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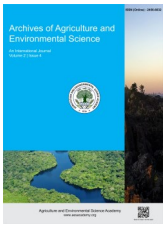

ORIGINAL RESEARCH ARTICLE

Performance of locally discovered rice cultivar (*Haridhan*) in Bangladesh under urea sprays technology

Ekramul Haque, Md. Rashedur Rahman* and Abdul Kader

Department of Agronomy, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh - 2202, BANGLADESH
*Corresponding author's E-mail: rashedagron@bau.edu.bd

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ABSTRACT

The research work was conducted at the Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the period from July to November 2015 to evaluate the yield performance of BRRI dhan56 and a locally discovered rice cultivar *Haridhan* under foliar and traditional application of urea. The experiment included six treatments of urea application technique as T_1=N_0 (control), T_2=$N_{65\%}$, T_3=$N_{50\%}$+US (15%), T_4=$N_{50\%}$+US (20%), T_5=$N_{60\%}$+US (15%), T_6=$N_{100\%}$ (traditional method) and two rice varieties viz. HYV rice cultivar BRRI dhan56 and locally discovered rice cultivar *Haridhan*. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Foliar application of urea had significant effect on yield and yield components of BRRI dhan56 and *Haridhan*. It has been found that the treatment $N_{50\%}$+US (20%) produced highest grain yield (6.14 t ha^{-1}) which might be due to the highest number of total tillers $hill^{-1}$ (15.03), effective tillers $hill^{-1}$ (12.11), panicle length (26.21 cm) and grains $panicle^{-1}$ (156.91) got from this treatment. From the result it can be concluded that both the varieties produced highest grain yield with 50% of the required urea applied to the soil and 20% of the required urea applied as foliar spray that can save an amount of 30% of recommended dose of urea in rice field of Bangladesh

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INTRODUCTION

Bangladesh is an agro based country where agriculture is the single largest sector and the main of country economy (Sabnam, 2013). Rice (*Oryza sativa* L.) is the most extensively cultivated cereal crop in Bangladesh. Rice (*Oryza sativa L.*) is also the staple food for more than two millions of people in Africa and Latin America (Akter, 2017). In 2015-16, 475.64 million metric tons rice where consumed worldwide (Statistica, 2018). It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country (BBS, 2011). Bangladesh is a densely populated country and at present its population growth rate is 1.37% (BBS, 2017). Rice crop area is decreasing day by day due to high population pressure. Therefore, attempts should be taken to increase the yield per unit area by applying improved technology and proper management of fertilizers to achieve the goal of self-sufficiency in rice production. Use of high yielding variety has been increased remarkably in recent years and the country has almost reached a level of sufficiency in rice. Some reasons of higher production may be due to high response to fertilizers especially nitrogenous fertilizers. The importance of the role of nitrogenous fertilizer increasing rice yield has been widely recognized (Singh and Chauhan, 2001). However traditional method of urea application on the soil leads to various losses in soil mainly due to leaching, run off, volatilization and de nitrification. In such situation combination of urea spray on foliage and traditional application of urea (soil application) increase nitrogen use efficiency compared to conventionally applied prilled urea. Farmers of the country usually do not apply nitrogen in their fields properly and timely. It is estimated that only about 25% of the added nitrogen is

