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RESPONSE OF WHEAT TO FOLIAR APPLICATION OF UREA FERTILIZER

M Z Rahman*[1], M R Islam[2], M A Karim[2] and M T Islam[3]

[1]*Department of Agronomy & Haor Agriculture, Sylhet Agricultural University, Sylhet-3100, Bangladesh*
[2]*Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh*
[3]*Department of Biotechnology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh*

Abstract

An experiment was conducted at the Field Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706 during November 2011 to March 2012 to study the response of wheat to foliar application of urea fertilizer. Three fertilizer treatments were maintained in the 3m × 2m experimental plots in a Randomized Complete Block Design (RCBD). A non-fertilized control was compared with two foliar fertilized treatments receiving 20 kg ha^{-1} of N in soil at crop emergence and also received foliar spray of 1% and 2% urea in each time at 36, 53 and 68 Days After Sowing (DAS). Soil Plant Analysis Development (SPAD) value was taken from middle portion of the latest fully developed leaf of tagged plants at 3 day interval from 36 DAS using Minolta Chlorophyll meter upto 89 DAS. Perusal of the data revealed that significant effect was found in total dry matter production, leaf area index and SPAD values for chlorophyll content. Significant increase was recorded in number of effective tillers m^{-2}, spikelets $spike^{-1}$, grains $spike^{-1}$, thousand-grain weight and grain yield with foliar application of urea. Foliar application of 2% urea resulted in maximum number of effective tillers m^{-2}, spikelets $spike^{-1}$, grains $spike^{-1}$ and grain yield. Maximum thousand-grain weight was recorded from 1% urea spray which was statistically similar to that of 2% urea foliar spray. It was concluded that foliar spray of 1% urea solution at tillering, jointing and booting stages along with 20 kg ha^{-1} of N at crop emergence helped in enhancing yield and yield components of wheat.

Key words: Wheat, foliar spray, SPAD, grain yield

Introduction

Wheat (*Triticum aestivum* L.) is the second staple food in Bangladesh next to rice and contributes more than 80% of the total cereal production in South Asia (Timsina and Connor, 2001). Macronutrients availability is influenced by soil chemical and physical properties. The naturally available soil nutrient content may not be always enough to fulfill crop requirement. Nitrogen (N) is the most widely used fertilizer nutrient in wheat and its consumption has increased substantially in the past decades (FAOSTAT, 2009). When N is applied indiscriminately, a large portion of the applied N can escape soil–plant system to reach water bodies and the atmosphere, and, thus creates soil and environmental pollution. Application of nitrogenous fertilizer to the leaves is more efficient because in this way many possible pathways for N loss associated with the application of nitrogen to the soil are avoided (Mosali *et al*. 2006). Alston (1979) reported that foliar application of nitrogen and phosphorus increased grain yield of wheat.

SPAD reading is quite closely correlated with chlorophyll content of leaf (Markwell *et al*. 1995). Chlorophyll meter instantly provides an estimate of leaf N status as chlorophyll content by clamping the unplucked leafy tissue in the meter. The chlorophyll meter indicates the need of a nitrogen top dressing that would result greater agronomic efficiency of nitrogen fertilizer than commonly pre-application of nitrogen (Hassan *et al*. 2009).

The reported experiment was undertaken to study the possible effect of foliar application of urea on yield and yield components of wheat.

Materials and Methods

The experiment was carried out at the Field Research Site of the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706 during November 2011 to March 2012. It is located in Madhupur Tract under AEZ-28 at geographic coordinate $24^0 05'$ North latitude and $90^0 16'$ East longitude with an

***Corresponding author: M Z Rahman,** Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet-3100, Bangladesh, email: zillur_bsmrau@yahoo.com.*

elevation of 8.4 m above the mean sea level. The crop tested in the experiment was wheat (*Triticum aestivum* L.) variety BARI Gom-26 which has been released by Bangladesh Agricultural Research Institute (BARI) in 2010. BARI Gom-26 was sown at a row-to-row spacing of 20 cm.

