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Influence of Organic and Inorganic Nitrogen on the Growth and Yield of Wheat

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

To assess the effects of organic and inorganic N fertilizers regarding wheat yield and growth a field experiment was carried out from November 2019 to March 2020 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. There were three replications of the experiment, which was set up using a randomized full block design. The experiment comprises four varieties viz. BARI Gom-28, BARI Gom-30, BARI Gom-31, BARI Gom-32 and five levels of N viz. Control, 90 kg N ha^{-1} from prilled urea (PU), 57 kg N ha^{-1} from prilled urea (PU) + 3 t ha^{-1} poultry manure (PM) as organic N source, 62 kg N ha^{-1} from PU + 5 t ha^{-1} cowdung as organic N source, 29 Kg N ha^{-1} from PU + 4 t ha^{-1} vermicompost as organic N source. The outcome of the experiment revealed that there were substantial differences in the growth and yield of wheat due to different varietal effects and application of organic and inorganic nitrogen fertilizers, although some of the attributes were not found significant. At growth, BARI Gom-32 produced the highest number of total tillers $hill^{-1}$ and leaf area index, while the highest number of total tillers $hill^{-1}$ and leaf area index were obtained from 57 kg N ha^{-1} from PU and 3 t ha^{-1} PM at 20, 40, 60 and 80 DAS. At harvest, the highest number of effective tillers $plant^{-1}$ (2.82), filled grain $spike^{-1}$ (32.06), 1000-grain weight (61.07 g), grain yield (3.94 t ha^{-1}), straw yield (5.85 t ha^{-1}) and harvest index (40.11%) were obtained from BARI Gom-32. While, application of 57 kg N ha^{-1} from PU and 3 t ha^{-1} PM produced the tallest plant (95.49 cm), number of

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total tillers plant^{-1} (3.96), number of effective tillers plant^{-1} (3.20), filled grain spike^{-1} (36.61), 1000-grain weight (60.18 g from T5), grain yield (4.34 t ha^{-1}), straw yield (6.23 t ha^{-1}) and harvest index (41.07%). Again, the maximum number of total tillers plant^{-1} (4.06), number of effective tillers plant^{-1} (3.46), filled grain spike^{-1} (39.13), 1000-grain weight (64.62 g), grain yield (4.38 t ha^{-1}), straw yield (6.27 t ha^{-1}) and harvest index (41.16%) were found from BARI Gom-32 in combination with 57 kg N ha^{-1} from prilled urea and 3 t ha^{-1} poultry manure. Therefore, it can be concluded that BARI Gom-32 in combination with 57 kg N ha^{-1} from prilled urea and 3 t ha^{-1} poultry manure was more potential in terms of yield and would be suggested for the cultivation of wheat.

Keywords: Inorganic N; organic N; growth; yield; wheat.

1. INTRODUCTION

"One of the most widely grown cereal crops in the world is wheat (*Triticum aestivum* L), which ranks first in terms of area (218.4 million hectares) and third in terms of production (734.74 million metric tons) after maize and rice" [1-2]. Wheat accounts for over half of all grain crop production globally [3]. Wheat is the second largest cereal crops in Bangladesh. Over the past four decades, Bangladesh has made impressive strides in its wheat output. There is a great prospect of wheat cultivation in almost every areas of our country as the country's land is quite appropriate for growing wheat. The entire area planted with wheat was 332274 ha in 2019 and 3289224 ha in 2020 [4]. It comprises for 4% of the overall cropped land and 11% of the rabi crop area, which together produce 7% of all food cereal output [5]. As very large number of people are crossing the low income line day by day the increasing demand of food grains is rising in Bangladesh as well [1]. Compared to most other food grains, wheat have a higher protein content. Wheat might encounter a protein need of between 10 to 12% [1]. "But the yield of wheat in Bangladesh is not still satisfactory. The traditional methods, poor field management, lack of using proper plant densities, late planting, unavailability of quality seed, use of local cultivars, climatic hazards, intensive cropping and non-replenishment of soil nutrients, inadequate fertilizer use, irregular irrigation, and fertilizer management are all factors that contribute to the low yield of wheat. The growth and yield of wheat depends largely on the application of different fertilizers effectively. One of the vital nutrients for plants is nitrogen. Numerous researchers found that N positively affects wheat yield and yield-contributing traits. If N is scarce, the plant may not respond as well to other nutrients, which could result in lower yield" [5]. Therefore, the most crucial component for successful wheat development and yield is N. It also shows an imperative part to increase photosynthetic processes, leaf area production, net assimilation rate, greater productivity results from the plant's capacity for tillering, food quality and as a result an adequate supply of nitrogen increases the protein content and nutritional value of grains as well as their backing characteristics [6- 8]. While, fertilizer with a very low quantity of N does not provide the right nutrients to plants, which eventually lowers the output [9]. Some studies showed that application of organic and inorganic sources of N increase most of the growth parameters resulting in an increase yield of crops [10-11]. In a study Imdad et al. [12] reported that the treatment with nitrogen applied at 203 kg per hectare produced the tallest plants, the greatest number of tillers, and the best biological yield; however, the treatment with nitrogen applied at 145 kg per hectare had the highest grain yield, 1000 grain weight, and seeds per spike. Moreover, in another study by Asif et al. [13] revealed that aggregate level of N fertilizer considerably augmented the physical characteristics of wheat plant and therefore increase the yield of wheat. The main source of N are organic and inorganic materials such as prilled urea, poultry manure, cowdung, vermicompost. For ensuring adequate amount of N fertilizer in the soil of wheat crop correct application as well as management practices should be taken on. Considering the above facts, the current study was therefore embarked on to observe the effects of organic and inorganic sources of nitrogen on the growth and yield of wheat varieties.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experimentation

