

Influence of organic and inorganic nitrogen on the growth and yield of wheat

Abstract

To evaluate the effects of organic and inorganic N fertilizers on the growth and yield of wheat a field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, from November 2019 to March 2020. The experiment was laid out in a randomized complete block design with three replications. 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, 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure as organic N source, 62 kg N ha⁻¹ from prilled urea + 5 t ha⁻¹ cowdung as organic N source, 29 Kg N ha⁻¹ from prilled urea + 4 t ha⁻¹ vermicompost as organic N source. The experimental result showed that there were significant 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 prilled urea and 3 t ha⁻¹ poultry manure 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 prilled urea and 3 t ha⁻¹ poultry manure produced the highest plant height (95.49 cm), number of 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 highest 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. So, the experiment showed that application of 57 kg N ha⁻¹ from prilled urea and 3 t ha⁻¹ poultry manure in combination with BARI Gom-32 was more potential in terms of yield of wheat.

Keywords: Inorganic N; Organic N; Growth; Harvest index; Yield; Wheat

1. Introduction

Wheat (*Triticum aestivum* L) is one of the most world's leading cereal crops cultivated popularly around the world making it the third most produced cereal after maize and rice [1]. Almost half of the total world grain crop production is occupied by wheat [2]. It ranks first in area (218.5 million hectares) and third in production (734.74 million metric tons) among the grain crops in the world [3]. Wheat is the second largest cereal crops in Bangladesh. Bangladesh achieved remarkable progress in wheat production during the last four decades. There is a great prospect

of wheat cultivation in almost every areas of our country as it is cultivated in the winter season. Besides that, the land of the country is much suitable for wheat production. The total area under wheat cultivation was 332274 ha in 2019 and 3289224 ha in 2020 [4]. It occupies some 4% of the total cropped area and 11% of the area cropped in the *rabi* season, which contributing 7% of the total output of food cereals [5]. This indicates that wheat cultivation may solve to a considerable extent of the food problem and save huge foreign currency of the country as well. But the yield of wheat in Bangladesh is not still satisfactory. The low yield of wheat is attributable to a number of reasons, viz. the traditional practices, 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. The demand for food grains is expected to rise not only a function of population growth but also as more and more people cross the poverty line with economic and social development [1]. Wheat grains are comparatively better source of protein. About 10-12% protein requirement can be encountered by wheat [1]. The growth and yield of wheat depends largely on the application of different fertilizers effectively. Nitrogen is one of the essential plant nutrient elements. Many researchers observed that N has positive influence on the yield and yield contributing characters of wheat. If N is limiting, it may limit the response to other plant nutrients and thus yield may be reduced [5]. Therefore, N is the most important element for enhancing the growth and yield of wheat. It also plays an important role to increase photosynthetic processes, leaf area production, net assimilation rate, tillering capacity of plant which leads to increase production, food quality and as a result optimum supply of N raises the protein content, nutritive value of grain and also improves baking qualities [6- 8]. While, very low level of N fertilizer does not supply proper nutrient to plants which eventually reduces the yield [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 [12] reported that the highest plant height, maximum number of tillers and biological yield was recorded from the treatment where nitrogen was applied @ 203 Kg ha⁻¹, while 1000 grain weight, seeds spike⁻¹ and grain yield was achieved highest where nitrogen was applied @ 145 Kg ha⁻¹. Moreover, in another study by [13] revealed that increasing level of N fertilizer significantly increased the number of total tillers hill⁻¹, number of effective tillers hill⁻¹, number of filled grains spike⁻¹, number of spikelets spike⁻¹ 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. Leaching and volatilization loss of N is the main problem for the deficiency of N in the soil. Due to losses huge amount of N is needed to apply much amount of nitrogenous fertilizer. For that reason, the production cost increases. For maintaining the nitrogen level in the soil, slow releasing organic fertilizer can be used. Losses may be also minimized by making application of fertilizers in correct dose, method and suitable stage of plant growth. Considering the above facts, the present study was therefore undertaken to evaluate 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

