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EFFECT OF VARIOUS DOSES OF COWDUNG AND NITROGEN ON THE YIELD PERFORMANCE OF MUSTARD IN COASTAL AREA OF BANGLADESH (*Brassica sp.*)

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ABSTRACT

The experiment was conducted at the agriculture field laboratory of Noakhali Science and Technology University during the period from October 2021 to January 2022 to observe the effect of various doses of cowdung and nitrogen on the performance of mustard. The experiment comprised of two factors viz: cowdung and nitrogen. One organic fertilizer like different level of cowdung-control 0 t ha^{-1} (C_0), 15 t ha^{-1} (C_1), 30 t ha^{-1} (C_2), 45 t ha^{-1} (C_3) and another inorganic fertilizer nitrogen - control 0 kg ha^{-1} (N_0), 100 kg ha^{-1} (N_1), 200 kg ha^{-1} (N_2), 300 Kg ha^{-1} (N_3). The experiment was laid out in Randomized Complete Block Design (RBCD) with three replications. Application of different doses of cowdung and nitrogen significantly influenced the Plant height (cm), branches $plant^{-1}$ (no.), effective siliqua $plant^{-1}$ (no.), seeds $siliqua^{-1}$ (no.), 1000-seed weight (g), seed yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) of mustard. The maximum plant height, number of branches $plant^{-1}$, number of effective siliqua $plant^{-1}$, siliqua length, number of seeds $siliqua^{-1}$, 1000-seed weight, seed yield, stover yield, biological yield and harvest index was obtained with the application of 45 t ha^{-1} cowdung (C_3). On the other hand, with the application of 300 kg ha^{-1} N the maximum plant height, number of branches $plant^{-1}$, number of effective siliqua $plant^{-1}$, siliqua length, number of seeds siliqua, 1000-seed weight, seed yield, stover yield, biological yield was found except the harvest index. In case of interaction effect of treatment, the highest seed yield (1.77 t ha^{-1}) was obtained from the treatment combination of C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) and the lowest seed yield (0.93 t ha^{-1}) was found from the control (C_0N_0) treatment.

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INTRODUCTION

Mustard (*Brassica* sp.) is one of the most important oil seed crops throughout the world after soybean and groundnut. Bangladesh produces rapeseed (*Brassica Campestris*) and mustard (*Brassica Juncea*), but both are commonly known as "mustard." "Tori"and "shet" are rapeseed while "rai" is mustard; however, all are marketed and consumed as "mustard" in Bangladesh. The country also imports rapeseed and blends it with mustard during crushing and produces "mustard oil" for sale in the local market. Based on the DAE's crop production data, for MY 2022-2023, Post forecasts the rapeseed or mustard planting area at 630 thousand hectares and production at 820 thousand MT. Post estimates the MY 2021-2022 mustard harvested area at 610 thousand hectares and production at 800 thousand MT, up 144 percent and 248 percent (USDA, 2022). Post's estimate for mustard production is 787 thousand hectares, up 242 percent over the USDA estimate. Bangladesh is suffering from acute shortage of edible oil in terms of domestic production. About two thirds of the total edible oil consumed in the country is imported. Edible oil prices have been trending higher and are now increasingly volatile due to poor market transparency and the Russian invasion of Ukraine. Bangladesh is exporting soybean meal to both India and Nepal. For rapeseed, Post revised its numbers to combine the production, marketing, and consumption data of both rapeseed and mustard (FA0, 2022).

The south Asian soils have generally been reported to be low in nitrogen, phosphorus and sulphur because of the multiple cropping and introduction of high yielding varieties, and the deficiency of these nutrients in soil becoming wider. Fertilizer plays an important role in plant growth and shows a significant increase in yield (Singh *et al.,* 2017). The use of organic fertilizers is one of the alternatives to provide nutrients for plants so that mustard production can increase. The addition of organic matter can improve soil properties, thereby determining the status of soil fertility (Hanafiah*,* 2010). Cowdung has been recognized as perhaps the most desirable animal manures because of its high nutrient and organic matter content. Addition of cow dung increases the organic carbon content of degraded soil which may lead to the increasing activity of beneficial soil microorganisms as well as the fertility status of soil by increasing the availability of nutrients in soil. Cow dung significantly increased the growth and yield of plants (Gudugi and Akande, 2013). Mustard is a leafy vegetable that requires a lot of nitrogen in vegetative growth. This condition will also be encouraged if it contains a lot of organic matter and enough moisture (Yulia *et al*., 2011). Nitrogen is considered to be the most important nutrient for the crop to activate the metabolic activity and transformation of energy as well as chlorophyll and protein synthesis (Kumar *et al.,* 2011). Significant response of nitrogen was obtained when it was applied up to 80 kg under rainfed and 120 kg ha under irrigated conditions (Keivanrad and Zandi, 2012). The integrated plant nutrient management is maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop production through optimization of benefits from all possible sources of plant nutrients. Various sources of plant nutrients such as organic manures, fertilizers and bio-fertilizers were even though applied in mustard in an integrated manner (Chand, 2007). So, the primary view of the research work is to find out the effect of cowdung and nitrogen on yield performance of mustard in coastal area of Bangladesh. Hopefully this research work will be end up with a positive outcome and helps to contribute the production of mustard as well as meet up the scarcity of edible oil in Bangladesh.