Throughout November 2019 and March 2020, an experiment was conducted at the Agronomy Field Laboratory of the Bangladesh Agricultural University to see how organic and inorganic nitrogen affected wheat growth and yield.

Geographically, the site of the experimental plot was located at 24.75° N latitude and 90.50°E longitude at an elevation of 18 m above the mean sea level. The site is in Agroecological Zone-9, Old Brahmaputra Floodplain [14]. A medium-high land with a silty clay loam soil texture and a pH value of 6.8 used as the experimental field. High temperatures and somewhat high rainfall throughout the *Kharif* season (April to September) and low temperatures during the *Rabi* season (October to March) were the defining characteristics of the experimental area's environment. The temperature was typically low and there was a lot of sunshine during the *Rabi* season. The experimental treatments comprised of four varieties of wheat viz; BARI Gom-28 (V_1), BARI Gom-30 (V_2), BARI Gom-31 (V_3) and BARI Gom-32 (V_4), and five fertilizer treatments viz; Control (T_1), 90 kg N ha^{-1} from prilled urea (PM) (T_2), 57 kg N ha^{-1} from PU + 3 t poultry manure (PM) ha^{-1} as organic N source (T_3), 62 kg N ha^{-1} from PU + 5 t cowdung ha^{-1} as organic N source (T_4) and 29 kg N ha^{-1} from PU + 4 t vermicompost ha^{-1} as organic N source (T_5). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 4.0 m × 2.5 m (10 m^2). The total number of plots was 60 (5×4×3). Block to block and plot to plot distance were l.0 m and 0.5 m, respectively.

2.2 Crop Husbandry

The field was prepared with a tractor-drawn plough in late November 2019. In order to get the desired tilth, the field was afterwards cross-ploughed three times by a country plough, then laddered. The corners and levees of the experimental filed were trimmed by spade and visible large clods were broken into small pieces by wooden hammer. The land was uniformly fertilized with TSP, MoP, gypsum and boric acid @ 180, 50, 120 and 6.5 kg ha^{-1}. The entire amount of TSP, MoP, gypsum and boric acid were applied at the time of final land preparation. In treatment Control, there was no fertilizer and manure used. In treatment 90 kg N ha^{-1} from prilled urea (PU), 90 kg N ha^{-1} from PU was applied in two equal halves at 20 and 60 DAS. In treatment 57 kg N ha^{-1} from PU + 3 t poultry manure (PM) ha^{-1} as organic N source, 57 kg N ha^{-1} from PU was applied in two equal halves at 20 and 60 DAS and 3 t PM ha^{-1} was applied before sowing. In treatment 62 kg N ha^{-1} from PU + 5 t cowdung ha^{-1} as organic N source, 62 kg N ha^{-1} from PU was applied in two equal halves at 20 and 60 DAS and 5 t cowdungha^{-1} was applied before sowing. In treatment 29 kg N ha^{-1} from PU + 4 t vermicompost, 29 kg N ha^{-1} from PU was applied in two equal halves at 20 and 60 DAS and 4 t vermicompost ha^{-1} was applied before sowing. Seed of four varieties of wheat named BARI Gom 28, BARI Gom 30, BARI Gom 31 and BARI Gom 32 were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. Seeds were sown in line sowing method. Bird damage was carefully avoided for up to 15 days after seeding. After plant establishment, some seedlings were uprooted to optimize plant population. Weeding was done at 30 and 60 DAS by hand weeding method. Two irrigations were applied to the crop, one at the CRI stage and the other during the early booting stage.

2.3 Data Collection on Growth Traits

Data on growth characters viz., plant height (PH), number of tillers (No. T) $hill^{-1}$ and leaf area index (LAI) were taken at 20, 40, 60and 80 DAS. Five hills were marked by bamboo stick excluding boarder rows to collect data on PH and No. T $hill^{-1}$. Five hills were collected every sampling date for LAI. An automatic leaf area meter (Type AAN-7, Hayashi Dam Ko Co., Japan) was used to measure leaf area. As described by Hunt [15], LAI was calculated as the ratio of total leaf area and total ground area of the sample.

$$LAI = LA/P$$

Where,

LAI = Leaf area index
LA = Total area of leaf of all the plants sampled (cm2)
P = Ground surface area covered by the plant (cm^2)