The experiment was carried out at the Agronomy Field Laboratory of the Bangladesh Agricultural University, Mymensingh during the period November 2019 to March 2020 to study the influence of organic and inorganic nitrogen on the growth and yield of wheat. Geographically, the experimental site 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 falls under the Old Brahmaputra Floodplain, Agro-ecological Zone-AEZ-9 [14]. The experimental field was a medium high land with silty clay loam soil texture having pH value of 6.8. The climate of the experimental area was characterized by high temperature accompanied by moderately high rainfall during *Kharif* season (April to September) and low temperature in the *Rabi* season (October to March). In *Rabi* season temperature was generally low and there was plenty of sunshine. The experimental treatments consisted of four varieties of wheat viz; BARI Gom-28, BARI Gom-30, BARI Gom-31 and BARI Gom-32 and five fertilizer treatments viz; Control, 90 kg N ha⁻¹ from prilled urea, 57 kg N ha⁻¹ from prilled urea + 3 t poultry manure ha⁻¹ as organic N source, 62 kg N ha⁻¹ from prilled urea + 5 t cowdung ha⁻¹ as organic N source and 29 kg N ha⁻¹ from prilled urea + 4 t vermicompost ha⁻¹ as organic N source. 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 m²). The total number of plots was 60 (5×4×3). Block to block and plot to plot distance were 1.0 m and 0.5 m, respectively.

2.2 Crop husbandry

The land was opened in late November, 2019 with a tractor drawn plough. Later on, the land was ploughed and cross ploughed three times by a country plough followed by laddering to obtain the desirable tilth. The corners and levees of the experimental field 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, 90 kg N ha⁻¹ from prilled urea was applied in two equal halves at 20 and 60 DAS. In treatment 57 kg N ha⁻¹ from prilled urea + 3 t poultry manure ha⁻¹ as organic N source, 57 kg N ha⁻¹ from prilled urea was applied in two equal halves at 20 and 60 DAS and 3 t poultry manure ha⁻¹ was applied before sowing. In treatment 62 kg N ha⁻¹ from prilled urea + 5 t cowdung ha⁻¹ as organic N source, 62 kg N ha⁻¹ from prilled urea was applied in two equal halves at 20 and 60 DAS and 5 t cowdung ha⁻¹ was applied before sowing. In treatment 29 kg N ha⁻¹ from prilled urea + 4 t vermicompost, 29 kg N ha⁻¹ from prilled urea 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. Care was taken to avoid bird damage up to 15 days after sowing. After plant establishment, some seedlings were uprooted to optimize plant population. Weeding was done at 30 and 60 DAS by hand weeding method. The crop received two irrigations, one at CRI stage and the other at early booting stage.

2.3 Data collection on growth traits

Data on growth characters viz., plant height, number of tillers hill⁻¹ and leaf area index were taken at 20, 40, 60 and 80 DAS. Five hills were marked by bamboo stick excluding border rows to collect data on plant height and number of total tillers hill⁻¹. Five hills were collected every sampling date for leaf area index. An automatic leaf area meter (Type AAN-7, Hayashi Dam Ko Co., Japan) was used to measure leaf area. As described by [15], leaf area index was calculated as the ratio of total leaf area and total ground area of the sample.

$$\text{LAI} = \text{LA/P}$$

Where,

LAI = Leaf area index

LA = Total leaf area of the leaves of all the sampled plants (cm²)

P = Area of the ground surface covered by the plant (cm²)

2.4 Data collection on yield and yield contributing characters

Five plants were selected randomly from each plot prior to harvest excluding boarder plants to collect the data on yield and yield contributing characters viz; plant height (cm), number of total tillers hill⁻¹, leaf area (cm²), 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 tha⁻¹. The harvest index was calculated as follows:

Biological yield = Grain yield + Straw yield

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

2.5 Statistical analysis of data

The collected data were analyzed using the analysis of variance technique with the help of computer package program MINITAB-17 and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) [16].

3. Result and discussion

3.1 Growth parameters of wheat cultivars

3.1.1 Effects of different variety on growth parameters of wheat

Plant height and leaf area index (LAI) were significantly affected by variety at 20, 40, 60 and 80 days after sowing (DAS), while number of total tillers plant⁻¹ was not significantly affected by variety (Fig. 1A, 1B & Fig. 2A). BARI Gom-28 produced the highest plant height of 29.82 and 64.13 cm at 20, 40 days after sowing, respectively. On the contrary, BARI Gom-30 gave the shortest plant height of 57.73 cm at 40 DAS (Fig. 1A). On the other hand, numerically, BARI Gom-32 produced the highest number of total tillers hill⁻¹ of 1.40, 4.03, 4.06 and 4.09 at 20, 40, 60 and 80 days after sowing, respectively. On the contrary, BARI Gom-28 gave the lowest number of total tillers 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 days after sowing, 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). [17-19] 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, number of total tillers plant⁻¹ and leaf area index (LAI) at 20, 40, 60 and 80 DAS (Fig. 1C-1D & Fig. 2B). The highest plant height of 29.16 and 98.75 cm were found in 57 kg N ha⁻¹ from prilled urea and 3 t ha⁻¹ poultry manure at 20 and 80 days after sowing, respectively. On the contrary, the shortest plant