MATERIALS AND METHODS

Location and soil

The research was conducted at the Agriculture Research Field of Noakhali Science and Technology University, during the period from October 2021 to January 2022. The research site belongs to Young Meghna Estuarine Flood Plain under the soil of Argo- Ecological Zones (AEZ)-18. The experiment field was almost level land having sandy loam soil, moderately alkaline, with pH value 7.3 to 8.5. General fertility is medium but low in organic matter.

Climate

The experimental area is under the subtropical climate zone. The average annual temperature is 25.0 °C and the average annual rainfall is about 2200 mm. The average air temperature during October to February remains 26.4°C.

Experimental design and layout

Two-factor experiment was laid out at Randomized Complete Block Design (RCBD) with three replications. The experimental area was divided into three blocks each representing a replication. Each block was then divided into 16 plots. Therefore, the total number of plots was 48. The size of unit plot was 4m × 1.5m = 6 m^2 where block to block and plot to plot distance was 1m and 0.5m, respectively.

Experimental treatment details

The experiment was designed to study the effect of various doses of cowdung and nitrogen on the yield performance of mustard. The following are the two factors that were used in the experiment: Factor A: Cowdung (C): 0 t ha^{-1} (C_0), 15 t ha^{-1} (C_1), 30 t ha^{-1} (C_2), 45 t ha^{-1} (C_3). Factor B: Nitrogen (N): 0 kg ha^{-1} (N_0), 100 kg ha^{-1} (N_1), 200 kg ha^{-1} (N_2), 300 kg ha^{-1} (N_3) and there were 16 treatment combinations in total, including the following: C_0N_0, C_1N_0, C_2N_0, C_3N_0, C_0N_1, C_1N_1, C_2N_1, C_3N_1, C_0N_2, C_1N_2, C_2N_2, C_3N_2, C_0N_3, C_1N_3, C_2N_3, C_3N_3.

Planting materials

Seeds of mustard cultivar, 'BARI SHARISHA 14' were used and sown on 1st November 2021

Land preparation

The soil of the experimental land was first opened on 20th October 2021 with the help of a tractor-drawn disc plough, later 25th 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 28th October 2021.

Fertilizer application

The plots were fertilized with triple superphosphate (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 cowdung and urea were applied as per treatment of the experimental research.

Seed sowing

Seeds of mustard were sown on 1st November 2021 in 2-3 cm deep furrows made by hand rake. After placement of seeds in furrow, seeds were covered with soil followed by a light pressure by hand.

Intercultural operations

A minor gap filling was done and where necessary using the seedling or separated tillers from the previous source as per treatment. Weeding was done three times in each plot as and when necessary. 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. Plants were infested with leaf rust (*Alternaria Brassicae*) to some extent which was successfully controlled by applying *Robral* (0.2%) @ 10 ml /10 liter of water.

Data collection:

During the experiment, data on the growth and yield parameters were collected from the sample plants. Five plants were sampled randomly from each unit plot for the collection of data.

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 DISCUSSION

Effect of cowdung on plant height

Plant height was found to be increased significantly with the increase in cowdung doses up to 45 t ha^{-1}**.** The highest plant height (48.82 cm) was recorded by the application of C_3 (45 t ha^{-1} Cowdung) treatment which was not statistically identical with any other treatment. The shortest plant height (36.40 cm) was recorded from control treatment C_0 (Fig.1). The result showed that cowdung boosts mustard growth, resulting in the longest plants. Nur *et al*. (2017) also found the same result with the application of 10 t ha^{-1}, 15 t ha^{-1}, 20 t ha^{-1}, 25 t ha^{-1} and 30 t ha^{-1} treatment. From this experiment, it was found that application of increased rate of cowdung significantly increased plant height of mustard.

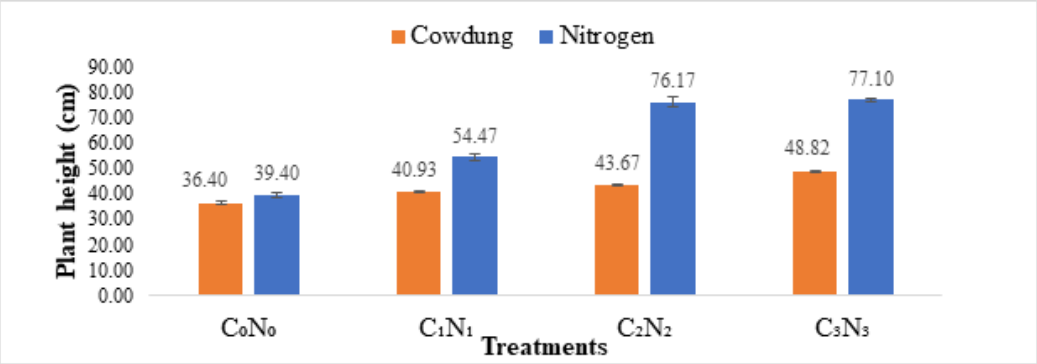

Figure 1. Effect of cowdung and nitrogen on plant height (cm) of mustard

Effect of nitrogen on plant height (cm)

The plant height of mustard was significant with all the application of different treatments. The highest plant height (77.10 cm) was recorded by the application of N_3 (300 kg ha^{-1} N) treatment which was statistically identical (76.17 cm) with N_2 treatment (200 kg ha^{-1} N). The shortest plant height (39.40 cm) was found in control treatment (N_0) (Fig.1). From this experiment it was resulted that nitrogen boosts mustard growth. Priyanka *et al*. (2021) was also disclosed that plant height increased with the application of 100 kg ha^{-1} N.