2.4 Data Collection on Yield and Yield Contributing Characters

Before harvest, five plants, excluding boarder plants, were randomly chosen from each plot to collect the data on yield and yield contributing characters viz; plant height (cm), number of total tillers $hill^{-1}$, leaf area (cm^2), number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, number of filled grains $spike^{-1}$, number of unfilled grains $spike^{-1}$, number of spikelets $spike^{-1}$, weight of 1000-grain, grain yield (t ha^{-1}) and straw yield (t ha^{-1}). The harvested crop of each plot was bundled separately and then carried to the threshing floor. Grains were dried carefully up to

14% moisture content. Straws also sun dried properly. Grain and straw weights were recorded plot wise and converted to t ha^{-1}. The harvest index (HI) was calculated as follows:

Biological yield (BY) = Grain yield (GY) + Straw yield (SY)

$$HI\ (\%) = \frac{GY}{BY} \times 100$$

2.5 Statistical Analysis of Data

"Using a computer package program MSTAT, the acquired data were analyzed using the analysis of variance method and Duncan's Multiple Range Test (DMRT) was used to determine mean differences" [16].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters of Wheat Cultivars

3.1.1 Effects of different variety on growth parameters of wheat

Plant height (PH) and leaf area index (LAI) were significantly affected by variety at 20, 40, 60 and 80 days after sowing (DAS), while the number of total tillers (No. TT) $plant^{-1}$ was not significantly affected by variety (Fig. 1A, 1B & Fig. 2A). BARI Gom-28 produced the tallest plant of 29.82 and 64.13 cm at 20, 40 days after sowing, respectively. On the contrary, BARI Gom-30 gave the shortest plant of 57.73 cm at 40 DAS (Fig. 1A). On the other hand, numerically, BARI Gom-32 produced the highest (No. TT) $hill^{-1}$ of 1.40, 4.03, 4.06 and 4.09 at 20, 40, 60 and 80 days after sowing (DAS), respectively. On the contrary, BARI Gom-28 recorded the lowest (No. TT) $plant^{-1}$ of 1.27, 3.75, 3.79 and 3.97 at 20, 40, 60 and 80 DAS, respectively (Fig. 1B). Again, BARI Gom-32 produced significantly the highest LAI of 0.32, 1.61, 1.86 and 1.05 at 20, 40, 60 and 80 DAS, respectively. While, BARI Gom-28 gave the lowest LAI of 0.30, 1.49, 1.83 and 0.83 at 20, 40, 60 and 80 DAS, respectively (Fig. 2A). Kumar et al. [17], Abo-Elela et al. [18] and Bhutta et al. [19] were found similar varietal effects on different growth parameters of wheat.

3.1.2 Effects of different sources of N on growth parameters of wheat

Different sources of N exerted significance influence on plant height (PH), number of total tillers $plant^{-1}$ (No. TT) and leaf area index (LAI) at 20, 40, 60 and 80 DAS (Fig. 1C-1D & Fig. 2B). The tallest plant of 29.16 and 98.75 cm were recorded in 57 kg N ha^{-1} from prilled urea (PU) and 3 t ha^{-1} poultry manure (PM) at 20 and 80 DAS, respectively. On the contrary, the shortest plant of 60.49, 91.61 and 88.63 cm were found in control at 40, 60 and 80 DAS, respectively (Fig. 1C). A similar result was found by Mukhtiar et al. [20] in wheat under different source of nitrogen. The highest No. TT $plant^{-1}$ of 1.72, 4.30, 4.31, and 4.34 were also observed in 57 kg N ha^{-1} from PU and 3 t ha^{-1} PM at 20, 40, 60 and 80 DAS, respectively. While, the lowest No. TT $plant^{-1}$ 1.15, 3.01, 3.06, 3.31 were found in control at 20, 40, 60 and 80 DAS, respectively (Fig. 1D). Again, the highest LAI of 0.35, 1.97, 2.10 and 1.68 were recorded from 57 kg N ha^{-1} from PU and 3 t ha^{-1} PM at 20, 40, 60 and 80 DAS, respectively. On the contrary, the lowest LAI of 0.28, 67, 1.35, and 0.50 were attained in control at 20, 40, 60 and 80 DAS, respectively (Fig. 2B). Similarly, Abedi et al. [21], Abbas [22] and Hammad et al. [23] found that combined organic and inorganic source of nutrient were more effective in wheat plant.

3.2 Yield and Yield Contributing Parameters of Wheat Cultivars

3.2.1 Effects of different variety on yield and yield contributing parameters of wheat cultivars

Plant height (PH), 1000-grain weight (GW), grain yield (GY), straw yield (SY), biological yield (BY) and harvest index (HI) were significantly influenced by variety (Fig. 3A, 3B & Table 1). The tallest plant (93.37 cm) was obtained from BARI Gom-31 and the shortest plant (88.86 cm) was observed in BARI Gom-32. Numerically, the highest number of total tillers $plant^{-1}$ (No. TT) (3.58) was recorded from BARI Gom-30 and the lowest No. TT $plant^{-1}$ (3.40) was found in BARI Gom-28. Again, numerically, the higher number of effective tillers (No. ET) $plant^{-1}$ (2.82) was obtained from BARI Gom-32 and the lowest No. ET $plant^{-1}$ (2.61) was observed in BARI Gom-28. A similar result was also observed by Hossain et al. [24]. In addition, numerically, the highest number of grains (No. G) $spike^{-1}$ (32.06) was recorded from BARI Gom-32. Whereas, the lowest No. G $spike^{-1}$ (30.94) was found in BARI Gom-28. Moreover, numerically, the longest spike (10.40 cm) was recorded from BARI Gom-32 and the shortest spike (10.17 cm) was observed in BARI Gom-28. These circumstances