height 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 [20] in wheat under different source of nitrogen. The highest number of total tillers plant⁻¹ of 1.72, 4.30, 4.31, and 4.34 were also observed in 57 kg N ha⁻¹ from prilled urea and 3 t ha⁻¹ poultry manure at 20, 40, 60 and 80 days after sowing, respectively. While, the shortest number of total tillers plant⁻¹ 1.15, 3.01, 3.06, 3.31 were observed 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 found from 57 kg N ha⁻¹ from prilled urea and 3 t ha⁻¹ poultry manure at 20, 40, 60 and 80 days after sowing, 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, [21 and 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, 1000-grain weight, grain yield, straw yield, biological yield and harvest index were significantly influenced by variety (Fig. 3A, 3B & Table 1). The highest plant height (93.37 cm) was obtained from BARI Gom-31 and the lowest plant height (88.86 cm) was obtained from BARI Gom-32. Numerically, the highest number of total tillers plant⁻¹ (3.58) was recorded from BARI Gom-30 and the lowest number of total tillers plant⁻¹ (3.40) was recorded from BARI Gom-28. Again, numerically the higher number of effective tillers plant⁻¹ (2.82) was recorded from BARI Gom-32 and the lowest number of effective tillers plant⁻¹ (2.61) was recorded from BARI Gom-28. A similar result was observed by [24]. In addition, numerically the highest number of grains spike⁻¹ (32.06) was obtained from BARI Gom-32. Whereas, the lowest number of grains spike⁻¹ (30.94) was obtained from BARI Gom-28. Moreover, numerically the highest spike length (10.40 cm) was recorded from BARI Gom-32 and the lowest spike length (10.17 cm) was recorded from BARI Gom-28. These circumstances are in accordance with the earlier study of [17]. Again, the highest 1000-grain weight (61.07 g) was obtained from BARI Gom-32 and the lowest 1000-grain weight (53.07 g) was obtained from BARI Gom-28. In addition, BARI Gom-32 produced the highest grain yield (3.94 t ha⁻¹). Whereas, the lowest grain yield (3.63 t ha⁻¹) was obtained from BARI Gom-28 (Fig. 3A). Also similar trend among different varieties were observed by [25-26]. On the other hand, the highest straw yield (5.85 t ha⁻¹) was obtained from BARI Gom-32. Whereas, the lowest straw yield (5.56 t ha⁻¹) was obtained from BARI Gom-28 (Fig. 3B). Again, the highest biological yield (9.80 t ha⁻¹) was obtained from BARI Gom-32 and the lowest biological yield (9.20 t ha⁻¹) was obtained from BARI Gom-28. BARI Gom-32 produced the highest harvest index (40.11) and the lowest harvest index (39.24) was obtained from BARI Gom-28. The similar results were obtained with [18 and 21].