utilize by the crops and the rest 75% is lost due to leaching, surface runoff, NH_3 volatilization, decreased nitrification and other processes. Besides, at present the nitrogen fertilizer is very costly. So, it has become very expensive to apply sufficient amount of nitrogen fertilizers. Under these circumstances, it is important to find out the effective method of application of urea fertilizer that would give higher yield of crops and also reduce fertilizer cost. Chemical fertilizer, if applied in excess amount, has a harmful effect on soil physical, chemical and biological properties. It inhibits growth and development of soil microorganism. Therefore, excessive use of N fertilizer is one of the major concerns in sustainable agriculture for its decreased N utilization efficiency by crops and increased N released to the environment, resulting atmosphere and water systems pollution (Zhu *et al*., 1997). In Bangladesh, N fertilizer input is as high as 265kg $Nha^{-11}yr^{-1}$ in rice–rice cropping pattern (BBS, 2011). As foliar application reduces the use of excess chemical fertilizer, it will be beneficial for soil environment. In many cases aerial spray of nutrients is preferred and it gives quicker and better results than the soil application (Jamal *et al*., 2006). Foliar application of urea has a significant effect on yield (Moeini *et al*., 2006). Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants. Moreover, in Bangladesh context it has been reported that application of urea through foliar spray can reduce the requirement of urea fertilizer by 80% of soil application (AIS, 2008). So fertilizer cost can be greatly reduced. Considering the above facts an attempt has been taken to evaluate comparative yield performance of BRRI dhan56 and locally discovered rice variety *Haridhan* under various methods of urea application and find out the optimum amount of urea fertilizer to be applied as foliar spray technique to obtain the highest grain yield.

MATERIALS AND METHODS

Description of experimental site

The experiment was conducted at Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from July 2015 to Nov 2015. Geographically the experimental site is located at 24.75° N latitude and 90.50°E longitude at an elevation of 18 m above the mean sea level under the Agro-ecological Zone of the Old Brahmaputra Floodplain (FAO and UNDP, 1988).

Characteristics of test variety

Haridhan

Haridhan was used as the test variety in the study. It is one of the important rice cultivars developed by a farmer Haripad Kapali. It attains the height of 121.69 cm and grain yield reported by farmers is 6.08 t ha^{-1}.The Department of Agricultural Extension of the Government after examining the paddy has declared *Haridhan* as a profitable cultivar. It costs little to cultivate. Moreover, compared to the profuse growth, the expenditure for its cultivation seems to be very little. The farmers are getting bumper yield from *Haridhan*.

BRRI dhan56

Variety BRRI dhan56 was first evaluated by the Seed Certification Agency (SCA) in 2010. Then it was released by the National Seed Board (NSB) in 2011 as a drought tolerant variety. The cultivation of newly developed rice variety 'BRRI dhan56' in the current *Aman* season brought smile on the faces of the farmers in the country's northern and south-western regions where aridity used to lead to crop failure to their woes. This variety have ushered a new era in rice cultivation during 'Monga' period in the drought prone areas to mitigate 'Monga'. Researchers said BRRI dhan 56 is a short-duration variety which is cultivated during *Aman* season. It is also disease resistant variety, grain type is medium bold and plant attains a height of about 115 cm. The yield of this variety is about (4.5- 5.0 tha^{-1}) in normal condition and in drought condition at about is 3.0-3.5 tha^{-1}.

Preparation of the experimental land and raising of crop

The experimental land was first opened with a power tiller. The land was thoroughly preapred with the help of country plough and ladder. Weeds and stubble were removed from the field. The bunds around individual plots were made for proper water management between the plots. The individual plots of each block were prepared thoroughly by spading and then levelled just before the specified date of transplanting. Thirty day old seedlings were uprooted carefully from the nursery bed and transplanted in the individual plot on 18 July 2015 at the rate of 2-3 seedlings $hill^{-1}$ with a spacing of 25 cm × 15 cm. Various intercultural operations *viz.*, irrigation, weeding, disease and pest management etc. were done and when necessary to ensure and maintain the favourable condition for normal plant growth and development.

Layout of the experiment

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Individual plot size was 4m × 2.5 m. There were 36 plots in the experiment. The experiment was superimposed in the Agronomy Field Laboratory, where another student grew the same crop surrounding the experiment. The field was fertilized with triple super phosphate, muriate of potash and gypsum @ 52, 82, 60 kg ha-1, respectively. The whole amount of triple super phosphate, muriate of potash and gypsum was applied at final land preparation.