Three fertilizer treatments were maintained in the 3m × 2m experimental plots in a Randomized Complete Block Design (RCBD) with four replications. A non-fertilized control was compared with two fertilized treatments receiving 20 kg ha^{-1} of N in soil at crop emergence plus supplementary nitrogen which was applied as follows, two treatment plots were applied via foliar spray 1% (FN_{38}=38 kg N ha^{-1}) and 2% (FN_{77}=77 kg N ha^{-1}) urea in each time at 36, 53 and 68 DAS. Foliar spray of urea at 1% and 2% concentrations were prepared by the addition of urea fertilizer in water (w/v) and in each time 760 ml solution of 1% and 2% urea are applied to each plot of wheat plant according to the respective protocol of the treatment.

A basal dose of 60 kg P_2O_5, 40 kg K_2O and 20 kg S per hectare was added to every plot. The source for N, P, K and S were urea, triple super phosphate, muriate of potash and gypsum, respectively. Total amount of triple super phosphate, muriate of potash and gypsum fertilizers were applied plot wise during final land preparation. A chlorophyll meter (SPAD-502, Minolta Camera Co. Ltd, Osaka, Japan) was used to record the chlorophyll content (SPAD value) from 36 DAS up to 89 DAS. A fully matured leaf from the top of the plant was selected for recording the SPAD values and the mean of five readings per plant was taken. Five plants were selected at random for mean SPAD value per treatment. Plants were sampled periodically from a row length of 0.5 linear m per plot by harvesting at the base and these areas are converted to per meter square. The sampling was done at 50, 60, 70, 80 and 90 days after sowing. The above ground plant parts were segmented into different components as leaf, stem and spike with grain. Leaf area in each interval was measured by an automatic leaf area meter (AAM-8, Hayashi Dehnko, Japan) immediately after harvest. The segmented plant parts were then dried in an oven at 70°C for 72 hours and weighed. The experiment was terminated at plant maturity, when the plants were ripen and started to die. The harvest of wheat was started on 14 March and finished on 19 March 2012. Significant treatment mean differences were determined using Duncan's multiple range test (DMRT; Duncan 1955) and LSD test at 0.05 level of probability.

Results and Discussion

Total dry matter production

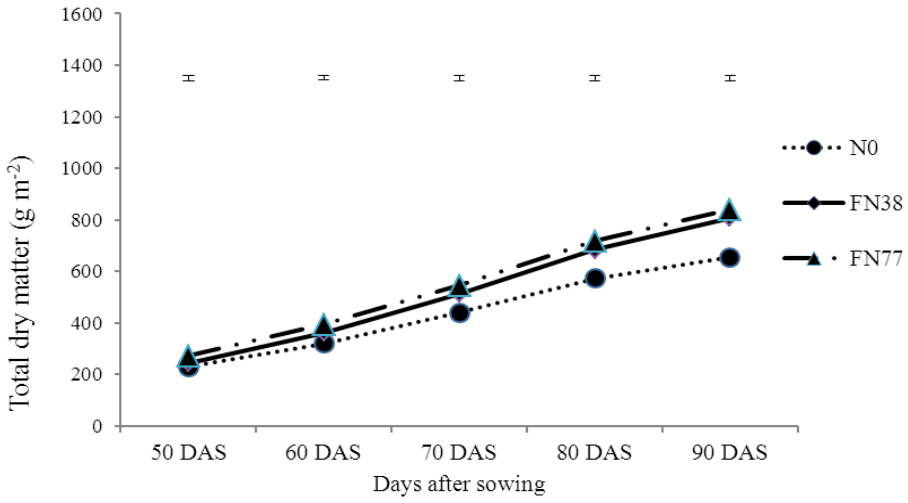

Fig.1. Effect of foliar spray of urea on total dry matter accumulation in wheat over time *(Here, N_0= No Nitrogen, FN_{38} and FN_{77} are the application of N at 1% and 2% urea, respectively in each time)*

Effect of foliar application of urea on total dry matter production revealed significant differences (Fig. 1). Maximum dry matter production was recorded by spraying of 2% urea (FN_{77}) which was followed by 1% urea (FN_{38}), whereas minimum dry matter was produced by control (N_0). It might be due to increased photosynthetic rate and higher leaf area that increased total dry matter production. The results are in line with Gooding and Devies (1992) who reported

better performance of wheat crop for foliar application of N. The highest rate of total dry matter production was observed from 70 to 90 DAS irrespective of nitrogen levels.