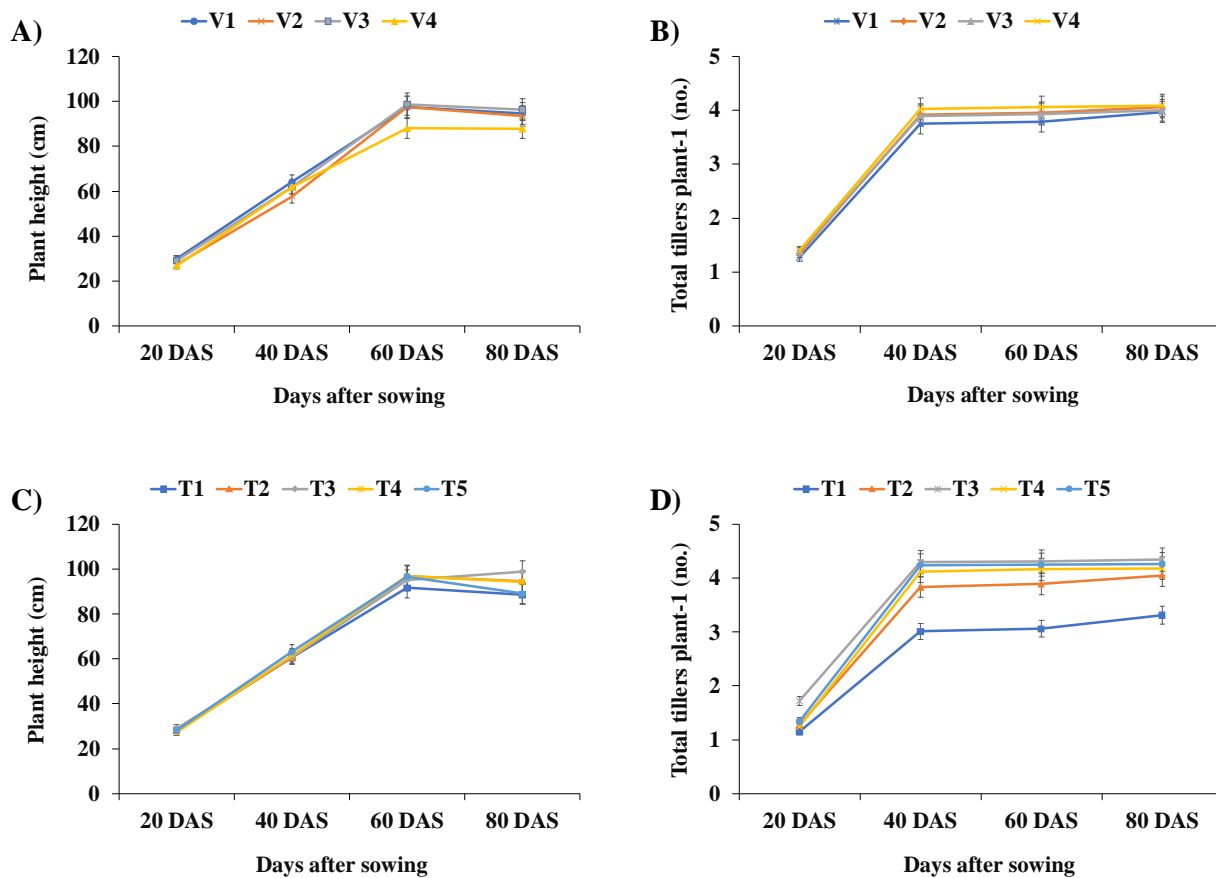


Fig. 1. Effects of variety and sources of nitrogen on plant height and number of total tiller plant⁻¹ of wheat cultivars at different DAS (A-D)

Here, V₁-BARI Gom-28, V₂-BARI Gom-30, V₃-BARI Gom-31, V₄-BARI Gom-32

T₁-Control, T₂-90 kg N ha⁻¹ from prilled urea, T₃-57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure, T₄-62 kg N ha⁻¹ from prilled urea + 5 t ha⁻¹ cowdung, T₅-29 kg N ha⁻¹ from prilled urea + 4 t ha⁻¹ vermicompost.

