International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 6, No. 1, p. 89-95, 2015

INNSPUB

RESEARCH PAPER OPEN ACCESS

Influence of source of nitrogen on growth and yield of wheat

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Key words: *Triticum aestivum*, Wheat, Urea super granules, Prilled urea.

Article published on January 25, 2015

Abstract

An experiment was conducted at Agronomy research field, Sher-e-Bangla Agricultural University, Bangladesh from November, 2012 to March, 2013 to find out the influence of source of nitrogen on growth and yield of wheat. The experiment consisted four different sources of nitrogen *i.e.* N_0= control (no nitrogen fertilizer), N_1= urea super granules (1.8 g) @ 60 kg N/ha, N_2= urea super granules (2.7 g) @ 90 kg N/ha and N_3= prilled urea (92 kg N/ha) using completely randomized block design with three replication. Maximum plant height (84.3 cm), tiller number (621.1/m²), plant dry matter (18.0 g/m²), leaf area index (1.2), number of effective tiller (234.4/m²), number of spikelets (18.3/spike), number of grains (53.3/spike), 1000-grain weight (52.2 g), grain yield (4.1 t/ha), straw yield (5.5 t/ha), biological yield (9.6 t/ha), harvest index (42.3%) was found from N_1 (urea super granules 1.8g) while minimum from N_0. Urea super granules (1.8g) @ 60kg N/ha could be used instead of prilled urea to reduce nitrogen fertilizer cost and better production of wheat.

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Introduction

Wheat (*Triticum astivum* L.) is the third largest cereal production in the world after maize and rice (FAO, 2013). Average yield of wheat in Bangladesh is very low and it can be raised up to 6.8 t/ha (BARI, 2010). Nutrient deficiency and imbalance fertilization are critical factors reducing the yield of wheat (Khan *et al.,* 2010). Nitrogen is the most important nutrient element for plants and rate of nitrogen application has a great influence on growth and yield of wheat (Karamanos *et al.,* 2005; Engel *et al.,* 2001; Walley *et al.,* 2001). Grain yield of wheat increases with increasing nitrogen level up to 120 kg/ha (Singh *et al.,* 2013). Urea is the cheapest nitrogenous fertilizer containing high nitrogen (46%).

Prilled or granular urea is a fast releasing nitrogen fertilizer that causes considerable loss as ammonia volatilization, immobilization, denitrification and surface run off etc (Xiang *et al.,* 2013). Loss of applied urea through ammonia volatilization is up to 50% (Vlek and Craswell, 1979). Losses of nitrogen from the soil/plant system not only reduce soil fertility and plant yield but can also create adverse impacts on the environment (Cameron, 2013). Deep placement of slow releasing nitrogenous fertilizer like urea super granule reduces loss as well as increases its use efficiency (Radhika *et al.,* 2013). Islam *et al.* (2011) found urea super granules to be more effective than prilled urea in case of wheat and its use can reduce production of reactive gases like N_2O etc. (Khalil *et al.,* 2011).

Application of urea super granule requires only one-time application in rice or wheat cultivation and easy for farmers. Thus an experiment was conducted to compare the influence of prilled urea and urea super granules on the growth and yield of wheat with suitable dose of urea super granules for wheat.

Materials and methods

Experimental site and duration

An experiment was conducted at Agronomy field, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during period from November 2012 to March 2013.

Treatments of the experiment

Experiment consisted four sources of nitrogen viz. N_0 = No urea (Control), N_1 = Urea super granules (1.8 g/granule) @ 60 kg N/ha, N_2 = Urea super granules (2.7 g/granule) @ 90 kg N/ha and N_3 = Prilled urea @ 92 kg N/ha following Randomized Completely Block Design with three replication.

Application of treatments

In control treatment no nitrogen fertilizer was applied. All other fertilizers were applied as per as BARI recommended dose. Whereas in case of two urea super granules treatments urea supergranules were applied in alternate line each 33 cm apart from another at 10 DAS and total eight alternate lines/plot and 8 urea super granules/line. Urea super granules were placed 10 cm below surface using urea super granule placement stick. Nitrogen was approximately @ 60 kg N/ha for urea super granules (1.8 g/granule) and @ 90 kg N/ha for urea super granules (2.7 g/granule). For the fourth treatment BARI recommended prilled urea dose i.e. 200 kg/ha were applied in two split. Two third were applied at the time of field preparation and the rest are applied during first irrigation (17-21 DAS).