Interaction effect of cowdung and nitrogen on plant height (cm)

The plant height was significantly influenced by the interaction treatments of cowdung and nitrogen application on mustard. The maximum vegetative growth was recorded at final harvest. The highest plant height of (85.70 cm) was found from the C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment and the lowest was (39.40 cm) from the control C_0N_0 (0 cowdung + 0 N) treatment (Table 1). Both cowdung and nitrogen's favored plant height according to the findings. Similar findings were observed by Singh and Pal (2011) with the application of recommended dose of fertilizers (RDF) i.e., 120:17.6:16.6:40, N:P:K:S kg ha^{-1} was applied along with FYM 10 tha^{-1}, 25kg ZnSO4 ha^{-1} and the highest plant height (66.60cm) was recorded from the combination of cowdung and N treatment (C45N60) in Kalmegh production.

Table 1. Interaction effect of cowdung and nitrogen on yield performance of mustard

Treatment combination	Plant height (cm)	Branches per plant	Effective siliqua per plant	No. of siliqua seeds	Siliqua length (cm)	1000 seeds weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
C_0N_0	39.40f	2.57d	57.33de	13.00cde	3.17cd	1.97de	1.00de	1.30g	2.36h	39.65bc
C_1N_0	42.26f	2.53d	53.33e	12.00de	3.10d	2.30cde	1.03de	1.35fg	2.38h	43.48a
C_2N_0	44.33f	2.93d	44.67e	11.33e	3.57bcd	1.87e	0.93e	1.36fg	2.23h	41.83ab
C_3N_0	43.07f	2.50d	54.67e	12.33de	3.57bcd	2.20cde	1.23bcde	1.52fg	2.75gh	44.87a
C_0N_1	54.47e	3.00d	43.67e	18.33bcd	3.60bcd	1.77e	1.10de	1.56fg	2.66gh	41.30abc
C_1N_1	70.47bcd	5.70abc	48.00e	18.00bcde	4.07abcd	2.40bcde	1.23bcde	1.47fg	2.70gh	45.87a
C_2N_1	72.70bcd	5.93abc	53.67e	18.00bcde	4.43abcd	2.40bcde	1.13cde	2.10ef	3.23fg	32.03bcd
C_3N_1	68.20cd	4.17cd	53.00e	19.33abc	3.47bcd	2.93abc	1.17bcde	2.65de	3.82e	30.77cd
C_0N_2	76.17bcd	4.17cd	60.00de	20.67ab	4.33abcd	2.90abcd	1.30bcde	3.37bcd	4.67cde	27.83d
C_1N_2	78.30ab	6.90a	65.33de	20.33ab	4.50abcd	3.13abc	1.27bcde	3.13cd	4.40de	28.80d
C_2N_2	67.30d	6.10ab	80.00cd	23.00ab	4.37abcd	3.27ab	1.37bcd	3.57bc	4.93bcd	27.70d
C_3N_2	68.00cd	5.03bc	90.67bc	20.67ab	4.73abcd	3.57a	1.31bcde	3.42bc	4.73cd	27.93d
C_0N_3	77.10abc	6.03ab	96.33bc	24.67ab	5.00abc	3.57a	1.53ab	3.90ab	5.43abc	28.07d
C_1N_3	75.00bcd	6.73ab	100.33abc	24.67ab	4.87abcd	3.53a	1.52abc	3.93ab	5.45abc	27.77d
C_2N_3	77.80ab	6.63ab	110.67ab	24.33ab	5.30ab	3.60a	1.56ab	4.03ab	5.59ab	27.90d
C_3N_3	85.70a	7.13a	121.33a	25.67a	5.57a	3.83a	1.77a	4.33a	6.10a	28.93d
Level of significance	*	*	*	*	*	*	*	*	*	*
CV (%)	**4.70**	**12.0**	**11.13**	**11.80**	**14.33**	**11.21**	**10.09**	**9.24**	**6.99**	**10.25**

Effect of cowdung on number of branches plant^{-1}

The application of cowdung C_3 (45 tha^{-1} cowdung) showed the maximum number of branches (3.70) which was not statistically identical with any other treatment. The minimum number of branches (1.57) was found with control treatment (Fig.2). According to the observation, the number of branches increases as the degree of cowdung application increased. Because cowdung promotes mustard growth, the maximum number of branches plant^{-1} was recorded for the highest quantity of cowdung. Cevheri and Yilmaz (2018) also reported significant response of cattle manure on the number of branches plant^{-1} of soybean @ 0, 500, 1000, 1500 and 2000 kg ha^{-1}.

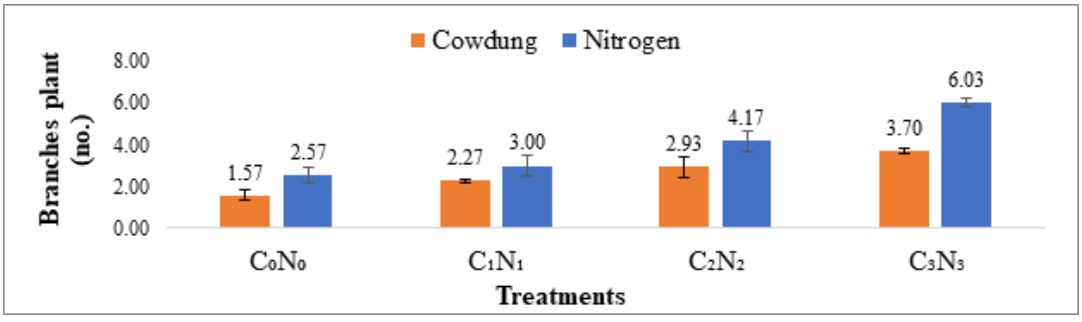

Figure 2. Effect of cowdung and nitrogen on number of branches plant^{-1} of mustard