Leaf area index (LAI)

The leaf area index (LAI) differed significantly with different doses of foliar application of urea (Fig. 2). Maximum LAI was produced by 2% urea spray (FN_{77}) followed by 1% urea (FN_{38}). On the other hand, minimum LAI was produced by control treatment (N_0). A marked enhancement of LAI in fertilization was also reported by Bali *et al.* (1991). The increase in LAI is caused by increase in number of tillers and in size of successive leaves. LAI increased progressively from early growth stage of wheat and attained peak at around 60 DAS (booting stage) irrespective of treatments.

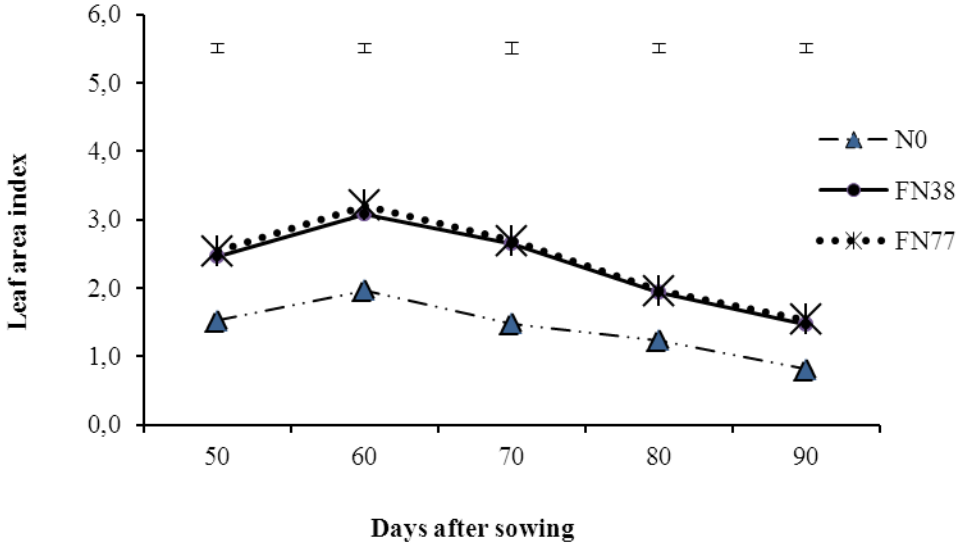

Fig. 2. Leaf area index (LAI) at different growth stages of wheat as influenced by foliar application of urea fertilizer *(Here, N_0= No Nitrogen, FN_{38} and FN_{77} are the application of N at 1% and 2% urea, respectively in each time)*

Yield contributing characters and grain yield

Effective tillers m^{-2}

The data on number of effective tillers m^{-2} revealed significant increase with foliar application of urea (Table 1). The maximum number of tillers (250) was recorded in the treatment of foliar spray of 2% urea (FN_{77}) which was statistically at par with the that of 1% urea (FN_{38}) and the minimum tillers (218) was recorded from the N_0 (control) treatment. These results are in agreement with those of Alston (1979) who reported better performance of wheat with foliar application of N. Hagras (1985) also reported increased number of effective tillers per square meter of wheat with increasing N rate.

Table 1. Effect of foliar application of urea on yield contributing characters and grain yield of wheat

Treatment	Tillers m^{-2} (no.)	Spikelets $spike^{-1}$ (no.)	Grains $spike^{-1}$ (no.)	1000-grains weight (gm)	Grain yield (t ha^{-1})
N_0	218	15	40.40	43.10	2.85
FN_{38}	243	17	47	46.32	3.01
FN_{77}	250	18	48	46.17	3.03
LSD	14.54	1.03	0.96	0.65	0.08
CV (%)	7.85	5.12	6.74	4.91	5.10

Here, N_0= No Nitrogen, FN_{38} and FN_{77} are the application of N at 1% and 2% urea, respectively in each time.

Filled Spikelets $spike^{-1}$

Analysis of the data revealed that foliar application of N resulted in a significant increase in number of filled spikelets $spike^{-1}$ (Table 1). Application of 2% urea resulted in maximum number of filled spikelets $spike^{-1}$ (18), which was followed by 1% urea solution (17). On the other hand, control (no nitrogen) treatment produced

minimum number of filled spikelets spike^{-1}(15). Similar results were also found by Nerson *et al*. (1980) who observed that the increasing N supply increased the number of filled spikelets due to promotion of the rate of spikelets initiation.