Plot size, genetic material and seed rate

The size of the individual plot was 3.5 m x 2.5 m with inter plot spacing of 0.50 m and inter block spacing of 1 m. BARI Gom 26 was used as plant materials and seed rate was 120 kg/ha.

Fertilization

All fertilizers except nitrogenous fertilizers were applied at the rate of BARI recommended dose as 180 kg/ha TSP, 50 kg/ha MOP, 120 kg/ha Gypsum (BARI, 2011). Fertilizers other than nitrogen were given during final land preparation.

Seed sowing

Seeds were sown continuously in 20 cm apart rows opened by specially made iron hand tine. Seed rate

was 120 kg/ha. After sowing, seeds were covered with soil and slightly pressed by hands.

Data collection

Data were collected on plant height, tiller number, plant dry matter, leaf area index, weed dry matter, effective tiller, spike length, number of spikelet /spike, number of filled grains spike, 1000-grain weight, grain yield, straw yield, biological yield and harvest index. Collected weeds were first dried in the sun and then kept in an electrical oven for 72 hours maintaining constant temperature of 80°C.

Biological yield was calculated by using following formula:

Biological yield= Grain yield + straw yield

Harvest index was calculated by using following formula:

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

Statistical analysis

Collected data were statistically analyzed using MSTAT-C computer package program and mean differences among treatments were evaluated by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

Results and discussion

Plant height

Plant height of wheat varied significantly among the different nitrogen sources at different days after sowing (DAS). Tallest plant was found from N_1 (84.3 cm) while minimum from N_0 (82.7 cm) at harvest (Fig. 1a). Islam *et al.* (2011), Mattas *et al.* (2011) and Pasha (2005) also found significant variation of wheat plant height due to nitrogen fertilizer. Hasan (2011) concluded that in any treatment of urea super granules performed better for plant height compared to those of prilled urea treatments.

Number of tiller

Number of tiller was varied significantly among the different nitrogenous sources at different DAS. Maximum number of tiller was found from N_1 (621.1/m²) while minimum from N_0 (259.6/m²) at harvest (Fig. 1b). Similar results were reported by Islam *et al.* (2011), Hasan (2011) and Rahman (2005).

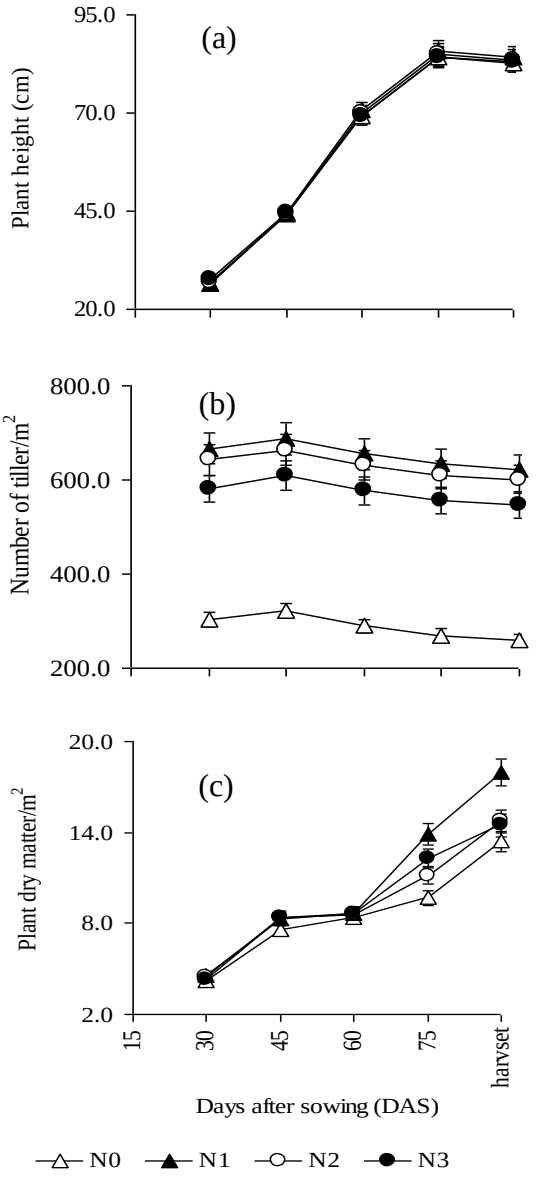

Fig. 1. Response of nitrogen sources on (a) plant height, (b) number of tiller and (c) plant dry matter.