Effect of nitrogen on number of branches plant^{-1}

Application of nitrogen significantly increases the number of branches plant^{-1}. The application of N_3 (300 kg ha^{-1} N) treatment resulted in the maximum number of branches (6.03) which was not statistically identical with any other treatment. The minimum number of branches (2.57) was found with control (N_0) treatment. (Fig.2). According to the observation, the number of branches increased as the degree of nitrogen application increased. Tripathi and Tripathi (2003) also agrees with this finding when application of 80, 120, 160, and 200 kg N ha^{-1} found that increasing rate of N increased the number of branches plant^{-1} of mustard.

Interaction effect of cowdung and nitrogen on number of branches plant^{-1}

The number of branches plant^{-1} of mustard was significantly influenced by the interaction effect of cowdung and nitrogen. The application of C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) treatment produced the highest number of branches (7.13) which was statistically identical with C_1N_2 (15 t ha^{-1} cowdung + 200 kg ha^{-1} N) treatment and the lowest number of branches (2.50) was observed from C_3N_0 (45 t ha^{-1} cowdung + 0 N) treatment (Table 1). The possible reason for such higher number of branches plant^{-1} due to increase in the cowdung and nitrogen level. Choudhary and Rai (2021) also reported that treating with FYM + Vermicompost+100% N:P: K enhanced maximum number of branches plant^{-1}.

Effect of cowdung on effective siliqua plant^{-1}

Effect of cowdung on number of effective siliqua plant^{-1} was significant among the treatments. The highest number of effective siliqua plant^{-1} (68.33) was recorded from the application of C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. The lowest number of effective siliqua plant^{-1} (42.00) was found in C_2 (30 t ha^{-1} cowdung) treatment (Fig.3). Similar results were found by Zamil *et al*. (2004) where the experiment showed increased effective siliqua plant^{-1} with the application of 20 t ha^{-1} poultry manure.

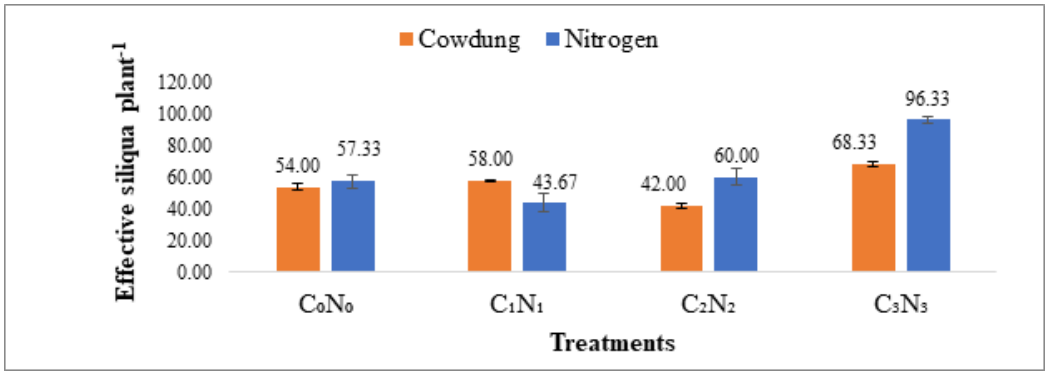

Figure 3. Effect of cowdung and nitrogen on effective siliqua plant^{-1} of mustard

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

Significant difference was varied in effective siliqua plant^{-1} due to application of different levels of nitrogen. The highest number of effective siliqua plant^{-1} (96.33) was recorded at the application of N_3 (300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment. The lowest number of effective siliqua plant^{-1} (43.67) was found in N_1 (100 kg ha^{-1} N) treatment (Fig.3). Keivanrad and Zandi (2012) also found that the maximum effective siliqua plant^{-1} (108.60) was obtained in plots which received 200 kg N ha^{-1} with 80 plant m^{-2}.

Interaction effect of cowdung and nitrogen on effective siliqua plant^{-1}

The number of effective siliqua plant^{-1} was significantly influenced by the interaction effect of cowdung and nitrogen. The plant received the treatment C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) produced the highest number of effective siliqua (121.33) plant^{-1} which was not statistically identical with any other treatment and the lowest number of effective siliqua plant^{-1} (43.67) was observed from C_0N_1 (0 cowdung + 100 kg ha^{-1} N) treatment (Table 1). Haque *et al*. (2022) also reported that the application of (30 t ha^{-1} cowdung + 45 kg ha^{-1} urea + 90 kg ha^{-1} TSP + 40kg ha^{-1} MoP +50 kg ha^{-1} Gypsum) gave the height effective siliqua plant^{-1}.

Effect of cowdung on siliqua length (cm)

The different level of cowdung application influenced the siliqua length of mustard. The highest siliqua length (4.23cm) was recorded from the application of C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. The shortest siliqua length (2.83cm) was found from control plot (Fig.4). The result showed that cowdung boosts mustard growth. Similar results were found by Tirkeya *et al.* (2021) where recommended doses of poultry manure (100%) gave the higher siliqua length (6.33cm) of mustard.