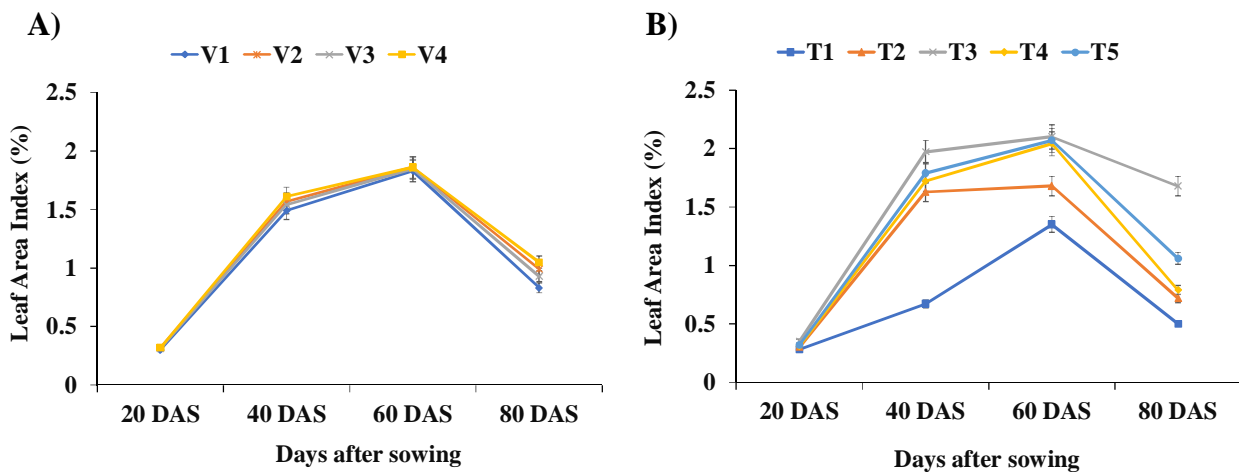


Fig. 2. Effects of variety and sources of nitrogen on leaf area index (LAI) of wheat cultivars at different DAS (A-B)

Here, V₁-BARI Gom-28, V₂-BARI Gom-30, V₃-BARI Gom-31, V₄-BARI Gom-32

T₁-Control, T₂-90 kg N ha⁻¹ from prilled urea, T₃-57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure, T₄-62 kg N ha⁻¹ from prilled urea + 5 t ha⁻¹ cowdung, T₅-29 kg N ha⁻¹ from prilled urea + 4 t ha⁻¹ vermicompost.

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

All yield and yield contributing parameters of wheat cultivars was significantly influenced by different sources of N except 1000-grain weight (Fig. 3C, 3D & Table 2). The highest plant height (95.49 cm) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest plant height (87.69 cm) was obtained from control. In a study, [27] found that chemical fertilizer recorded the highest plant height compared to inorganic fertilizer. However, the higher number of total tillers plant⁻¹ (3.96) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure and the lowest number of total tillers plant⁻¹ (3.14) was recorded from applying control. In addition, the highest number of effective tillers plant⁻¹ (3.20) was recorded from treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure and the lowest number of effective tillers plant⁻¹ (2.29) was recorded from applying control. Again, the highest number of grains spike⁻¹ was found (36.61) when treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure was applied. In case of control the lowest (28.37) number of grains spike⁻¹ was found. However, the highest spike length (10.94 cm) was recorded from treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure and the lowest spike length (9.73 cm) was recorded from control. [28] Found similar results in case of maize with 50% N + 50% poultry manure. Numerically, the highest 1000-grain weight (60.18 g) of wheat was found under 29 kg N ha⁻¹ from prilled urea + 4 t ha⁻¹ vermicompost. While, the lowest 1000-grain weight (56.31 g) of wheat was found under control. Again, the highest grain yield (4.34 t ha⁻¹) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest grain yield (2.80 t ha⁻¹) was obtained from control (Fig. 3C). A similar result was found in a study of [29] where maximum grain yield of (3248 kg ha⁻¹) was obtained from treatment where 25% N was applied from poultry manure and 75% from mineral fertilizer. The highest straw yield (6.23 t ha⁻¹) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest straw yield (4.73 t ha⁻¹) was obtained from control (Fig. 3D). Also another study of [29] a similar result where found where maximum straw yield of (7154 kg ha⁻¹) was obtained from treatment where 25% N was applied from poultry manure and 75% from mineral fertilizer. The highest biological yield (10.58 t ha⁻¹) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest biological yield (7.54 t ha⁻¹) was obtained from control. Again, the highest harvest index (41.07) was obtained from 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest harvest index (37.16) was obtained from control. Similar higher biological yield was obtained by [30] while used cowdung and recommended N to rice and by [31] while used farm yard manure and N to wheat.