Plant dry matter

Plant dry matter showed a significant variation among the nitrogen sources at different DAS. Maximum plant dry matter was found from N_1 (18.0 g/m²) while minimum from N_0 (13.4 g/m²) at harvest (Fig. 1c). It may be due to less loss of nitrogen from the soil thus in turn providing the plants with more

available nitrogen when needed. Use of urea super granules increases the total dry matter production is already proved. Total dry matter production increased when urea super granules was deeply placed (Hasan, 2011; Das, 2003; Vijaya and Subbaiah, 1997; Xiang *et al.,* 2007; Chanda and Gunri, 2004).

Leaf area index (LAI)

Leaf area index of wheat varied significantly due to various source of nitrogen at different DAS. Maximum LAI was found from N_1 (1.2) followed by N_3 (1.1) while minimum from N_0 (0.9) at 75 DAS (Fig. 2a). Ahmed (2002) concluded that all doses of source of nitrogen produced higher LAI with Urea Super Granules compared with Prilled urea and ammonium sulphate.

Weed dry matter

Weed dry matter showed significant variation among the different nitrogen sources at different DAS. However maximum weed dry matter was found from N_2 (9.3 g/m²) followed by N_1 (8.9 g/m²) while minimum in N_0 (4.5/m²) at 75 DAS (Fig. 2b).

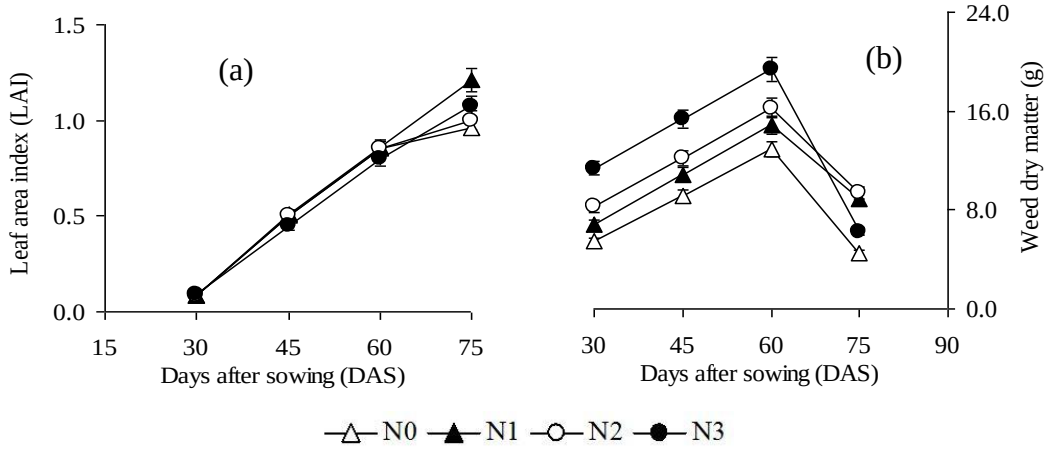

Fig. 2a. Effect of nitrogen sources on (a) leaf area index and (b) weed dry matter of wheat.

Effective tillers

Maximum number of effective tillers was found from N_1 (234.4/m²) while minimum from N_0 (62.1/m²) (Table 1). Islam *et al.* (2011) and Mattas *et al.* (2011) reported that urea super granules increase the effective tiller of wheat.

Spike length

Longest spike was found from N_2 (17.3 cm) which was statistically identical with N_1 (17.2 cm) and N_3 (16.5 cm) while minimum from N_0 (14.3 cm) (Table 1). Hasan (2011) found that urea super granules when placed at 10 cm depth at 20 DAS gave the longest spike (24.1 cm). The shortest spike length (17.3 cm) was recorded in the case of prilled urea broadcast. Similar results were also reported by Rahman (2005).

