



## Effect of foliar and soil application of nitrogen on the growth and yield of wheat

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### Abstract

A pot experiment was conducted at the Bangladesh Institute of Nuclear Agriculture, Mymensingh during the period from November 2013 to March 2014 to examine the effect of nitrogen application methods on the growth and yield of wheat. Two application methods (Foliar spray and soil application) and three varieties viz. Sotabdi, Kanchan and BAW56 were included and experimental test crop. From the study it was found that plant height, total tillers plant<sup>-1</sup>, effective tillers plant<sup>-1</sup>, root dry weight plant<sup>-1</sup>, grains panicle<sup>-1</sup>, 100 grain weight, grain weight plant<sup>-1</sup>, straw weight plant<sup>-1</sup>, biological yield plant<sup>-1</sup> and harvest index were significantly higher by foliar spray method than the soil application of nitrogen. Higher grain yield (9.01 g plant<sup>-1</sup>) was observed by the foliar spray application and lower grain yield was 6.07 g plant<sup>-1</sup> obtained from the soil application. Among 3 varieties Sotabdi was found to be better yielding ability and produced comparatively higher plant height, total tillers plant<sup>-1</sup>, effective tillers plant<sup>-1</sup>, root dry weight plant<sup>-1</sup>, grains panicle<sup>-1</sup>, 100 grains weight, grains weight plant<sup>-1</sup>, straw weight plant<sup>-1</sup>, biological yield plant<sup>-1</sup>, in respect of harvest index values. BAW56 was observed as medium performed variety and Kanchan was the least. Regarding interaction effect of the variety Sotabdi also showed the highest plant<sup>-1</sup>, total tillers plant<sup>-1</sup>, effective tillers plant<sup>-1</sup>, root dry weight plant<sup>-1</sup>, grains panicle<sup>-1</sup>, 100 grains weight, grains weight plant<sup>-1</sup>, straw weight plant<sup>-1</sup>, biological yield plant<sup>-1</sup> and harvest index by foliar spray. The results indicated that all the varieties gave higher grain yields under foliar spray application method.

**Key words:** Foliar and soil application, nitrogen, growth, yield, wheat.

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### Introduction

Wheat (*Triticum aestivum*) is one of the major leading cereals in the world, which ranks first in terms of acreage and production. About one third of the world populations live on wheat grain for their subsistence (Hanson *et al.*, 1982). It is the second important cereal crop in Bangladesh after rice. Wheat covered 7.74 Million ha having a total production of 2.19 million tons of grain in 2000-2001 (BBS, 2001). Wheat is the most important nutritious cereal crop, contributing 45% of energy and provides 30% of the total carbohydrate in the human diet as well as in feeding livestock (Evans,

1993). The grain contains 12.0% protein, 1.72% fat, 69.90 carbohydrates and 27.20% mineral matter (BARI, 1997).

The average yield of wheat in Bangladesh is 1.9 ton ha<sup>-1</sup>, which is very low compared to other wheat growing countries like Holland, UK, France and Norway where average yield is 7.1, 5.9, 5.6, and 4.1 to ha<sup>-1</sup>, respectively (FAO, 1987). Various factors such as judicious fertilizers application, method of fertilizer application, good varieties, good cultural operation etc.

are mainly responsible for the successful production of wheat. of the several reasons of low yield of wheat in Bangladesh, unscientific method of fertilizer application, improper dose of fertilizer and sometimes use of wrong varieties are important ones. The efficiency applied fertilizer depends mostly on the methods, mode of application and rate of fertilizer.

There are three major nutrients such as nitrogen, phosphorus and potash play major role for successful growth and development of cereal crops. Among them nitrogen I considered to be the most important nutrient element for plants. Rate of nitrogen application has a great influence of growth, development and yield of wheat. High requirements coupled with wide spread of this nutrients in our soil assume a greater importance. Added nitrogenous fertilizer is subjected to various losses in the soil mainly due to leaching, run off and denitrification. In consideration of cost and availability of the fertilizer minimum amount with higher efficient use is always desirable. Improved efficiency of fertilizers may be achieved by reducing various losses. Losses may be minimized by making application of fertilizers in correct dose. Method and at suitable stage of plant growth According to Kalimuddin (1974), nitrogen, requirement of wheat varies from 33.61 to 179.24 kg N ha<sup>-1</sup>