Sampling, harvesting and processing

The crop was harvested at full maturity. The date of harvesting was confirmed when 90% of the grains became golden yellow in color. Harvesting of BRRI dhan56 was done on 7 November 2015 and *Haridhan* was 27 Nov 2015. Five hills (excluding border hills) were selected randomly from each individual plot and uprooted before harvesting for recording data. After sampling the whole plot was harvested. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The harvested crops were

threshed manually. The grains were cleaned and dried to a moisture content of 14%. Straws were sun dried properly. Final grain and straw yields plot^{-1} were recorded and converted to t ha^{-1}.

RESULTS AND DISCUSSION

Crop characteristics

Plant height

The difference of plant height between BRRI dhan56 (110.47cm) and *Haridhan* (121.69cm) might be due to genetic make-up variation (Table 1). Islam *et al.* (2012) and Tayeb *et al.* (2013) observed such variation in plant height due to varietal differences. The highest plant height (118.50cm) was obtained from T_3 treatment when 15% urea was applied as foliar spray which was higher than T_6 treatment (traditional method) (Table 2). The highest plant height 114.73cm was obtained from V_1T_3 treatment which is higher than traditional application of urea and highest plant height 123.13cm from traditional application of urea which has not significant difference of the plant height 122.80cm found from V_2T_5 treatment when 15% urea used for foliar spray and 60% urea for traditional method. So interaction effect of variety and foliar application of urea was significant effect on plant height (Table 3).

Total tillers hill^{-1}

BRRI dhan56 and *Haridhan* produced total tillers hill^{-1}(11.92) and (15.58) (Table 1). Variable effect of variety on number of total tillers hill^{-1} was also reported by Nuruzzaman *et al.* (2000), Jaiswal and Singh (2001) and Hossain *et al.* (2007) who noticed that number of totals tillers hill^{-1} differed among the varieties. Number of total tillers hill^{-1} was significantly different among the varieties at transplanting dates up to harvesting. BRRI dhan56 and *Haridhan* produced highest number of total tillers hill^{-1} in T_4 treatment (when 20% urea was applied as foliar spray) which was higher than 100% traditional application of urea. Number of total tillers hill^{-1} was significantly influenced by foliar application of urea (Table 2). The number of total tillers hill^{-1} varied due to varietal differences of urea at different concentrations exhibited significant difference in producing number of total tillers hill^{-1} (Kabir *et al.*, 2004). Interaction effect of variety and foliar application of urea was significant effect on total tillers hill^{-1} (Table 3).

Table1. Effect of variety on yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Variety	Plant height (cm)	Total tiller hill^{-1}	Panicle length (cm)
BRRI dhan56	110.47b	11.92b	24.89b
Haridhan	121.69a	15.58a	26.54a
CV (%)	3.25	5.01	5.62
Level of sig.	**	**	**

In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT; *= Significant at 5% **= Significant at 1% NS=Non-significant.

Table 2. Effect of foliar spray of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Treatment	Plant height (cm)	Total tiller hill^{-1}	Panicle length (cm)
T_1	112.17c	13.07b	25.29
T_2	117.37ab	13.97b	25.55
T_3	118.50a	13.57b	26.04
T_4	115.07bc	15.03a	26.21
T_5	117.15ab	13.40b	25.70
T_6	116.23ab	13.47b	25.52
CV (%)	3.25	5.01	5.62
Level of sig.	**	**	NS

*= Significant at 5%, **= Significant at 1%, NS=Non significant; In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT. T_1 = N_0 (Control); T_2 = $N_{65\%}$; T_3 = $N_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method).