Number of grains per spike

There was a significant impact of nitrogen treatment on the average number of grains per spike of wheat (Table 1). Maximum number of grains spike^{-1} (48) was produced by 2% urea spray which was statistically at par with 1% urea spray (47), whereas minimum number of grains spike^{-1} (40) was produced by control treatment. It might be because of the availability of nitrogen to the crop at later growth stages which might have resulted in more number of grains spike^{-1}. The findings are in agreement with those of Gooding and Devies (1992) who found better performance of wheat crop for foliar application of N. Significant increased in grain number per spike with increasing N rates up to certain limit was also reported by Wali *et al*. (1987) and Ellen (1990).

Thousand-grain weight

Study of the data revealed that foliar application of urea resulted in a significant increase in thousand grain weight (Table 1). The highest thousand-grain weight (46.32g) was found from 1% urea spray which was statistically identical with that of 2% urea spray (46.17g). The lowest thousand-grain weight (43.10g) was noticed from the control (N_0) treatment. Foliar application of urea at the later growth stages of the crop might have increased the availibity of nitrogen to the crop which favoured enhanced accumulation of photosynthate in the grains. The results are in line with Abedin (1995) who reported significant increase in thousand-grain weight with application of nitrogen.

Grain yield

The data revealed significant increase in grain yield with foliar application of urea (Table 1). The highest grain yield (3.03 t ha^{-1}) was produced by 2% urea application. The yield was, however, statistically at par with that of 1% urea application (3.01 t ha^{-1}). On the contrary, the lowest grain yield (2.85 t ha^{-1}) was produced by control treatment. This increase might be mainly due to the additional availability of nitrogen till later growth stages of wheat. The findings are in agreement with those of Alston (1979), Strong (1982) and Gooding and Devies (1992) who reported increased grain yield for foliar application of nitrogen.

Chlorophyll dynamics and grain yield

Table 2. Chlorophyll dynamics and grain yield of wheat as influenced by foliar application of urea

Treatments	Chlorophyll content (SPAD Value)										Grain yield (t ha^{-1})
	36 DAS	42 DAS	48 DAS	53 DAS	59 DAS	65 DAS	71 DAS	77 DAS	83 DAS	89 DAS	
N_0	38.96a	38.43^{b}	37.55^{c}	36.47^{b}	35.72^{b}	35.13^{b}	36.88^{b}	36.47^{b}	34.06^{b}	30.56^{c}	2.85^{b}
FN_{38}	38.83^{b}	39.92^{a}	44.47^{b}	42.50^{a}	46.20^{a}	44.22^{a}	45.25^{a}	47.28^{a}	44.97^{a}	38.00^{b}	3.02^{a}
FN_{77}	39.51^{a}	39.78^{a}	45.55^{a}	42.82^{a}	46.50^{a}	43.90^{a}	45.82^{a}	48.38^{a}	45.14^{a}	39.45^{ab}	3.03^{a}

In a row, means followed by the same letter are not significantly different at the 5% level by DMRT; Here, N_0= No Nitrogen, FN_{38} and FN_{77} are the application of N at 1% and 2% urea, respectively in each time.

The results regarding the influence of foliar nitrogen applications on chlorophyll content (SPAD values) as well as in grain yield of wheat are shown in Table 2. Foliar urea application had significant effect on chlorophyll content as well as in grain yield. Significant differences in chlorophyll reading were found between foliar nitrogen receiving treatments and control treatment. At 77 DAS, the highest chlorophyll content was obtained from 2% urea spray (48.38) followed by 1% urea spray (47.28) whereas the lowest chlorophyll content (36.47) was obtained from control treatment. The increases in chlorophyll content through foliar application of urea were found to have significant influence on grain yield of wheat. As the SPAD value gave the best indicator of photosynthetic activity in cereals (Sarkar *et al*. 1998), the increased chlorophyll content is also correlated with increased wheat yield.

The results obtained from present study indicate that the effects of foliar urea application were significant on chlorophyll content, LAI, yield and yield contributing attributes. The results of the study also indicated that, 0.18 t ha^{-1} increased grain yield by using 77 kg of N (2% urea spray) as compared to control treatment. Balanced N management practices need to be established and followed to improve N use efficiency leading to desirable grain yield. More study may be carried out to find out the better utilization of foliar urea in wheat.

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