are in accordance with the earlier study of Kumar et al. [17]. Again, the highest 1000-GW (61.07 g) was obtained from BARI Gom-32 and the lowest 1000-GW (53.07 g) was found in BARI Gom-28. In addition, BARI Gom-32 produced the highest GY (3.94 t ha^{-1}). Whereas, the lowest GY (3.63 t ha^{-1}) was obtained from BARI Gom-28 (Fig. 3A). Also, similar trend among different varieties were observed elsewhere [25-26]. On the other hand, the highest SY (5.85 t ha^{-1}) was recorded from BARI Gom-32. Whereas, the lowest SY (5.56 t ha^{-1}) was found in BARI Gom-28 (Fig. 3B). Again, the highest BY (9.80 t ha^{-1}) was obtained from BARI Gom-32 and the lowest BY (9.20 t ha^{-1}) was observed in BARI Gom-28. Similarly, BARI Gom-32 produced the highest HI (40.11) and the lowest HI (39.24) was obtained from BARI Gom-28. The similar results were obtained with Abedi et al. [21] and Abo-Elela et al. [18].

3.2.2 Effects of different sources of N on yield and yield contributing parameters of wheat cultivars

Wheat cultivars' yield and yield-contributing parameters were all significantly influenced by different sources of N except 1000-grain weight (GW) (Fig. 3C, 3D & Table 2). The tallest plant (95.49 cm) was obtained from 57 kg N ha^{-1} from prilled urea (PU) + 3 t ha^{-1} poultry manure (PM). Whereas, the shortest plant (87.69 cm) was observed in control. In a study, Islam et al. [27] found that chemical fertilizer recorded the tallest plant compared to inorganic fertilizer. However, the higher number of total tillers (No. TT) $plant^{-1}$ (3.96) was recorded from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM and the lowest No. TT $plant^{-1}$ (3.14) was found in control. In addition, the highest number of effective tillers (No. ET) $plant^{-1}$ (3.20) was obtained from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM and the lowest No. ET $plant^{-1}$ (2.29) was observed in control. Again, the highest number of grains (No. G) $spike^{-1}$ (36.61) was recorded when 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM was applied. While, the lowest No. G $spike^{-1}$ (28.37) was found in control. However, 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM produced the longest spike (10.94 cm), while control produced the shortest spike (9.73 cm). Ali et al. [28] found similar results in case of maize with 50% N + 50% PM. Numerically, the highest 1000- GW (60.18 g) of wheat was recorded under 29 kg N ha^{-1} from PU + 4 t ha^{-1} vermicompost. While, the lowest 1000-GW (56.31 g) of wheat was found under control. Again, the highest grain yield (GY) (4.34 t ha^{-1}) was obtained from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM whereas, the lowest GY (2.80 t ha^{-1}) was observed in control (Fig. 3C). The maximum GY of (3248 kg ha^{-1}) was obtained from treatment where 25% N was provided from PM and 75% from mineral fertilizer (MF) in a study by [29], which reported a similar outcome. The highest straw yield (SY) (6.23 t ha^{-1}) was obtained from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest SY (4.73 t ha^{-1}) was obtained from control (Fig. 3D). A similar outcome was also found in another investigation by Shah et al. [29], where the maximum SY of (7154 kg ha^{-1}) was obtained from a treatment where 25% N was applied from PM and 75% from MF. The highest biological yield (BY) (10.58 t ha^{-1}) was obtained from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest BY (7.54 t ha^{-1}) was found in control. Again, the highest HI (41.07) was recorded from 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest HI (37.16) was observed in control. Similar higher BY was obtained by Hossain et al. [30] while used cowdung and recommended N to rice and by Kavinder et al. [31] while used farm yard manure and N to wheat.

3.3 Interaction Effects of Different Variety and Nitrogen Source on Yield and Yield Contributing Parameters of Wheat

Variety and different sources of N exerted significant influence on all yield and the variables that contribute to yield of wheat cultivars except 1000-grain weight (GW) (Table 3). The tallest plant (97.61 cm) was obtained from interaction of BARI Gom-31 along with 57 kg N ha^{-1} from prilled urea (PU) and 3 t ha^{-1} poultry manure (PM). Whereas, the lowest plant height (PH) (79.94 cm) was observed in interaction of BARI Gom-32 along with control. However, the interaction of BARI Gom-32 with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM resulted in the maximum number of total tillers $plant^{-1}$ (No. TT) (4.06) and effective tillers (ET) $plant^{-1}$ (3.46), and the lowest No. TT $plant^{-1}$ (3.06) and the lowest ET $plant^{-1}$ (2.25) were found in interaction of BARI Gom-28 along with control. A similar kind of result is also observed by Hossain et al. [24] in different wheat varieties. Again, the highest number of grains (No. G) $spike^{-1}$ (39.13) was obtained from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest No. G $spike^{-1}$ (27.80) was observed in interaction of BARI Gom-28 along with control. The longest spike (11.04 cm) was obtained from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM.