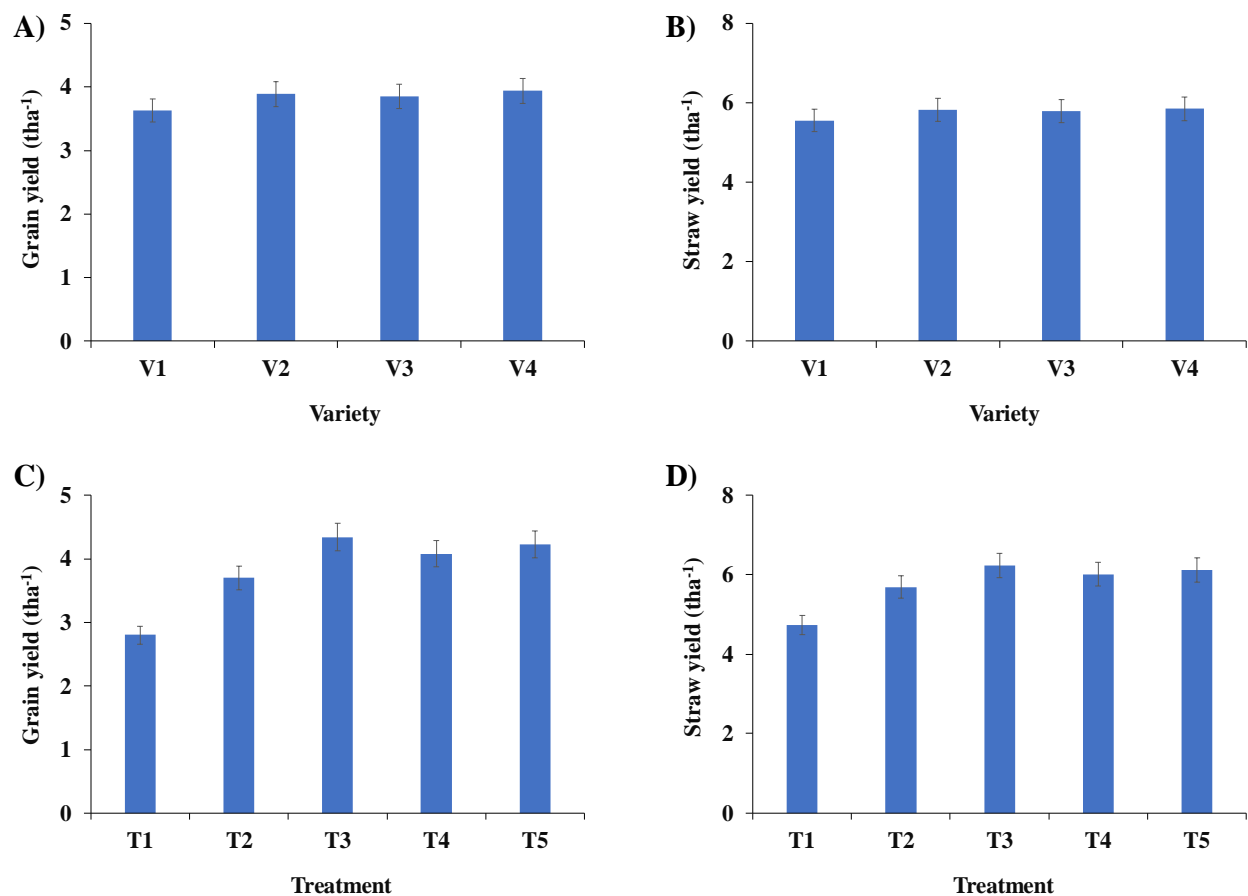


Fig. 3. Effects of variety and sources of nitrogen on grain yield and straw yield of wheat (A-D)

Here, V₁-BARI Gom-28, V₂-BARI Gom-30, V₃-BARI Gom-31, V₄-BARI Gom-32

T₁-Control, T₂-90 kg N ha⁻¹ from prilled urea, T₃-57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure, T₄-62 kg N ha⁻¹ from prilled urea + 5 t ha⁻¹ cowdung, T₅-29 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)	Number of 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
LSD _(0.05)	3.03	0.21	0.24	0.29	0.89	1.68	3.71	0.03	0.11
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 LSD); **=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
LSD _(0.05)	3.38	0.24	0.27	0.33	0.99	1.88	4.21	0.03	0.12
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 LSD); T₁-Control, T₂-90 kg N ha⁻¹ from prilled urea, T₃-57 kg N ha⁻¹ from prilled urea+3 t ha⁻¹ poultry manure, T₄-62 kg N ha⁻¹ from prilled urea+5t ha⁻¹ cow dung, T₅-29 kg N ha⁻¹ from prilled urea+4 t ha⁻¹ vermicompost.; **=Significant at 1% level of probability; NS= Not significant