Among different methods of nitrogen application foliar application of urea has drawn a considerable attention in recent years. But a little information is available. Mathur et al. (1969) reported that yield and yield contributing characters of wheat increased with other foliar application of urea. It has been found that a substantial percentage on the total requirement of certain plant nutrients can be fed by the foliar method. Feeding plant nutrients through the soil is a slow process. Recent researchers showed that nutrient solution sprayed on plant foliage could be quickly absorbed and metabolized. Absorption takes place from both the upper and lower surface of the leaves plant absorbs nutrients not only through their leaves but also through the young fruits stems, flowers and other parts

of the plant. Young and rapidly expanding leaves are more efficient in absorption than the fully matured leaves (Mitsui, 1967)

As the applied nitrogen is lost from the soil mainly through leaching and denitrification the application of nitrogenous fertilizer to the soil may not always be ensured a steady supply to the crops which may be subjected to loss due to rainfall. Flood irrigation and also of the nature of soil. In such situation foliar application of fertilizer- N may be more efficient. In view of the above facts, the present study has been under taken to study the efficiencies of nitrogen application methods (Soil and foliar application) on the growth and yield of wheat and to explore the varietal influence on the utilization of nitrogen.

## **Material and Methods**

**Field Experimental field and site:** A field experiment was carried out at Bangladesh institute of Nuclear Agriculture, Mymensingh during the period from November 2013 to march 2014. The experimental site was conducted on a medium high, and loamy textural having pH 6.8 and the site belonging to non calcareous dark grey flood plain soil under Old Brahmaputra Floodplain (AEZ-9).

**Test Crop:** Sotabdi was developed by BARI and released in 2000. This variety attains a height of 90-100 cm and it takes 105-112 days to complete life cycle. It takes 69 days to heading and the yield was 3.6-5.0 t/ha. Kanchan was developed by BARI and released in 1983. This variety attains a height of 90-100 cm and it takes 60-68 days to Heading. It takes 106-112 days to complete its life cycle and in susceptible to leaf rust disease. The yield was 3.5- 4.0t /ha

Baw is a semi dwarf variety. This variety attains a height of 95- 105 cm. Number of tiller per hill is 5-7. Leaves are in green in colour. Flag leaf erect and flat. The yield was 3.5- 4.5t /ha.

**Climate:** Details of the climatic data during the study period have been recorded.

**Treatments:** The experiment consists of the following treatments:

A: Methods: 2

I. Foliar spray application of Nitrogen ( $T_1$ )

II. Soil application of Nitrogen ( $T_2$ )

B. Variety-3

I. Sotabdi coded as  $V_1$

II. Kanchan coded as  $V_2$

III. RAW 56 coded as  $V_3$

**Experimental design:** The experiment was laid out in 2 factorial RCBD design with five replication. Total number of pot was 30. The area of the pot size was  $0.030 \text{ m}^2$

**Seed sowing:** Seeds were sown on 17 November, 2013 and 8 seeds were sown in each pot.

**Harvesting:** The crop was harvested at full maturity on 1 March 2014

**Data collection:** The data were collected on the following parameters- Plant height per plant, Total no. of tillers per plant, Effective tiller per plant, Root dry weight per plant, Grains per Panicle, No. of sterile spiklets per panicle, 1000-grain weight, Grain weight per plant, Straw weight per plant, Biological yield per plant and Harvest index.

**Statistical analysis:** Data were analyzed statistically using analyzed with computer package programme MSTAT and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and ranking was indicated by letters.

## Results and Discussion

**Plant height per plant:** It was observed that method of nitrogen application influenced the plant height significantly. The taller plant was obtained from foliar application of nitrogen method (71.50cm and 86.06cm) at 60 and 90 DAS of plant respectively. The lower

plant height was obtained from soil application of nitrogen method (66.61 cm and 82.22cm) at 60 and 90 DAS of plant (Table 1) respectively. It was observed that varieties influenced the plant height significantly (Appendix-1). The variety sotabdi produced maximum height (70.44cm) and (85.23cm) at 60 and 90 DAS of plant Kanchan gave the lowest height (67.47 cm and 82.99cm) at 60 and 90 DAS of plant (Table 2), respectively.

The interaction effect of method of nitrogen application and variety on plant height was statistically significant nitrogen application method. The tallest (72.50 cm and 87.02cm) at 60 and 90 DAS of plant was obtained from variety Sotabdi with foliar nitrogen application method respectively. The lowest plant as 64.44 cm and 80.46cm at 60 and 90 DAS of plant was obtained from variety BA W 56 with foliar nitrogen application method (Table 3), respectively.