Whereas, the shortest spike (9.44 cm) was found in interaction of BARI Gom-28 along with control. Numerically, the highest 1000-GW (64.62 g) was recorded from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest 1000-GW (50.43 g) was observed in interaction of BARI Gom-28 along with control. Similar trend of the effect of source of nitrogen was observed by Ali et al. [28] and Das et al. [32] in different traits of wheat. The highest grain yield (GY) (4.38 t ha^{-1}) was obtained from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest GY (2.70 t ha^{-1}) was found in interaction of BARI Gom-28 along with control. Alam et al. [33] and Kumar et al. [17] observed "significant interaction effect between varieties and different N levels on wheat. The highest straw yield (SY) (6.27 t ha^{-1}) was recorded from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM". Whereas, the lowest SY (4.63 t ha^{-1}) was observed in interaction of BARI Gom-28 along with control. The highest biological yield (BY) (10.65 t ha^{-1}) was obtained from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest BY (7.32 t ha^{-1}) was found in interaction of BARI Gom-28 along with control. The highest HI (41.16) was recorded from BARI Gom-32 along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} PM. Whereas, the lowest HI (36.73) was observed in interaction of BARI Gom-28 along with control. Similarly, Jala-Abadi et al. [34] observed that a combined OM and biofertilizer treatment improved GY, BY, and HI in various wheat cultivars.

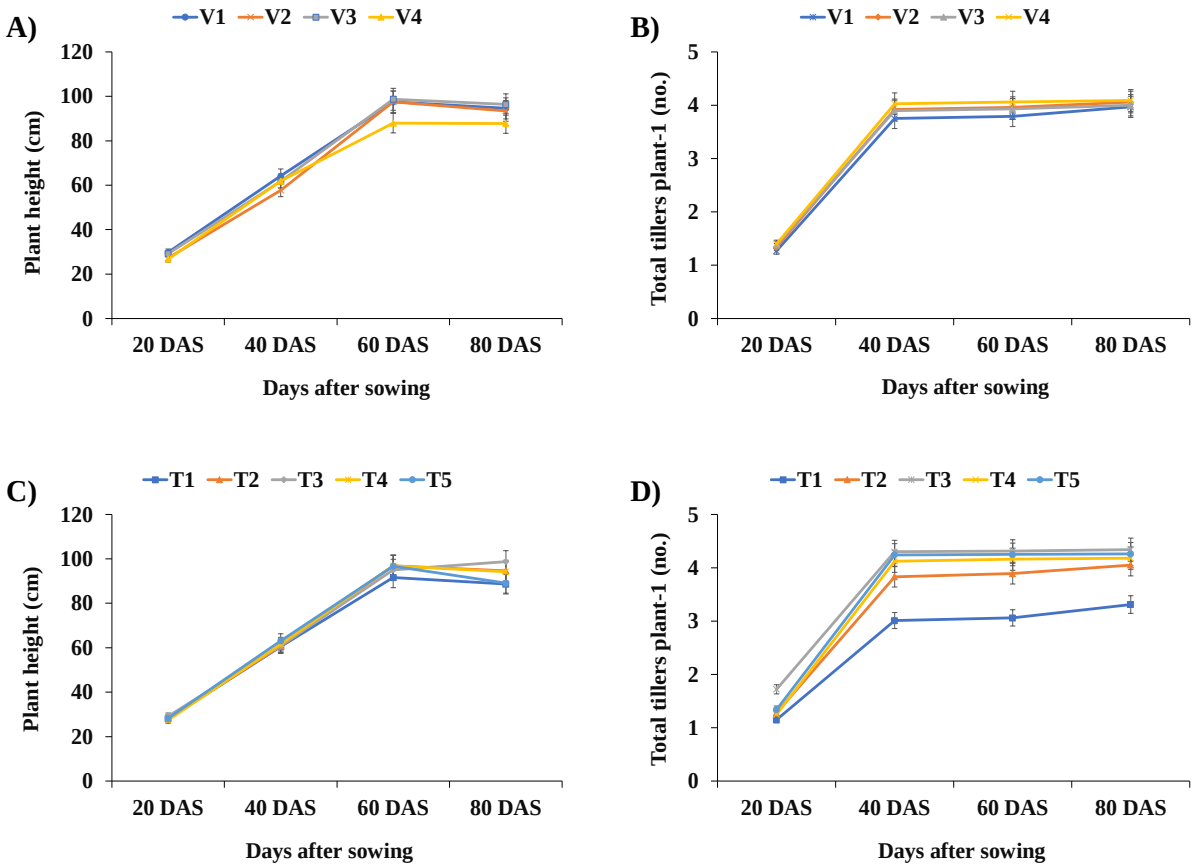

Fig. 1. Effects of variety and sources of nitrogen on plant height and number of total tiller plant^{-1} of wheat cultivars at different DAS (A-D)