Table 3. Interaction effect of variety and foliar application of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Interaction of variety and foliar application of urea	Plant height	Total tiller	Panicle length
V_1T_1	104.13e	11.47c	24.23
V_1T_2	111.73cd	12.40c	24.67
V_1T_3	114.73bc	11.93c	26.35
V_1T_4	111.40cd	12.33c	24.69
V_1T_5	111.50cd	12.00c	24.68
V_1T_6	109.33d	11.40c	24.72
V_2T_1	120.20a	14.67b	26.34
V_2T_2	123.00a	15.53b	26.43
V_2T_3	122.27a	15.20b	25.73
V_2T_4	118.73ab	17.73a	27.72
V_2T_5	122.80a	14.80b	26.71
V_2T_6	123.13a	15.53b	26.31
CV (%)	3.25	5.01	5.62
Level of sig.	*	*	NS

*= Significant at 5% **= Significant at 1% NS=Non-significant; In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT. T_1 = N_0 (Control); T_2 = $N_{65\%}$; T_3 = $_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method); V_1=BRRI dhan56; V_2=*Haridhan*.

Table 4. Effect of variety on yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Variety	Effective tiller hill^{-1}	Grain panicle^{-1}	Weight of 1000 seeds (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
BRRI dhan56	10.53	126.82	25.19	5.51	6.21	11.72	47.01
Haridhan	11.19	166.55	25.94	6.08	6.45	12.53	48.50
CV (%)	6.66	3.63	4.77	3.92	3.39	4.18	4.44
Level of sig.	**	**	NS	**	**	**	**

*= Significant at 5%, **= Significant at 1%, NS=Non significant.

Table 5. Effect of foliar spray of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Treatment	Effective tiller hill^{-1}	Grain panicle^{-1}	Weight of 1000 seeds (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
T_1	9.88c	131.79e	25.47	5.15c	5.82b	10.97c	46.90
T_2	11.27ab	152.68b	25.62	5.91b	6.43a	12.34ab	47.87
T_3	10.80bc	139.81d	25.42	5.82b	6.33a	12.15b	47.88
T_4	12.11a	156.91a	26.22	6.14a	6.41a	12.54a	48.92
T_5	10.60bc	148.33c	25.23	5.87b	6.53a	12.41ab	47.34
T_6	10.51bc	150.58bc	25.43	5.89b	6.46a	12.35ab	47.63
CV (%)	6.66	3.63	4.77	3.92	3.39	4.18	4.44
Level of sig.	**	**	NS	**	**	**	NS

*= Significant at 5% **= Significant at 1% NS=Non significant; In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT. T_1 = N_0 (Control); T_2 = $N_{65\%}$; T_3 = $N_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method).

Table 6. Interaction effect of variety and foliar application of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Interaction of variety and foliar application of urea	Effective tiller	Grain / panicle	Weight of 1000 seeds	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index
V_1T_1	9.47	116.20i	25.40	4.68f	5.57	10.25g	45.64
V_1T_2	10.80	127.70g	25.33	5.66cde	6.37	12.03def	47.04
V_1T_3	10.33	122.73h	24.80	5.70cde	6.19	11.89ef	47.92
V_1T_4	11.29	133.28f	26.20	5.84bcd	6.18	12.02def	48.62
V_1T_5	10.87	131.35fg	24.53	5.76cde	6.60	12.36cde	46.61
V_1T_6	10.42	129.65fg	24.87	5.45e	6.34	11.78f	46.23
V_2T_1	10.30	147.37e	25.53	5.63de	6.06	11.69f	48.16
V_2T_2	11.73	177.65a	25.90	6.16ab	6.49	12.64abc	48.69
V_2T_3	11.27	156.89d	26.03	5.93bcd	6.47	12.41cd	47.84
V_2T_4	12.93	180.53a	26.23	6.43a	6.63	13.06a	49.22
V_2T_5	10.33	165.32c	25.93	5.98bc	6.46	12.45bcd	48.07
V_2T_6	10.60	171.52b	26.00	6.33a	6.58	12.91ab	49.03
CV (%)	6.66	3.63	4.77	3.92	3.39	4.18	4.44
Level of sig.	NS	**	NS	**	NS	**	NS

*= Significant at 5% **= Significant at 1% NS=Non significant; In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT. T_1 = N_0 (Control); T_2 = $N_{65\%}$; T_3 = $N_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method); V_1=BRRI dhan56; V_2=*Haridhan*.