**Total of tillers per plant:** The analysis of variance indicates that the effect of nitrogen application method on number of total tillers plant<sup>-1</sup> was statistically significant. The higher number of total tillers plant<sup>-1</sup> as 6.020 and 6.01 at 60 and 90 DAS of plant respectively was obtained from foliar nitrogen application method and lower number of total tillers plant<sup>-1</sup> at 60 and 90 DAS of plant as (4.84 and 4.74) was obtained from soil nitrogen application method (Table 1)

From the analysis of variance, total number of total tillers plant<sup>-1</sup> was statistically significant in different variety. The higher number of total tiller plant<sup>-1</sup> ( 6.020 and 5.98) at 60 and 90 DAS of plant was obtained from variety sotabdi The lower number of total tillers plant<sup>-1</sup> at (4.97 and 4.72) at 60 and 90 DAS of plant obtained from variety Kanchan (Table 2).

The interaction effect of method of nitrogen application and variety on total number of tillers plant<sup>-1</sup> had no significant effect. The highest number of total tillers plant<sup>-1</sup> (6.58) was obtained from variety Sotabdi with foliar nitrogen application at 90 DAS of plant. The lowest number of effective tillers plant<sup>-1</sup> (4.10) was

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found from variety BAW 5 with soil nitrogen application method (Table 3).

**Effective tillers per plant:** It was observed that method of nitrogen application influenced the effective tillers plant<sup>-1</sup> significantly. The higher number of effective tillers plant<sup>-1</sup> as (3.19) was obtained from foliar nitrogen application method. The lower number of effective tillers plant<sup>-1</sup> as (2.76) was obtained from soil nitrogen application method (Table 1).

Effective tillers plant-1 showed significant response to varieties. The highest number of effective tiller per plant (3.22) was obtained from variety Sotabdi which

was similar to variety BAW 56. The lowest number of effective tillers per plant (2.760) was obtained from variety Kanchan (Table 2).

The interaction effect between nitrogen application method and variety on the production of effective tillers plant-1 was statistically significant. The highest number of effective tillers plant-1 (3.48) was obtained from the variety sotabdi with foliar nitrogen application and the lowest no. of effective tiller per plant (2.62) was found from variety BAW56 with soil nitrogen application method (Table 3).

**Table 1.** Effect of method of Urea application on plant morphological attributes of wheat.

Method	Plant height		Total tillers per plant		Effective tillers per plant	Root dry weight per plant
	60 DAS	90 DAS	60 DAS	90 DAS		
Foliar nitrogen application (T <sub>1</sub> )	71.51a	86.06a	6.02a	6.01a	3.19a	1.01a
Foliar nitrogen application (T <sub>2</sub> )	63.61b	82.20b	4.84b	4.74b	2.76b	0.54b
LOS	**	**	**	**	**	**
LSD 0.05	0.5916	0.3383	0.2642	0.2381	0.2536	0.0963

The common letters and without letter do not differ at 5% level of probability as per DMRT, \*\*= Significant at 1% level of probability.

**Table 2.** Varietal performance on plant morphological attributes of wheat

Method	Plant height		Total tillers per plant		Effective tillers per plant	Root dry weight per plant
	60 DAS	90 DAS	60 DAS	90 DAS		
Sotabdi	70.44a	85.23a	6.02a	5.98a	3.22a	0.88a
Kanchan	67.47c	82.99c	4.79c	4.72c	2.76b	0.65b
BAW56	69.27b	84.17b	5.48b	5.42b	2.95ab	0.80a
LS	**	**	**	**	**	**
LSD 0.05	0.7475	0.4275	0.3338	0.3008	0.3205	0.1216

The common letters and without letter do not differ at 5% level of probability as per DMRT, \*\*= Significant at 1% level of probability.

**Root dry weight per plant:** It was observed that methods of nitrogen application influenced the root dry weight significantly. The higher root dry weight per plant (1.01g) was obtained from foliar application of nitrogen method. The lower root dry weight per plant (0.54g) was obtained from soil application of nitrogen method (Table 1)

The effect of variety on the root dry weight per plant was significant. The highest root dry weight per plant

(0.65g) was obtained from variety Kanchan (Table 2).

The interaction effect between nitrogen application method and variety on root dry weight per plant (1.18g) was obtained from variety sotabdi with foliar application of nitrogen method and the lowest root dry weight per plant (0.44g) was obtained from variety BAW with soil application of nitrogen method (Table 3).