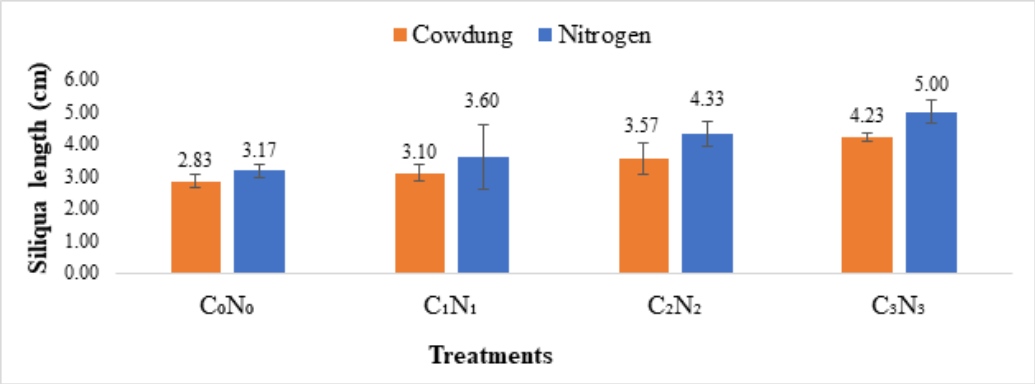

Figure 4. Effect of cowdung and nitrogen on siliqua length of mustard

Effect of nitrogen on siliqua length

Effect of nitrogen on siliqua length of mustard was significant among the different treatment. The highest siliqua length (5.00 cm) was recorded from the application of N_3 (300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment and followed by N_2 (200 kg ha^{-1} N) treatment and N_1 (100 kg ha^{-1} N) treatment which was 4.33 cm and 3.60 cm respectively. The shortest siliqua length (3.17 cm) was found from control plot (Fig.4). It was demonstrated that greater nitrogen application boosted siliqua length output. Singh and Meena (2004) also experimented and found the similar results.

Interaction effect of cowdung and nitrogen on siliqua length (cm)

The interaction effect of cowdung and nitrogen was significant variation on siliquae length. The plant received the treatment C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) produced the highest siliqua length (5.57 cm) which was not statistically identical with any other treatment and the lowest siliqua length (3.10 cm) was observed from C_1N_0 (15 t ha^{-1}cowdung + 0 N) treatment (Table 1). Both cowdung and nitrogen favored siliqua length according to the findings. According to Ghosh *et al.* (2014) the combination of organic manures and inorganic fertilizers significantly influenced the siliqua length and its attributing characters in mustard production.

Effect of cowdung on number of seeds siliqua^{-1}

The number of seeds siliqua^{-1} significantly varied due to the different level of cowdung application. Number of siliqua seeds was found to be statistically significant in all of the treatments. The highest number of siliqua seeds (15.33) was recorded from the application of C_3 (45 tha^{-1} cowdung) treatment which was not statistically identical with any other treatment. On the other hand, C_0 (control) treatment produced the lower number (8.67) of siliqua seeds (Fig. 5). Tirkeya *et al.* (2021) also reported that recommended doses of poultry manure (100%) gave the higher number of siliqua seeds (13.11) of mustard.

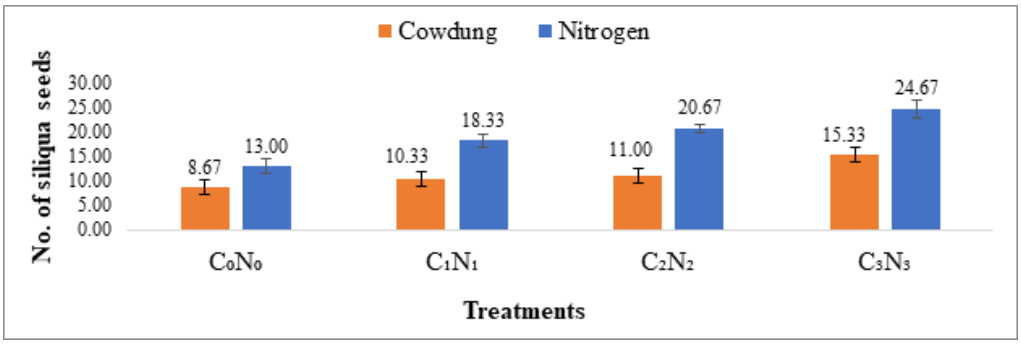

Figure 5. Effect of cowdung and nitrogen on number of seeds siliqua^{-1} of mustard

Effect of nitrogen on number of seeds siliqua^{-1}

Number of seeds per siliqua was found to be statistically significant in all of the treatments. The highest no. of seeds per siliqua (24.67) was recorded from the application of N_3 (300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment. Application of N_0 (control) treatment produced the lower number (13.00) of seeds per siliqua (Fig.5). Shorna *et al.* (2020) agrees with this finding. They found that increasing rate of N increased siliqua of mustard, claiming that siliqua seeds showed maximum number of siliqua seeds (23.00) in the application of 150 kg ha^{-1} urea.

Interaction effect of cowdung and nitrogen on number of seeds siliqua^{-1}

The number of siliqua length was significantly influenced by the interaction effect of cowdung and nitrogen. The plant received C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) treatment produced the highest siliqua seed (25.67) which was not statistically identical with any other treatment and the lowest siliqua seed (11.33) was observed from C_2N_0 (30 t ha^{-1} cowdung + 0 N) treatment (Table 1). Haque *et al.* (2022) also stated that the application of (30 t ha^{-1} cowdung + 45 kg ha^{-1} urea + 90 kg ha^{-1} TSP+ 40 kg ha^{-1} MoP+50 kg ha^{-1} Gypsum) showed the highest siliqua seeds of mustard.