Panicle length (cm)

BRRI dhan56 produced panicle length 24.89cm whereas *Haridhan* produced panicle length 26.54 cm (Table 1). The difference between the varieties might be due to genetic variation. This result is in agreement with the findings of Ali *et al.* (2014); Hossain *et al.* (2014); Shiyam *et al.* (2014); Sarker *et al.* (2013); Baset Mia and Shamsuddin (2011); Jeng *et al.* (2009) and Bakul *et al.* (2009) . They also found variation in panicle length due to the variation in genetic make-up of the varieties of rice. Highest panicle length (26.21cm) was found from T_4 treatment when 20% urea was used as foliar spray and lowest panicle length (25.29cm) was found from T_1 treatment (control plot). Results showed that panicle length (cm) was not significantly affected by the foliar application of urea. Panicle length (24.72cm) was obtained from BRRI dhan56 in T_6 treatment and highest panicle length (26.35cm) obtained from T_3 treatment (when 15% urea used for spray). Highest panicle length (27.72cm) was obtained from *Haridhan* in T_4 treatment (when 20% urea used for spray) and T_3treatment produced lowest panicle length (25.73cm) when 15% urea used for spray. The result of the study is in agreement with that of the finding of (Jamal, 2006) who also observed insignificant influence of interaction of variety and foliar spray of urea on panicle length (Table 3).

Yield and yield contributing characters and harvest index

Effective tillers hill^{-1}

Higher number of effective tillers hill^{-1} (12.93) was found in *Haridhan* and BRRI dhan56 (11.29) (Table 4). The probable reasons of difference in producing the number of effective tillers hill^{-1} was mainly genetic makeup of the variety. These findings corroborate with that of BINA (1998), Om *et al.* (1998), Bhowmick and Nayak (2000) who stated that number of effective tillers hill^{-1} varied with the varieties. Foliar spray of urea showed significant influence on the production of effective tillers hill^{-1} (Table 5).The highest number of effective tillers hill^{-1}(12.11) was obtained from T_4 treatment when 20% urea was applied as foliar spray which was higher than T_2 and T_6 treatment when 65% and 100% urea was used as traditional method. Interaction effect on variety from this study we found that foliar application has significant influence on effective tillers hill^{-1} (Table 6).

Grains panicle^{-1}

The number of grains panicle^{-1} (126.82) in BRRI dhan56 was statistically lower than *Haridhan* (166.55) (Table 4). The variation in filled grains production between varieties might be due to their genetic makeup. Uddin *et al.* (2011) reported the similar findings with the present study where they found that the significant differences were found in filled grains panicle^{-1} while BRRI dhan44 excelled significantly (97.67) and Lalchicon produced the lowest one (63.00). The highest grain panicle^{-1} (156.91) was obtained from T_4 treatment when 20% urea was applied as foliar spray method which was higher than T_2 and T_6 treatment when 65% and 100% urea was applied as traditional method). So significant variation in grain yield was observed in BRRI dhan56 and *Haridhan* due to the foliar application of urea (Table 5). The highest grain panicle^{-1} (133.28) and (180.53) was obtained from BRRI dhan56 and *Haridhan* in T_4 treatment which is higher than T_2 and T_6 treatment. So interaction effect of variety and foliar application of urea was significant effect on grains panicle^{-1} (Table 6).

Thousand grain weight

Thousand grains weight did not significantly vary due to varieties (Table 4). BRRI dhan56 showed 1000–grain weight 25.19g and *Haridhan* showed1000–grain weight 25.94g. Urea spray on foliage did not show significant influence on thousand grain weight in BRRI dhan56 and *Haridhan* (Table 5). Numerically the highest 1000-grains weight (26.20g) was found in BRRI dhan56 in T_4 treatment (when 20% urea was applied as foliar spray) and lowest 1000-grains weight (25.40) was found from T_1 treatment (control plot). So there is no significant difference between them (Table 6).