**Table 3.** Interaction effect of variety and method of urea application on plant characters of wheat.

Method	Plant height		Total tillers per plant		Effective tillers per plant(no)	Root dry weight per plant(g)
	60 DAS	90 DAS	60 DAS	90 DAS		
V <sub>1</sub> T <sub>1</sub>	72.50a	87.02a	6.54	6.58	3.48a	1.18a
V <sub>1</sub> T <sub>2</sub>	70.50b	85.28b	5.44	5.34	2.90bc	0.86b
V <sub>2</sub> T <sub>1</sub>	71.52ab	85.88b	6.08	6.10	3.20ab	1.00b
V <sub>1</sub> T <sub>2</sub>	68.38c	83.44c	5.50	5.38	2.96bc	0.58c
V <sub>3</sub> T <sub>1</sub>	64.44e	80.46d	4.88	4.34	2.70c	0.60c
V <sub>3</sub> T <sub>2</sub>	67.02d	82.70c	4.14	4.10	2.62c	0.44c
LS	*	*	NS	NS	*	*
LSD 0.05	1.057	0.6046	-	-	0.4532	0.1720

The common letters and without letter do not differ at 5% level of probability as per DMRT, LS= level of significance, V<sub>1</sub>= Sotabdi, V<sub>2</sub> = Kanchan, V<sub>3</sub>= RAW56, T<sub>1</sub>= Foliar application of nitrogen, T<sub>2</sub>= Soil application of nitrogen.

**Grain per panicle:** It was observed that the method of nitrogen application influenced the grain per panicle significantly. The higher number of grain per panicle (49.11) was obtained from foliar application of nitrogen method and the lowest number of grain per panicle (43.89) was obtained from soil application of nitrogen method (Table 4).

The number of grain per panicle was statistically significant in different variety. The highest number of grain per panicle (47.70) was obtained from variety Sotabdi and the lowest number of grains per panicle (44.87) was obtained from variety kanchan (Table 5).

The interaction effect between nitrogen application method and variety on the number of grain per panicle

was statistically significant. The highest number of grain per panicle (50.52) was obtained from variety sotabdi with foliar application of nitrogen method and the lowest number of grain per panicle (42.32) was obtained from variety BAW with soil application of nitrogen method (Table 6).

**Sterile Spikelets per panicle:** It was found that nitrogen application method had no significant effect on no. of sterile spikelet per panicle. However, It was found that apparently soil nitrogen method produced lowest no. of sterile spikelet per panicle than foliar application of nitrogen method (Table 4).

The effect of variety on of sterile spikelet per panicle was statistically significant. The highest number of

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sterile spikelet per panicle (6.29) was obtained from variety Kanchan and the lowest number of sterile spikelet per panicle (4.48) was obtained from variety Sotabdi (Table 5).

The interaction effect between nitrogen application method and variety of sterile spikelets per panicle was statistically significant. The highest number of sterile

spikelets per panicle of grain per panicle (7.02) was obtained from variety sotabdi with nitrogen application method and the lowest number of sterile pikelets per (4.32) was obtained from variety Kanchan with soil nitrogen application method (Table 6).

**Table 4.** Effect of method of urea application on plant morphological attributes of wheat

Method	Grains /panicle number	Sterile spikelets/panicle (no.)	1000-grains weight(g)	Grains weight/plant(g)	Straw weight/plant(g)	Biological yield/plant (g)	Harvest index (%)
Foliar nitrogen application (T <sub>1</sub> )	49.11	5.63	4.46a	9.01a	11.79a	20.76a	43.44a
Foliar nitrogen application (T <sub>2</sub> )	43.89	5.09	4.17b	6.07b	8.78b	14.85b	40.30b
L OS	**	NS	**	**	**		**
LSD 0.05	0.6437	-	0.081	0.6102	1.100		2.044

The common letters and without letter do not differ at 5% level of probability as per DMRT, \*\*= Significant at 1% level of probability.

**Weight of 100 grains:** The effect of nitrogen application method on 1000 grain weight was statistically significant. The higher 100 grain weight was (4.46g) was obtained from the foliar application of nitrogen method and lower one was (4.17g) in soil nitrogen application method (Table 4).

Varieties different significantly in respect to 1000 grain weight Sotabdi gave the highest 1000 grain weight (4.51g) and the lowest was the variety Kanchan (4.11g) (Table 5).

**Table 5.** Varietal performance on plant morphological attributes of wheat

Method	Grains /panicle number	Sterile spikelets/panicle (no.)	1000-grains weight(g)	Grains weight/plant(g)	Straw weight/plant(g)	Biological yield/plant (g)	Harvest index (%)
Sotabdi	47.70a	4.45b	4.51a	8.09a	10.50	18.59	43.24a
Kanchan	44.87b	6.29a	4.11c	7.18b	9.86	17.15	42.58a
BAW56	46.94a	5.32ab	4.33b	7.36b	10.50	17.68	-
L OS	**	*	**	*	NS	NS	*
LSD 0.05	0.8133	1.271	0.1022	7.710	-	-	2.582

The interaction effect between nitrogen application method and variety on 1000 grain weight was statistically significant. The highest value (4.72g) was noticed in variety Sotabdi with foliar nitrogen application method and lowest value (4.00g) was noticed in variety BAW56 with soil nitrogen application method (Table 6).