Effect of cowdung on 1000 seeds weight (g)

The maximum 1000 seeds weight (2.67g) was found from C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. Minimum 1000 seeds weight (1.77g) was found from C_0 (control) treatment (Fig.6). Mahabub *et al*. (2016) experimented and found that application of increased rate of cowdung significantly increased 1000 seeds weight (g) of mustard, the height 1000 seed weight (43.86 g) resulted from the application of 10 t ha^{-1} cowdung among the treatment; C_0: 0 ton cowdung ha^{-1} (control), C_1: 5 ton cowdung ha^{-1} and C_2: 10 ton cowdung ha^{-1}.

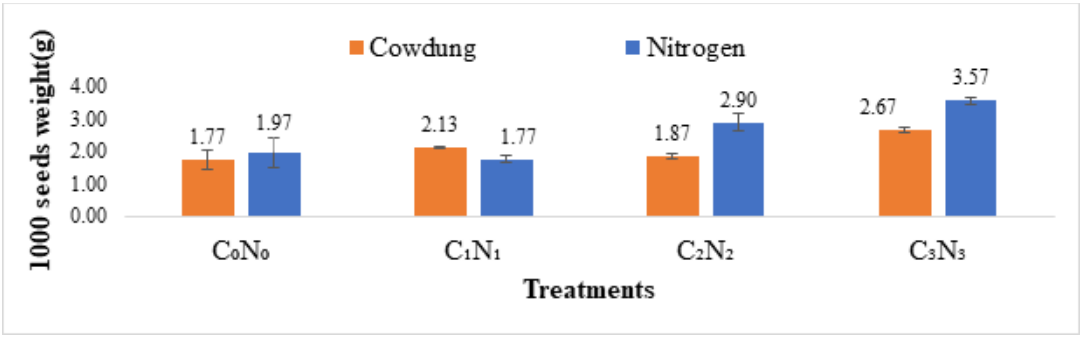

Figure 6. Effect of cowdung and nitrogen on 1000 seeds weight (g) of mustard

Effect of nitrogen on 1000 seeds weight (g)

The weight of 1000 seeds were found to be statistically significant in all of the treatments used in the experiment. The maximum 1000 seeds weight (3.57g) was found from N_3 (300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment. A minimum 1000 seeds weight (1.77g) was found from N_1 (100 kg ha^{-1}) treatment (Fig.6). Sharif *et al.* (2012) was also disclosed that 1000 seeds weight (g) increased with the application of 150 kg ha^{-1} nitrogen fertilizer.

Interaction effect of cowdung and nitrogen on 1000 seeds weight (g)

Combined effects of cowdung and nitrogen were significant in respect of 1000 seeds weight (g) of mustard. The plant received the treatment C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) produced the highest 1000 seeds weight (3.83g) and the lowest 1000 seeds weight (1.77g) was observed from C_0N_1 (0 cowdung+ 100 kg ha^{-1} N) treatment (Table 1). These findings support the result of Rasool *et al.* (2013) with the application of nitrogen, sulphur and farmyard manure.

Effect of cowdung on Seed yield (t ha^{-1})

In respect of seed yield of mustard significant variation was observed due to different level of cowdung. The highest seed yield (1.26 t ha^{-1}) was recorded from the C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. The lowest seed yield (0.90 tha^{-1} cowdung) was recorded from the C_0 (control) treatment (Fig.7). Tirkeya *et al.* (2021) also stated that recommended doses of poultry manure (100%) gave the higher number of seed yield (2.20 t ha^{-1}).

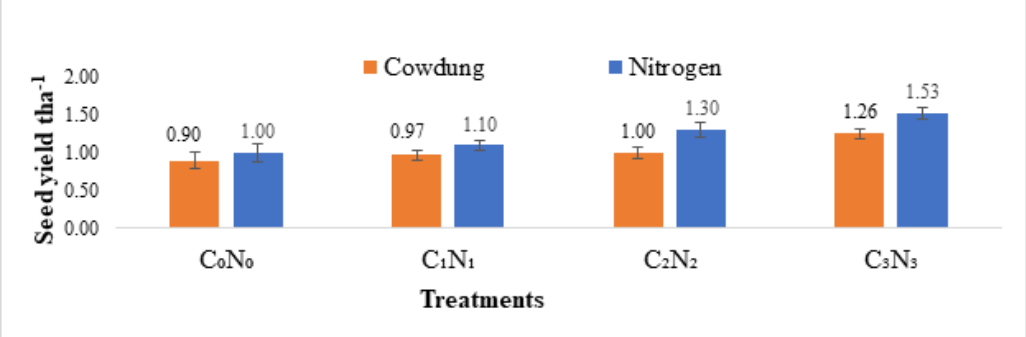

Figure 7. Effect of cowdung and nitrogen on seed yield (t ha^{-1}) of mustard

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

The seed yield of mustard is statistically significant due to the application of different treatments. The highest seed yield (1.53 t ha^{-1}) was recorded from the N_3 (300 kg ha^{-1} N) treatment which was not statistically identical with any other treatment. The lowest seed yield (1.00 t ha^{-1}) was recorded from the N_0 (control) treatment (Fig.7). Roy *et al*. (1981) also stated that 240 kg N ha^{-1} provided height seed yield (1957 kg ha^{-1}). The same kind of result also found by Parmar *et al*. (2010) from their experiment. Where three levels of N (50, 75 and 100 kg N ha^{-1}) were used and the results revealed that the application of (100 kg N ha^{-1}) significantly increased the seed yield of mustard.