Grain yield

BRRI dhan56 produced 5.51tha^{-1} and *Haridhan* produced grain yield 6.08tha^{-1}. The highest yield in *Haridhan* might be attributed to the production of maximum effective tillers m^{-2} and filled grains panicle^{-1}. Ali *et al.* (2014); Shiyam *et al.* (2014); Uddin *et al.* (2011) and Ashrafuzzaman *et al.* (2009) reported that the variety which produced higher number of effective tillers hill^{-1} and higher number of grains panicle^{-1} showed higher grain yield ha^{-1}. The highest grain yield (6.14 t ha^{-1}) was obtained from T_4 treatment when 20% urea was applied as foliar spray which was higher than T_2 and T_6 treatment when 65% and 100% urea was applied as traditional method. Foliar application of urea might be the contribution of more number of effective tiller hill^{-1}, grains panicle^{-1} and lowest number of sterile spikelets panicle^{-1}. The highest grain yield (5.84 tha^{-1}) was obtained from BRRI dhan56 in T_4 treatment (when 20% urea was applied as foliar spray) and lowest grain yield (5.45tha^{-1}) was recorded from T_6 treatment when 100% urea was applied as traditional method. Highest grain yield (6.43tha^{-1}) was obtained from *Haridhan* in T_4 treatment (when 20% urea was applied as foliar spray) which was higher than T_6 treatment when 100% urea was applied as traditional method. Interaction effect of variety and foliar application of urea has significant effect on grain yield (Table 6).

Table7. Effect of variety on yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Variety	Non effective tiller hill^{-1}	Sterile spikelets Panicle^{-1}
BRRI dhan56	1.39	25.09
Haridhan	4.38	39.66
CV (%)	12.59	7.34
Level of sig.	**	**

*= Significant at 5%, **= Significant at 1%, NS=Non-significant.

Table 8. Effect of foliar spray of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Treatment	Non effective tiller hill^{-1}	Sterile spikelets panicle^{-1}
T_1	3.18	40.65a
T_2	2.70	33.40b
T_3	2.77	31.16b
T_4	2.92	32.40b
T_5	2.80	25.29c
T_6	2.96	31.33b
CV (%)	12.59	7.34
Level of sig.	NS	**

*= Significant at 5%, **= Significant at 1%, NS=Non-significant. In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT. T_1 = N_0 (Control); T_2 = $N_{65\%}$; T_3 = $N_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method).

Table 9. Interaction effect of variety and foliar application of urea on the yield and yield contributing characters of BRRI dhan56 and *Haridhan*.

Interaction of variety and foliar application of urea	Non effective tiller hill^{-1}	Sterile spikelets Panicle^{-1}
V_1T_1	2.00	35.86cd
V_1T_2	1.60	24.64ef
V_1T_3	1.60	24.45ef
V_1T_4	1.04	26.33e
V_1T_5	1.13	18.03g
V_1T_6	0.98	21.21fg
V_2T_1	4.37	45.43a
V_2T_2	3.80	42.17ab
V_2T_3	3.93	37.86bc
V_2T_4	4.80	38.47bc
V_2T_5	4.47	32.55d
V_2T_6	4.93	41.45ab
CV (%)	12.59	7.34
Level of sig.	NS	**

*= Significant at 5% **= Significant at 1% NS=Non significant; In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT; T_1 = N_0 (Control); T_2 = $N_{65\%}$;T_3 = $N_{50\%}$ + US (15%); T_4 = $N_{50\%}$ + US (20%); T_5 = $N_{60\%}$ + US (15%); T_6 = $N_{100\%}$ (Traditional method); V_1=BRRI dhan56; V_2=*Haridhan*.