Here, V_1-BARI Gom-28, V_2-BARI Gom-30, V_3-BARI Gom-31, V_4-BARI Gom-32
T_1-Control, T_2-90 kg N ha^{-1} from prilled urea, T_3-57 kg N ha^{-1} from prilled urea + 3 t ha^{-1} poultry manure, T_4-62 kg N ha^{-1} from prilled urea + 5 t ha^{-1} cowdung, T_5-29 kg N ha^{-1} from prilled urea + 4 t ha^{-1} vermicompost

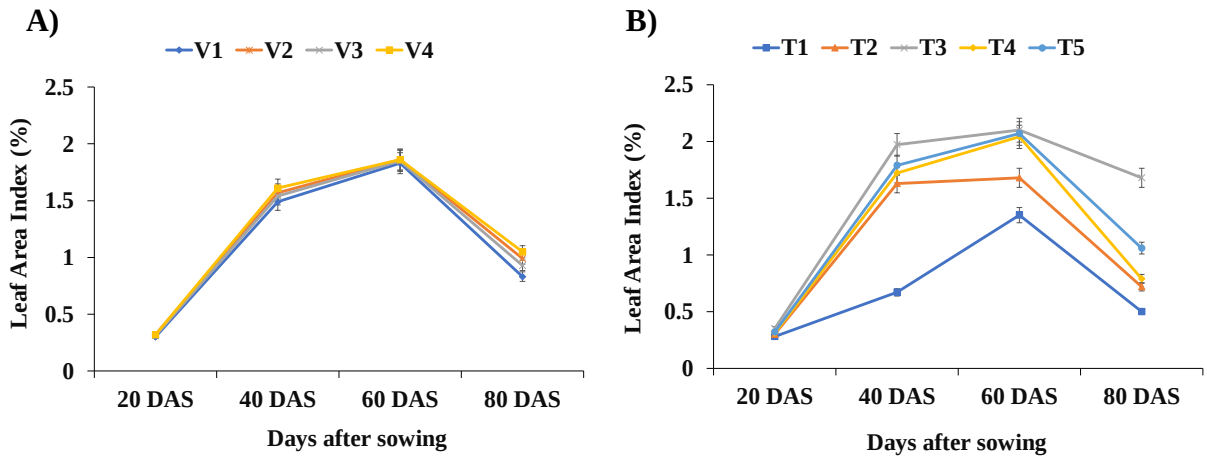

Fig. 2. Effects of variety and sources of nitrogen on leaf area index (LAI) of wheat cultivars at different DAS (A-B)

Here, V_1-BARI Gom-28, V_2-BARI Gom-30, V_3-BARI Gom-31, V_4-BARI Gom-32
T_1-Control, T_2-90 kg N ha^{-1} from prilled urea, T_3-57 kg N ha^{-1} from prilled urea + 3 t ha^{-1} poultry manure, T_4-62 kg N ha^{-1} from prilled urea + 5 t ha^{-1} cowdung, T_5-29 kg N ha^{-1} from prilled urea + 4 t ha^{-1} vermicompost