Number of spikelet

Maximum number of spikelets was found from N_1 (18.3/spike) while minimum from N_0 (15.2/spike) (Table 1). Similar result was also found by Islam *et al.* (2011) and Rahman (2005).

Number of filled grains

Maximum number of filled grains was found from N_1 (53.3/spike) while minimum from N_0 (45.1/spike). Hasan (2011) also reported the same results.

1000-grain weight

1000-grain weight was not varied significantly among the different nitrogen sources. However, maximum 1000-grain weight was found from super granules N_1 (52.2 g) while minimum from N_0 (49.6 g) (Table 1). Islam *et al.* (2011) found similar results. Non-significant variation of 1000-grain weight of wheat

might be because it is genetically inherited character and Khan *et al.* (2007) reported the same.

Grain yield

Maximum grain yield was found from N_1 (4.1 t/ha) followed by N_2 (3.7 t/ha) while minimum from N_0 (1.7 t/ha) (Table 1). Urea super granules 2.7g (N_2) produced 3.64 t/ha grain yields and the prilled urea produced 3.24 t/ha. Hasan (2011), Khalil *et al.* (2006), Das (2003) and Islam *et al.* (2011) found similar effect of urea super granules in wheat. It is observed that urea super granule 1.8g (N_1) which was applied @ 60 kg N/ha application has increased the wheat yield 26% than the prilled urea @ 92 kg N/ha. Also the other urea super granules treatments 2.7g (N_2) @ 90 Kg N/ha increased wheat yield 12% than the prilled urea treatment. This is because placing fertilizer N at about 10 cm below the soil surface with enough moisture in the soil has long been known to improve plant uptake of N (Mitsui, 1954). And effective nitrogen utilization in turn converted more yield. Similar facts were stated by Pillai (1980), Singh *et al.* (1989) and Khattak *et al.* (1988).

Straw yield

Wheat plant showed a significant variation for straw yield due to the application of different doses of Maximum straw yield was found from N_1 (5.5 t/ha) while minimum from N_0 (3.0 t/ha) (Table 1).

Table 1. Effect of different nitrogen sources on yield contributing characters and yield of wheat.

Nitrogen sources	Effective tiller /m²	Spike length (cm)	No of spikelets /spike	No. of filled grains /spike	1000-grain (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	HI (%)
N_0	62.1 c	14.3 b	15.2 c	45.1 c	49.6 a	1.7 d	3.0 c	4.7 d	36.8 c
N_1	234.4 a	17.2 a	18.3 a	53.3 a	52.2 a	4.1 a	5.5 a	9.6 a	42.3 a
N_2	207.8 b	17.3 a	17.1 b	50.7 b	50.5 a	3.7 b	5.1 b	8.7 b	41.5 ab
N_3	205.0 b	16.5 a	17.2 b	49.9 b	50.0 a	3.2 c	4.8 b	8.1 c	39.9 b
$LSD_{0.05}$	11.9	0.8	0.9	2.4	4.6	0.3	0.3	0.6	2.1
CV%	8.07	5.94	6.44	5.7	9.0	11.3	7.7	8.5	6.4

[X]In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

[Y]N_0= control (no nitrogen fertilizer), N_1= urea super granules (1.8 g) @ 60 kg N/ha, N_2= urea super granules (2.7 g) @ 90 kg N/ha and N_3= prilled urea (92 kg N/ha)

Biological yield

Maximum biological yield was found from N_1 (9.6 t/ha) followed by N_2 (8.7 t/ha) while minimum from N_0 (4.7 t/ha) (Table 1). Similar result was also reported by Hasan (2011).

Harvest index (HI)

Maximum harvest index was found from N_1 (42.3%) which was statistically identical with N_2 (41.5%) while minimum from N_0 (36.8%) (Table 1). Dissimilar results observed in case of harvest index. Islam *et al.* (2011), Hasan (2011) and Hira (2009) reported significant variation due to nitrogen source treatments.

Conclusion

Source of nitrogen treatments played vital role in wheat growth and yield. Among the source of nitrogen treatments urea super granules (1.8 g) when applied at the rate of 60 kg N/ha produced highest grain yield. Urea super granules (1.8g) @ 60kg N/ha could be used instead of prilled urea to reduce nitrogen fertilizer cost and better production of wheat.

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