N ha^{-1}) respectively the number of seed increased. They found in their study the highest seed (2,109 kg N ha^{-1}) yield with (80 kg N ha^{-1}) (Singh et al., 2004).

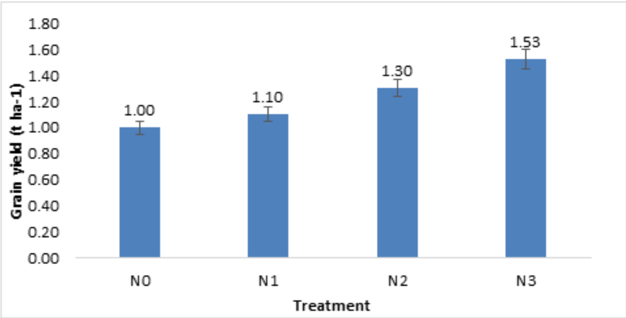

Figure 7. Effect of nitrogen on grain yield (t ha-1) of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

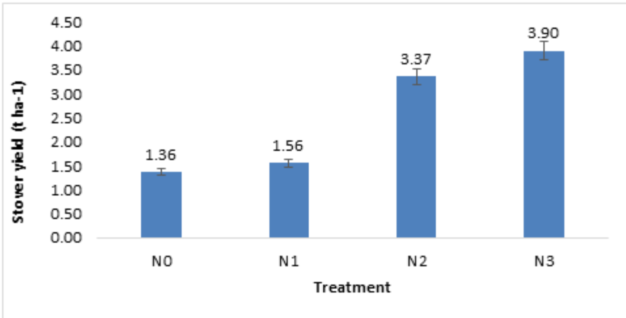

Figure 8. Effect of nitrogen on stover yield (t ha-1) of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

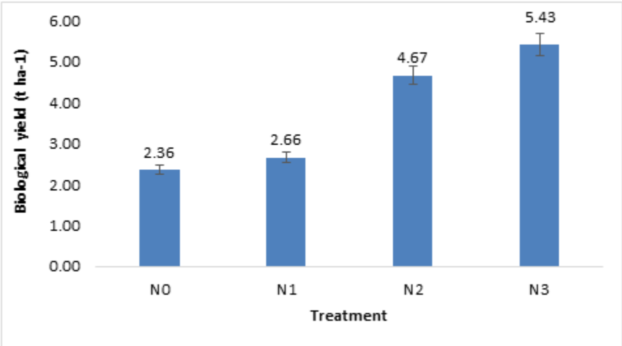

Figure 9. Effect of nitrogen on biological yield (t ha-1) of mustard. (Legends: N0=0 kg N ha-1, N1=90 kg N ha-1, N2=140 kg N ha-1, N3=190 kg N ha-1)

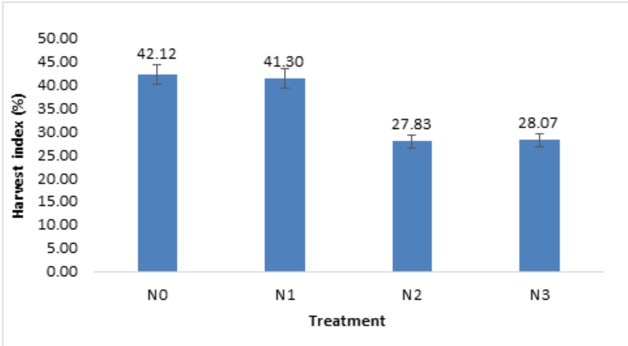

Figure 10. Effect of nitrogen on harvest index (%) of mustard. (Legends: N0=0 kg N ha-1 , N1=90 kg N ha-1 , N2=140 kg N ha-1 , N3=190 kg N ha-1)

Effect of nitrogen on stover yield (t ha^{-1})

The different level of nitrogen application influence on the stover yield (t ha^{-1}) of mustard. The yield range of the present study varied from (1.36-3.90 t ha^{-1}). The maximum stover yield (3.90 t ha^{-1}) was observed from N_3 (190 kg N ha^{-1}) treatment, (3.37 t ha^{-1}) from N_2 (140 kg N ha^{-1}) and (1.56 t ha^{-1}) from N_1 (90 kg N ha^{-1}) treatment respectively .The possible reason for such yield due to increase in the nitrogen level because nitrogen possess the vegetative growth which resulting the better yield (Figure 8). The same kind of result also found by some researchers from their experiment. There were three levels each of N (50, 75 and 100 kg N ha^{-1}) and the results revealed that the application of nitrogen at the rate of (100 kg N ha^{-1}) significantly increased the stover yield (Parmar et al., 2010).

Effect of nitrogen on biological yield (t ha^{-1})

The different level of nitrogen application influence on the biological yield (t ha^{-1}) of mustard. The yield range of the present study varied from (2.36-5.43t ha^{-1}). The maximum biological yield (5.43t ha^{-1}) was observed from N_3 (190 kg N ha^{-1}) treatment, 3.67 t ha^{-1} from N_2 (140 kg N ha^{-1}) and (2.66t ha^{-1}) from N_1 (90 kg N ha^{-1}) treatment respectively. The possible reason for such yield due to increase in the nitrogen level because nitrogen possesses the vegetative growth which resulting the better yield (Figure 9). A group of researchers, they got similar result in their experiment. Biological yield (kg ha^{-1}) of mustard plant was significantly affected by nitrogen fertilization. The highest biological yield (t ha^{-1}) was obtained for the crop utilized with (200 kg N ha^{-1}) in plots with 80 plant m^{-2} (Keivanrad et al., 2012).

Effect of nitrogen on harvest index (%)

The harvest index (%) was recorded to be the highest (42.11%) where N_0 (0 kg N ha^{-1}) was applied, (41.30%) was observed from N_1 (90 kg N ha^{-1}), (27.83%) was observed from N_2 (140 kg N ha^{-1}), (28.07 %) was observed from N_3 (190 kg N ha^{-1}) treatment (Figure 10). From these observations we found that harvest index decreases with the increase of N application. Same kinds of results are observed by a group of researchers. They used different levels (40, 80 and 120 kg N ha^{-1}) Harvest index increased with the application of (120 kg N ha^{-1}) (Mahipat et al., 2014).

CONCLUSION

Different levels of nitrogen doses significantly influenced all the parameters. Application of 190 kg ha^{-1} nitrogen gave the maximum plant height (cm), Branches plant-1 (no.), Effective siliqua plant-1 (no.), Siliqua length (cm), Seeds siliqua (no.), 1000-seed weight (g), Seed yield (t ha^{-1}), Stover yield (t ha^{-1}), Biological yield (t ha^{-1}). The result of the experiment revealed that the application of N3 (190 kg ha^{-1}) treatment gave the highest yield among the treatments. Therefore, the cv. 'BARI Sarisha-14' may be suggested to grow for higher yield with N_3 treatment. In saline condition if we maintain proper nitrogen dose, it will be possible to cultivate mustard in this area.

CONFLICT OF INTEREST STATEMENT

There is no conflict of research interest.

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