Interaction effect of cowdung and nitrogen on seed yield (t ha^{-1}):

The number of seed yield was significantly influenced by the interaction effect of cowdung and nitrogen. The plant received the treatment C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) produced the highest seed yield (1.77 t ha^{-1}) and the lowest seed yield (0.93 t ha^{-1}) was observed from C_0N_0 treatment (Table 1). Both cowdung and nitrogen favored seed yield according to the findings. These results were similar with Chand *et al.* (2006) where the experiment shown that supply of organic and inorganic fertilizer (T_4; N:P: K: 133:40:40 and FYM at 6.7 t ha^{-1}) was found as most suitable combination for seed yield productivity of mustard crop.

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

Analysis of variance showed that stover yield was significantly influenced by treatments The highest stover yield (1.88 t ha^{-1}) was recorded from C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. The lowest Stover yield (1.04 t ha^{-1}) was recorded from the C_0 (control) treatment (Fig.8). Zamil *et al*. (2004) was also disclosed that poultry manure @ 20 tha^{-1} resulted height stover yield (26.18 g pot^{-1}) of mustard.

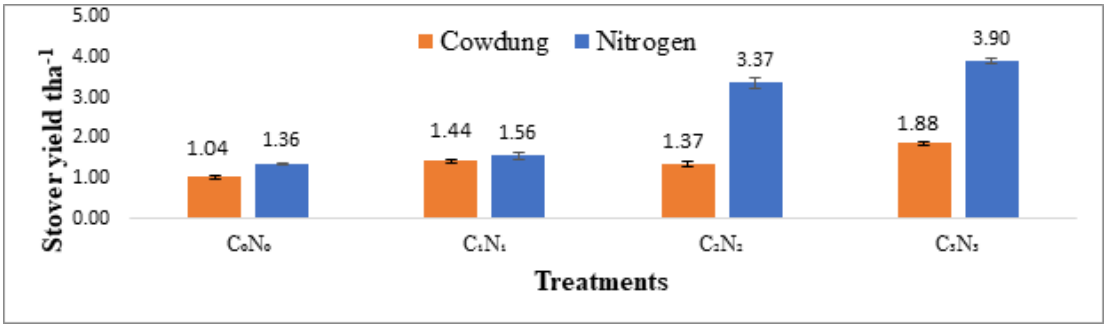

Figure 8. Effect of cowdung and nitrogen on Stover yield (tha^{-1}) of mustard

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

All the treatments significantly increased the stover yield over control. The highest stover yield (3.90 t ha^{-1}) was recorded in the treatment N_3 (300 kg ha^{-1} N) which was not statistically identical with any other treatment. The lowest stover yield (1.36 kg ha^{-1}) was recorded from the C_0 (control) treatment (Fig.8). These findings showed that nitrogen promotes mustard growth, resulting in a higher stover yield plant^{-1} than the control. Singh and Meena (2004) also found that the application of 90 kg N ha^{-1} enhanced the stover yield.

Interaction effect of cowdung and nitrogen on stover yield

The number of stover yield was significantly influenced by the interaction effect of cowdung and nitrogen. The plant received the treatment C_3N_3 (45 t ha^{-1} + 300 kg ha^{-1} N) produced the highest stover yield (4.33 t ha^{-1}) which was not statistically significant with any other treatment and the lowest stover yield (1.30 t ha^{-1}) was observed from C_2N_0 treatment (Table 1). Singh and pal (2011) also find out the similar results in mustard production where stover yields were recorded significantly higher when recommended dose of fertilizers (RDF) viz. 120:17.6:16.6:40, N:P:K:S kg ha^{-1} was applied along with FYM 10 tha^{-1}, 25kg ZnSO4 ha^{-1}.

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

The biological yield was statistically significant. Higher biological yield (2.91 t ha^{-1}) was found from the C_3 (45 t ha^{-1} cowdung) treatment which was not statistically identical with any other treatment. The lowest biological yield (1.36 t ha^{-1}) was found from C_0 (control) treatment (Fig.9). Similar results were found by Shete and Dubey (2022) where biological yield (7629.05 kg ha^{-1}) was recorded with the application FYM @ 7.5 tha^{-1} with rhizobium and PSB of soybean.

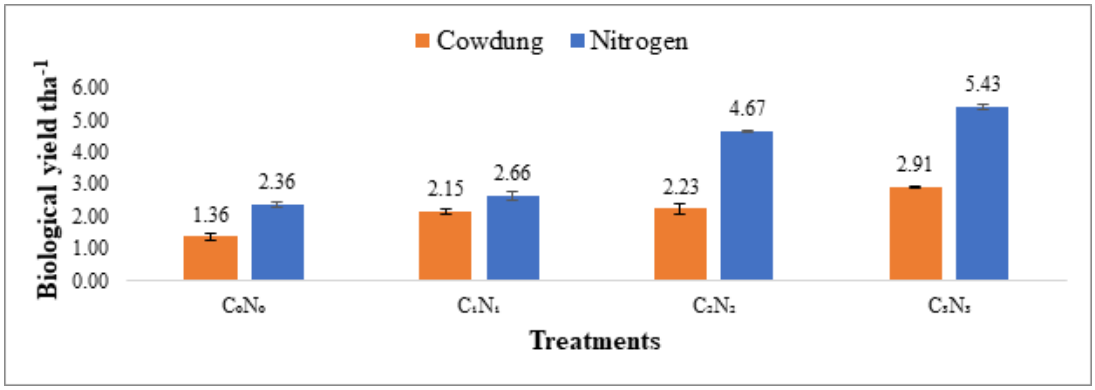

Figure 9. Effect of cowdung and nitrogen on biological yield (t ha^{-1}) of mustard