**Grains weight per plant:** It was observed that methods of nitrogen application influenced the grains weight per plant significant. The highest Grains weight per plant (9.10g) was obtained from the foliar application of nitrogen method and the lowest grains weight per plant (6.07g) was obtained from soil application of nitrogen method (Table 4).

Grains weight per plant was influenced by variety and it was statistically significant. The highest grains weight per plant (8.09g) was obtained from variety sotabdi and the lowest grains per plant (7.18g) was obtained from variety BAW56 (Table 5).

**Straw weight per plant:** It was observed methods to nitrogen application influenced the straw weight per plant significant. The higher straw yield per plant (11.79g) was obtained from the foliar application of nitrogen method and the lower straw weight per plant (8.78g) was obtained from soil application of nitrogen method (table4).

The influence of variety on straw weight per plant was not significant. However, the highest straw weight per plant (10.50g) was obtained from variety Sotabdi and BAW 56 and the lowest straw weight per plant (9.86g) (Table 5).

The interaction effect between nitrogen application method and variety on straw weight per plant was statistically significant. The highest straw weight per plant value (12.18g) was obtained from the variety Kanchan with foliar nitrogen application and the lowest straw weight per plant (8.56g) was obtained from varietyBAW56 with soil nitrogen application method (Table 6).

**Table 6.** Effect of variety and method of Urea application on yield and yield attributes of wheat.

Method	Grains /panicle number	Sterile spikelets/pan icle(no.)	1000-grains weight(g)	Grains weight/plant( g)	Straw weight/pla nt(g)	Biological yield/plant (g)	Harvest index (%)
V <sub>1</sub> T <sub>1</sub>	50.52a	4.64	4.72	9.60	12.04	21.64	44.37
V <sub>1</sub> T <sub>2</sub>	47.26b	7.02	4.22	8.80	11.16	19.82	44.39
V <sub>2</sub> T <sub>1</sub>	49.56a	5.24	4.44	8.64	12.18	20.82	41.57
V <sub>1</sub> T <sub>2</sub>	44.48c	4.32	4.30	6.58	8.96	15.54	42.11
V <sub>3</sub> T <sub>1</sub>	44.48c	5.56	4.22	5.92	8.82	14.54	40.77
V <sub>3</sub> T <sub>2</sub>	42.32d	5.40	4.00	5.72	8.56	14.48	38.02
Level of significance	*	*	**	**	**	NS	NS
LSD 0.05	1.150	1.797	0.1445	1.090	1.127	-	-

**Biological yield:** It was observed that methods of nitrogen application influenced biological yield per plant significantly. The higher biological yield per plant (20.76g) was obtained from foliar application of nitrogen method and the lower biological yield per plant (14.85) was obtained from soil application of

nitrogen method (Table 4). The effect of variety on biological yield per plant was not significant. However sotabdi produced the highest (18.59 gm) biological yield per plant and lowest biological yield per plant produced by Kanchan (17.15gm) and it was shown in (Table 5). The interaction effect of methods of nitrogen

application and variety had no significant effect on biological yield per plant. The highest biological yield per plant (21.64gm) was obtained from variety Sotabdi with soil nitrogen application method and the lowest biological yield per plant (14.48gm) was obtained from variety BAW56 with soil nitrogen method (Table 6).

**Harvest index:** The higher Harvest index (43.44%) was found from foliar application of nitrogen method and the lower harvest index (40.30%) was found from soil application of nitrogen method (table-4). The effect of variety on harvest index and lowest harvest index (39.79%) produced by BAW 56 (Table 5).

The interaction effect between nitrogen application method and variety on harvest index (44.392%) was obtained from variety sotabdi with soil nitrogen application method and the lowest harvest index (38.018%) was obtained from variety BAW 56 with soil nitrogen application method (Table 6).

### **Conclusion**

The present study revealed that foliar application of nitrogen method performed better compared to soil application of nitrogen method. Sotabdi produced highest yield among the three varieties under investigation. The variety sotabdi with foliar application of nitrogen gave highest yield in wheat. Therefore it may be concluded that the high yield in wheat could be obtained if variety sotabdi planted of Old Brahmaputra Floodplain.

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