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 yield contributing parameters of wheat cultivars except 1000-grain weight (Table 3). The highest plant height (97.61 cm) was obtained from interaction of BARI Gom-31 and 57 kg N ha⁻¹ from prilled urea and 3 t ha⁻¹ poultry manure. Whereas, the lowest plant height (79.94 cm) was obtained from interaction of BARI Gom-32 and 0 kg N ha⁻¹. However, the highest number of total tillers plant⁻¹ (4.06) was recorded from interaction of BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure and the lowest number of total tillers plant⁻¹ (3.06) was recorded from interaction of BARI Gom-28 and 0 kg N ha⁻¹. A similar kind of result is also observed by [24] in different wheat varieties. However, the higher number of effective tillers plant⁻¹ (3.46) was recorded from interaction of BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure and the lowest number of effective tillers plant⁻¹ (2.25) was recorded from interaction of BARI Gom-28 and 0 kg N ha⁻¹. Again, the highest number of grains spike⁻¹ (39.13) was obtained from BARI Gom-32 and treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest number of grains spike⁻¹ (27.80) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. The highest spike length (11.04 cm) was obtained from BARI Gom-32 and treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest spike length (9.44 cm) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. Numerically, the highest 1000-grain weight (64.62 g) was obtained from BARI Gom-32 and treatment 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest 1000-grain weight (50.43 g) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. Similar trend of the effect of source of nitrogen was observed by [28 and 32], in different traits of wheat. The highest grain yield (4.38 t ha⁻¹) was obtained from BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest grain yield (2.70 t ha⁻¹) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. [17 and 33] observed significant interaction effect between varieties and different N levels on wheat. The highest straw yield (6.27 t ha⁻¹) was obtained from BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest straw yield (4.63 t ha⁻¹) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. The highest biological yield (10.65 t ha⁻¹) was obtained from BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest biological yield (7.32 t ha⁻¹) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. The highest harvest index (41.16) was obtained from BARI Gom-32 and 57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure. Whereas, the lowest harvest index (36.73) was obtained from interaction of BARI Gom-28 and 0 kg N ha⁻¹. Similarly, [34] observed that application of combined organic manure and biofertilizer resulted into better grain yield, biological yield and harvest index in different wheat cultivars.

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 ₁ T 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 ₁ T 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 ₁ T 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 ₁ T 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 ₁ T 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 ₂ T ₁	85.64gh	3.16fg	2.30ghi	9.84ghi	14.06cd	28.60fg	53.41	2.84m	4.77m	7.61m	37.30i
V ₂ T 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 ₂ T 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 ₂ T 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 ₂ T 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 ₃ T 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 ₃ T 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 ₃ T ₃	97.61a	3.93abc	3.13abc	10.90abc	16.80ab	35.73ab	62.08	4.33bc	6.23bc	10.56bc	41.04ab
V ₃ T 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 ₃ T 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 ₄ T ₁	79.94h	3.20fg	2.36f-i	9.85ghi	14.20cd	28.93efg	58.81	2.91i	4.82i	7.73i	37.61h
V ₄ T 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 ₄ T 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 ₄ T 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 ₄ T 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
LSD _(0.05)	6.77	0.47	0.53	0.67	1.99	3.76	8.43	0.04	0.03	0.05	0.24
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 LSD) Here, V₁-BARI Gom-28, V₂-BARI Gom-30, V₃-BARI Gom-31, V₄-BARI Gom-32; T₁-Control, T₂-90 kg N ha⁻¹ from prilled urea, T₃-57 kg N ha⁻¹ from prilled urea + 3 t ha⁻¹ poultry manure, T₄-62 kg N ha⁻¹ from prilled urea + 5 t ha⁻¹ cow dung, T₅-29 kg N ha⁻¹ from prilled urea + 4 t ha⁻¹ vermicompost; **-Significant at 1% level of probability; NS-Not significant.

Conclusion

Results revealed that organic and inorganic N treatments had significant effects on grain yield and yield contributing characters of wheat. 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 t ha⁻¹ poultry manure. While, these lowest values were found from BARI Gom-28 and control. The overall results of the present study demonstrated that wheat may be grown successfully for obtaining maximum yield from 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, before making conclusion concerning the appropriate dose of organic and inorganic N, the study needs further investigation in other Agro-Ecological Zones (AEZs) of Bangladesh for country-wide recommendation which will be useful.

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