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

Analysis of variance showed that the biological yield was statistically significant. Higher biological yield (5.43 tha^{-1}) was found from the N_3 (300 kg ha^{-1}) treatment which was not statistically identical with any other treatment. The lowest biological yield (2.36 tha^{-1}) was found from N_0 (control) treatment (Fig. 9). The result revealed the effect of nitrogen had the opportunity increase biological yield of mustard. It might be because the effect of nitrogen provided higher biological yield. Sharma *et al.* (2022) agrees with this finding where application of 125% recommended dose of nitrogen + 30 kg sulphur ha^{-1} found increased the biological yield of mustard.

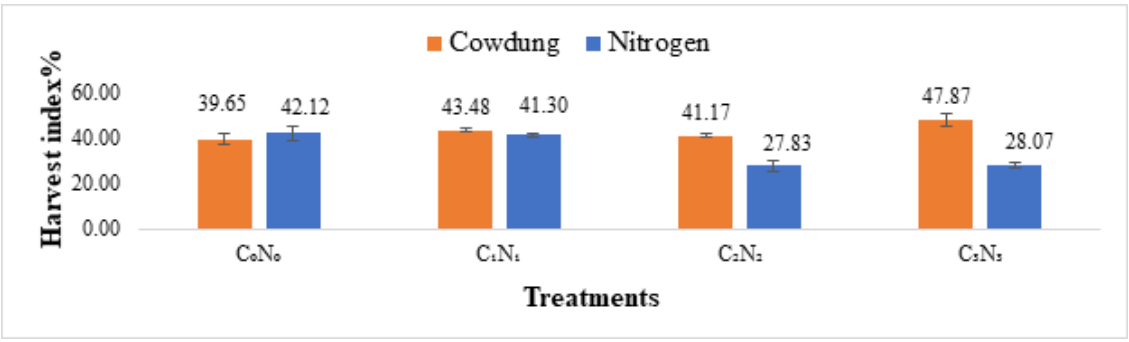

Figure 10. Effect of cowdung and nitrogen on harvest index (%) of mustard

Interaction effect of cowdung and nitrogen on biological yield (t ha^{-1})

The biological yield was statistically significant due to the application of different treatments of cowdung and nitrogen. However, the highest biological yield (6.10 t ha^{-1}) was found from C_3N_3 (45 t ha^{-1} cowdung + 300 kg ha^{-1} N) which was not statistically identical with any other treatment and the lowest biological yield (2.23 t ha^{-1}) was found from C_2N_0 (cowdung 30 t ha^{-1} + 0 N) treatment (Table 1). Similar findings were observed by Royhan (2008) with the application of 2.5 t ha^{-1} cowdung, 20kg N, 16 kg P and 16 kg ha^{-1} which gave the highest biological yield (4.54 t ha^{-1}) of mungbean.

Effect of cowdung on harvest index (%)

It was found that the harvest index was statistically significant in all the treatments. The highest harvest index (47.87%) was found in C_3 (45 t ha^{-1} Cowdung) treatment which was statistically non-significant with other treatments. Minimum harvest index (38.78%) was found from C_0 (control) treatment (Fig.10). Kobir *et al*. (2020) also stated that the highest harvest index (0.075) was observed in N_2 (75% N from urea + 25% N from cowdung).

Effect of nitrogen on harvest index (%)

It was found that the harvest index was statistically significant in all the treatments. The highest harvest index (42.12%) was found from N_0 (control) treatment which was statistically identical with N_1 (100 kg ha^{-1}) treatment and the minimum harvest index (27.83%) was found from N_2 (200 kg ha^{-1}) treatment. Riaj *et al.* (2018) also found that the heigh harvest index (24.23 %) was recorded from the application of 120 kg ha^{-1} N.

Interaction effect of cowdung and nitrogen harvest index (%)

The interaction of cowdung and nitrogen on mustard found that the harvest index was statistically significant in all the treatments. However, the highest harvest index (45.87%) was found from C_1N_1 (15 t ha^{-1} cowdung + 100 kg ha^{-1} N) treatment which was statistically identical with C_3N_0 (45 t ha^{-1} cowdung + 0 N) and C_1N_0 (15 t ha^{-1} cowdung + 0 N) treatments respectively and minimum harvest index (27.70) was found from C_2N_2 (30 t ha^{-1} cowdung + 200 kg ha^{-1} N) treatment (Table 1). These findings support the result of Mondal *et al.* (2017) in mustard production.

CONCLUSION

The result of the experiment revealed that the application of C_3N_3 (45 t ha^{-1} Cowdung + 300 kg ha^{-1} N) treatment gave the highest seed yield (1.77 t ha^{-1}) among the tested treatments. From this research findings, it can be suggested that application of C_3N_3 treatment is suitable for growing mustard in coastal area. Before the recommendation more trail is necessary across the country.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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