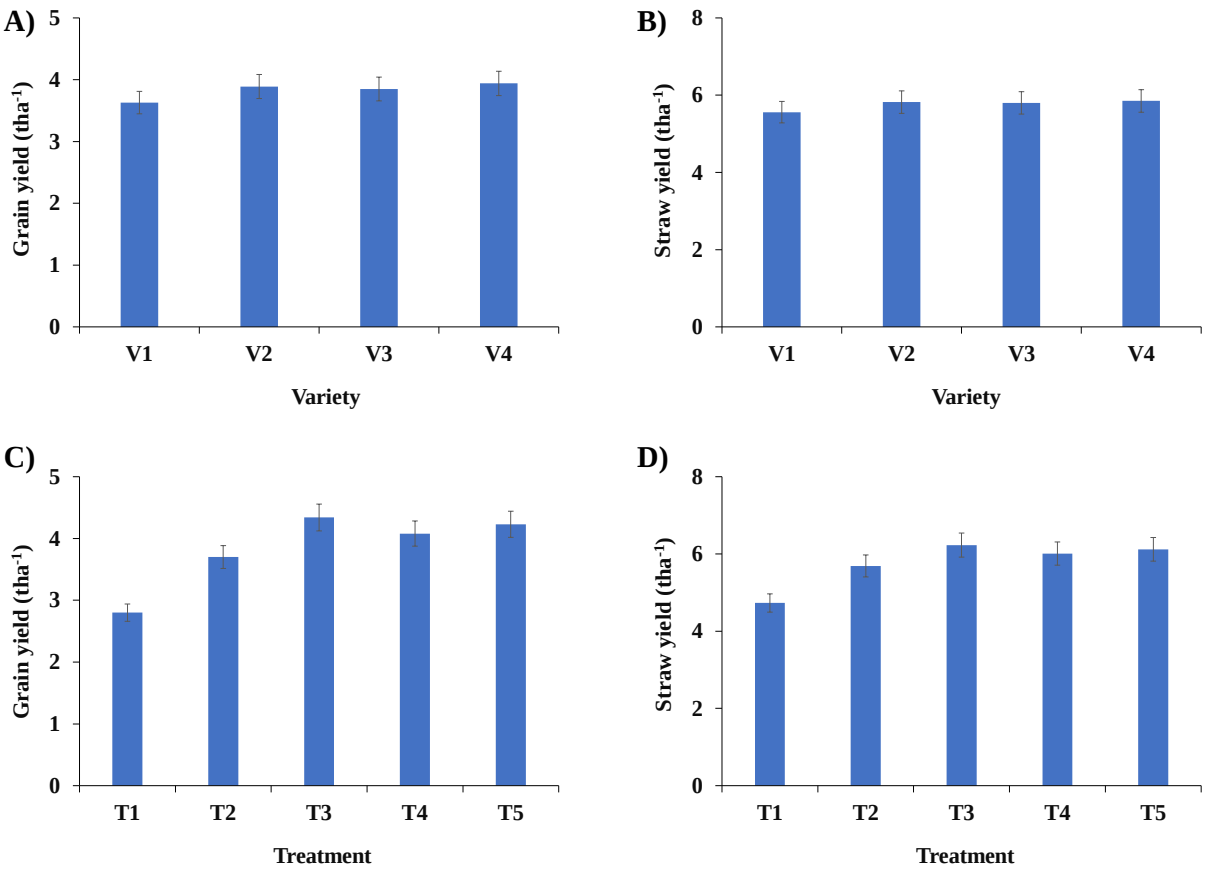

Fig. 3. Effects of variety and sources of nitrogen on grain yield and straw yield of wheat (A-D)

Here, V_1-BARI Gom-28, V_2-BARI Gom-30, V_3-BARI Gom-31, V_4-BARI Gom-32
T_1-Control, T_2-90 kg N ha^{-1} from prilled urea, T_3-57 kg N ha^{-1} from prilled urea + 3 t ha^{-1} poultry manure, T_4-62 kg N ha^{-1} from prilled urea + 5 t ha^{-1} cowdung, T_5-29 kg N ha^{-1} from prilled urea + 4 t ha^{-1} vermicompost

Table 1. Effects of variety on yield and yield contributing characters of wheat cultivars

Variety	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Length of spike (cm)	Numberof spikelets spike^{-1}	No. of grains spike^{-1}	1000-grain weight (g)	Biological Yield (tha^{-1})	Harvest Index (%)
BARI Gom-28	90.97ab	3.4	2.61	10.17	14.98	30.94	53.07c	9.20d	39.24d
BARI Gom-30	92.38a	3.58	2.73	10.35	15.38	31.5	57.15b	9.72b	39.93b
BARI Gom-31	93.37a	3.45	2.68	10.29	15.24	31.3	60.62ab	9.66c	39.76c
BARI Gom-32	88.86b	3.57	2.82	10.4	15.45	32.6	61.07a	9.80a	40.11a
Level of Significance	**	NS	NS	NS	NS	NS	**	**	**
CV%	4.49	8.25	11.96	3.92	7.91	7.21	8.80	2.36	3.37

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ***** =*** *Significant at 1% level of probability; NS= Not significant*

Table 2. Effects of sources of N on yield and yield contributing characters of wheat

Treatment	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Length of spike (cm)	Number of spikelets spike^{-1}	No. of grains spike^{-1}	1000-grain weight (g)	Biological Yield (t ha^{-1})	Harvest Index (%)
T_1	87.69c	3.14c	2.29c	9.73d	14.03d	28.37d	56.31	7.54e	37.16e
T_2	91.93b	3.28c	2.45c	9.99cd	14.36cd	29.62cd	56.77	9.40d	39.28d
T_3	95.49a	3.96a	3.20a	10.94a	16.78a	36.61a	58.91	10.58a	41.07a
T_4	90.00bc	3.52b	2.74b	10.27bc	15.35bc	30.53c	57.7	10.10c	40.45c
T_5	91.87b	3.60b	2.88b	10.58b	15.78b	32.78b	60.18	10.35b	40.85b
Level of Significance	**	**	**	**	**	**	NS	**	**
CV%	4.49	8.25	11.96	3.92	7.91	7.21	8.80	2.36	3.37

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); T_1-Control, T_2-90 kg N ha^{-1} from prilled urea, T_3-57 kg N ha^{-1} from prilled urea + 3 t ha^{-1} poultry manure, T_4-62 kg N ha^{-1} from prilled urea + 5 t ha^{-1} cow dung, T_5-29 kg N ha^{-1} from prilled urea + 4 t ha^{-1} vermicompost.; *****=*** *Significant at 1% level of probability; NS= Not significant*

Table 3. Interaction effects between variety and sources of N on yield and yield contributing characters of wheat cultivars