Straw yield

Variety was significantly influenced on straw yield (Table 4). The variety BRRI dhan56 produced straw yield (6.21tha^{-1}) and *Haridhan* produced straw yield (6.45tha^{-1}). In straw yield significant variation was observed in BRRI dhan56 and *Haridhan* due to the foliar application of urea (Table 5).The highest straw yield (6.53tha^{-1}) was obtained from T_5 treatment when 15% urea was applied as foliar spray which was significantly superior to that of traditional method of urea application. The lowest straw yield (5.82tha^{-1}) was obtained from T_1 treatment (control plot). In straw yield significant variation was not observed in BRRI dhan56 and *Haridhan* due to interaction of variety and foliar application of urea (Table 6).

Biological yield

Variation of biological yield among the varieties might be due to the genetic makeup of the studied varieties. Similar results were found supported by Uddin *et al.* (2011) who reported that the BRRI dhan44 produced higher biological yield than Lalchicon. The highest biological yield (12.54tha^{-1}) was obtained from T_4 treatment when 20% urea was applied as foliar spray which was significantly superior to that of T_2 and T_6 treatment. Biological yield was significantly influenced by interaction of variety and foliar application of urea (Table 6). The highest biological yield in BRRI dhan56 (12.36tha^{-1}) and *Haridhan* (13.06tha^{-1}) was obtained from T_5 and T_4 treatment which was higher than T_6 treatment when 100% urea was applied as traditional method.

Harvest index (%)

Variety showed significant influence on harvest index (Table 4). However, statistically BRRI dhan56 gave lower harvest index (47.01%) than *Haridhan* gave higher harvest index (48.50%). Foliar spray of urea did not show any significant influence on harvest index (Table 5). Interaction effect of variety and foliar application of urea did not show any significant influence on harvest index (Table 6).

Yield retarding characters

Non-effective tillers hill^{-1}

Statistically the higher number of non-effective tillers hill^{-1} (1.39) was found in BRRI dhan56 and *Haridhan* produced higher number of non-effective tillers hill^{-1} (4.38). The result shows that variety had significant effect on non-effective tillers hill^{-1}. Foliage and traditional application of urea did not show significant influence in producing number of non-effective tillers hill^{-1} in BRRI dhan56 and *Haridhan* (Table 8).The lowest number of non-effective tillers hill^{-1}(2.70) was found from T_2treatment when 65% urea was applied as traditional method which was lower than T_3, T_4 and T_5 treatment when 15% and 20% urea was applied as foliar spray. Interaction of variety and foliar application of urea did not show significant influence in producing number of non-effective tillers hill^{-1} in BRRI dhan56 and *Haridhan* (Table 9).

Sterile spikelet panicle^{-1}

The highest number of sterile spikelets panicle^{-1} (25.09) was obtained from BRRI dhan56 and (26.54) was obtained from *Haridhan* . So varietal effect present. The lowest number of sterile spikelets panicle^{-1}(25.29) was obtained from T_5 treatment. The highest number of sterile spikelets panicle^{-1}(40.65) was produced from T_1 treatment (control plot). Lowest number of sterile spikelets panicle^{-1} (35.86) was obtained with the interaction of variety BRRI dhan56 and treatment T_5. Lowest number of sterile spikelets panicle^{-1} (32.55) was obtained from interaction of *Haridhan* and T_5 treatment which was lower than V_2T_2 treatment when 65% urea applied as traditional method.

Conclusion

Foliar application of urea solution at different concentrations had significant effect on yield and yield components BRRI dhan56 and *Haridhan* except number of non-effective tiller, panicle length, weight of 1000 seeds and harvest index. The result revealed that highest grain yield (6.14tha^{-1}) was obtained from foliar application of urea i.e. when 50% of recommended dose of urea was applied as soil application and 20% was applied as foliar. The lowest grain yield was obtained from the treatment with no urea application (N_0). From the experiment it can be concluded that the yield and yield contributing characters greatly influenced by urea foliar application method in rice crop. This will help rice cultivating farmers to save at least an amount of 20% recommended dose of urea fertilizer and can contribute to national economy of Bangladesh.

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Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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