Interaction	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Length of spike (cm)	Number of spikelets spike^{-1}	No. of grains spike^{-1}	1000-grain weight (g)	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Biological Yield (tha^{-1})	Harvest Index (%)
V_1T_1	93.60a-d	3.06g	2.25i	9.44i	13.86d	27.80g	50.43	2.69o	4.63o	7.32o	36.73k
V_1T_2	87.76d-g	3.23fg	2.40f-i	9.95f-i	14.26cd	29.30efg	51.14	2.95k	4.91k	7.87k	37.56h
V_1T_3	96.74ab	3.86a-d	3.00a-d	10.81a-d	15.96abc	35.46abc	53.2	4.31cd	6.20cd	10.51cd	41.02ab
V_1T_4	86.81efg	3.36efg	2.60c-i	10.21d-h	15.20bcd	30.20d-g	53.83	4.03h	6.00gh	10.03h	40.20ef
V_1T_5	89.97b-g	3.50c-g	2.80b-h	10.47a-g	15.60a-d	31.93c-f	56.76	4.18f	6.09f	10.27f	40.72cd
V_2T_1	85.64gh	3.16fg	2.30ghi	9.84ghi	14.06cd	28.60fg	53.41	2.84m	4.77m	7.61m	37.30i
V_2T_2	94.14a-d	3.30fg	2.46d-i	10.00f-i	14.40cd	29.66efg	56.64	3.94j	5.96ij	9.90ij	39.84g
V_2T_3	93.78a-d	4.00ab	3.20ab	11.00ab	17.16ab	36.13ab	55.76	4.35ab	6.24ab	10.60ab	41.07ab
V_2T_4	93.57a-e	3.86a-d	2.80b-h	10.29c-h	15.40a-d	30.46d-g	61.2	4.11g	6.02g	10.14g	40.59d
V_2T_5	94.76abc	3.60a-f	2.90b-f	10.60a-f	15.86abc	32.66b-e	58.74	4.23e	6.12e	10.36e	40.88bc
V_3T_1	91.58ab-g	3.13fg	2.26hi	9.78hi	14.00cd	28.16g	62.6	2.77n	4.72n	7.49n	36.99j
V_3T_2	95.77ab	3.26fg	2.43e-i	9.99f-i	14.33cd	29.60efg	58.9	3.92j	5.94j	9.86j	39.74g
V_3T_3	97.61a	3.93abc	3.13abc	10.90abc	16.80ab	35.73ab	62.08	4.33bc	6.23bc	10.56bc	41.04ab
V_3T_4	93.10ab-f	3.40d-g	2.73b-i	10.23d-h	15.33a-d	30.40d-g	55.28	4.05h	6.01gh	10.06h	40.30e
V_3T_5	88.81c-g	3.53b-g	2.86b-f	10.55a-f	15.73a-d	32.60b-e	64.23	4.21ef	6.11ef	10.32ef	40.76cd
V_4T_1	79.94h	3.20fg	2.36f-i	9.85ghi	14.20cd	28.93efg	58.81	2.91l	4.82l	7.73l	37.61h
V_4T_2	90.06b-g	3.33efg	2.50d-i	10.04e-i	14.46cd	29.93efg	60.41	3.98i	5.98hi	9.96i	39.98fg
V_4T_3	93.82a-d	4.06a	3.46a	11.04a	17.20a	39.13a	64.62	4.38a	6.27a	10.65a	41.16a
V_4T_4	86.52fgh	3.46c-g	2.83b-g	10.35b-h	15.46a-d	31.06d-g	60.51	4.14g	6.03g	10.18g	40.73cd
V_4T_5	93.94a-d	3.80a-e	2.96a-e	10.70a-e	15.93abc	33.93bcd	61	4.30d	6.17d	10.47d	41.07ab
Level of Significance	**	**	**	**	**	**	NS	**	**	**	**
CV%	4.49	8.25	11.96	3.92	7.91	7.21	8.80	2.57	2.37	2.36	3.37

*In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) Here, V_1-BARI Gom-28,V_2-BARI Gom-30, V_3-BARI Gom-31, V_4-BARI Gom-32; T_1-Control, T_2-90 kg Nha^{-1} from prilled urea, T_3-57 kg N ha^{-1} from prilled urea + 3 t ha^{-1} poultry manure, T_4-62 kg N ha^{-1} from prilled urea + 5 t ha^{-1} cow dung, T_5-29 kg N ha^{-1} from prilled urea + 4 t ha^{-1} vermicompost; ****-**Significant at 1% level of probability; NS-Not significan*

4. CONCLUSION

The results revealed that the effects of organic and inorganic N treatments on wheat grain yield and yield-contributing traits were substantial. At growth, the highest number of total tillers hill^{-1} and leaf area index were obtained from BARI Gom-32, while 57 kg N ha^{-1} from prilled urea and 3 t ha^{-1} poultry manure recorded the highest number of total tillers hill^{-1} and leaf area index at all sampling dates. Again, at harvest, maximum number of total tiller plant^{-1}, number of effective tillers plant^{-1}, number of grains spike^{-1}, 1000-grain weight, grain yield, straw yield and harvest index were obtained from BARI Gom-32 when treated with 57 kg N ha^{-1} from prilled urea and 3 tha^{-1} poultry manure. While, these lowest values were found from BARI Gom-28 along with control. Therefore, the overall findings of this study showed that wheat may be effectively cultivated to produce the highest yield potential using the variety BARI Gom-32 in combination with the application of 57 kg N ha^{-1} from prilled urea and 3 t ha^{-1} poultry manure. However, further research in additional Agro-Ecological Zones (AEZs) of Bangladesh is required before drawing conclusions about the right amount of organic and inorganic N. This will allow for meaningful recommendations to be made for the entire country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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