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Yield performance of *Boro* rice in response to urea super granular (USG)

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Abstract

The experiment was conducted during December 2012 to June 2013 in the farmer's field adjacent to Bangladesh Agricultural University (BAU), a village named Boira under Sadar Upazilla of Mymensingh to study the yield performance of *Boro* rice in response to USG. The experiment comprised two rice varieties viz. Binadhan-5 and BRRI dhan29 and seven levels of USG viz.i) prilled urea (PU) 280 kg ha^{-1}(control),ii)USG 1.8g/4 hills in every alternate row applied at 5 cm depth, iii) USG 1.8g/4 hills in every alternate row applied at 10 cm depth, iv) USG 2.7g/4 hills in every alternate row applied at 5 cm depth, v)USG 2.7g/4 hills in every alternate row applied at 10 cm depth, vi) USG 3.6g/4 hills in every alternate row applied at 5 cm depth and vii)USG 3.6g/4 hills in every alternate row applied at 10 cm depth. The experiment was laid out in a randomized complete block design with three replications. Variety, level of USG and their interaction exerted significant influence on yield contributing characters and yield of *Boro* rice. BRRI dhan29 produced higher number of effective tillers $hill^{-1}$ and heaviest grain than that of Binadhan-5. As a result of superior yield parameters, BRRI dhan29 gave higher yield (7.67 t ha^{-1}) than Binadhan-5 (6.52 t ha^{-1}). In case of USG, the highest number of total tillers $hill^{-1}$, grains $panicle^{-1}$, 1000-grain weight and grain yield (7.59 t ha^{-1}) were obtained from USG @ 3.6g/4 hills in every alternate row applied at 5cm depth. The lowest values of all the parameters were obtained from PU. Considering their interaction effect, BRRI dhan29 with USG 3.6g/4 hills in every alternate row applied at 5cm depth produced best yield attributes, grain (8.38 t ha^{-1}) and straw yield (9.26 t ha^{-1}). The lowest performance was observed in Binadhan-5 with PU. The overall results suggest that farmers can be advised to cultivate BRRI dhan29 fertilized with USG 3.6g/4 hills in every alternate row at 5 cm depth for getting highest yield in *Boro* season under the agro-climate condition of the study area.

Keywords: *Boro*rice, Yield, USG

Introduction

Bangladesh is favourable for rice cultivation throughout the year, but the unit area yield is much below to those of other leading rice growing countries of the world. Emphasis should be given to increase the yield of rice (specially *Boro* rice) through adaptation of intensive fertilizer management along with other improved technology. Plant nutrients are essential for cultivation of crops. Among the nutrients, N is the most important and key input for rice production all over the world for its large requirements and instability in soil. After the primary input seed i.e., crop variety, N fertilizer is one of the major input for crop production that can contribute a lot for higher rice yield. Total N uptake by rice plant per unit area varies among rice varieties. N is required in adequate amount at early, at midtillering and panicle initiation stage for better grain development. It is a fact that rice plants require more nutrients to produce more yield. The efficiency of N fertilizer especially urea is very low in rice though urea is the principal source of nitrogen for rice in Bangladesh agriculture. This important element has been found to be deficit in most agricultural soils of Bangladesh. However, the nature and magnitude of N loss largely depends upon the sources of N fertilizer and methods of N fertilizer application. Prilled urea (PU) is the most commonly used N fertilizer for rice cultivation in Bangladesh. Unfortunately, the efficiency of PU in rice culture is only 25-30 per cent and rest 70-75% is lost for many reasons after application (BRRI, 2008). On the other hand, USG can save 30% more N than that of PU, increase absorption rate, improve soil health and ultimately increase the rice yield (Savant *et al*. 1991). Placement of USG in the root zone is another most effective method for increasing the N use efficiency (NUE) and rice yield (Sharma, 1985). The loss of nitrogen can considerably be reduced by deep placement of USG. USG stops denitrification process and minimizes urea concentration in irrigation water. As a result, it reduces N loss and improves its use efficiency by 20-25% (Craswell and De Datta, 1980 and Pillai, 1981). The present study was, therefore, undertaken to determine the optimum dose of USG with depth of placement for maximizing yield and yield attributes of two *Boro* rice varieties.

Materials and Methods

The experiment was carried out in the farmer's field adjacent to BAU, a village named Boira, Sadar Upazilla of Mymensingh under University-Community Bridging project funded by British Council during December 2012 to June 2013 to study the yield performance of Binadhan-5 and BRRI dhan29 during *Boro* season under different levels of USG applied at various depth of placement. The experiment consisted of two rice varieties viz Binadhan-5 and BRRI dhan29 and seven levels of USG viz. (i) prilled urea 280 kg ha^{-1}, (ii) USG 1.8g/4 hills in every alternate row applied at 5 cm depth, (iii) USG 1.8g/4 hills in every alternate row applied at 10 cm depth, (iv) USG 2.7g/4 hills in every alternate row applied at 5 cm depth , (v) USG 2.7g/4 hills in every alternate row applied at 10 cm depth, (vi) USG 3.6g/4 hills in every alternate row applied at 5 cm depth, (vii) USG 3.6g/4 hills in every alternate row applied at 10 cm depth. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each replication represented a block and each block was divided into 14 unit plots. Total number of unit plot was 42. The size of unit plot was 4.0 m $\times$ 2.5 m. The distance between blocks and plots were 1 m and 0.75 m, respectively. Seeds of Binadhan-5 and BRRI dhan29 were collected from BADC Seed Production Farm, Mymensingh. The seeds were sprouted by soaking in water for 48 hours and seedlings were raised in wet nursery bed. Thirty five-day old seedlings were uprooted from the seedbed very carefully and were transplanted in the experimental plots on 2 February, 2013. High border around the each plot was maintained to control water movement. Intercultural operations were done as and when necessary. Harvesting was done when 90% of the grains became golden (Binadhan-5) and golden yellow (BRRI dhan29) in color. BRRI dhan29 was harvested on 21 May, 2013 and Binadhan-5 on 13 May 2013. Whole plots were harvested to record the data on grain and straw yields. Prior to harvest, five hills (excluding border hills) were selected randomly from each plot to record the data on yield contributing characters. After recording data, the grains and straws from five sampling hills were added to the total grain and straw yields of respective plots. Data on different parameters were compiled and tabulated in proper form for statistical analysis. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Varietal performance

Yield contributing characters and yield of *Boro* rice were significantly affected by variety (Table 1). Binadhan-5 produced taller plant (112.4 cm) compared to that of BRRI dhan29 (97.37cm). These differences are mostly due to the genetic variation among the varieties. These results were consistent to those of Khisha (2002) and Rahman (2003), who recorded variable plant height among the varieties. Higher number of total tillers $hill^{-1}$(16.16) was found in BRRI dhan29 and the lower one (14.33) was counted in Binadhan-5. Similar results were reported elsewhere (Nuruzzaman *et al*. 2000; Tyeb*et al*. 2013 and Islam *et al*. 2014). BRRI dhan29produced higher number of effective tillers $hill^{-1}$ (14.00),total spikelets $panicle^{-1}$ (184.0), grains $panicle^{-1}$ (170.7), 1000-grain weight (25.32 g)and lower number of effective tillers $hill^{-1}$(11.91), total spikelets $panicle^{-1}$ (169.2), grains $panicle^{-1}$ (153.6), 1000-grain weight (24.65 g)was produced by the variety Binadhan-5. BRRI dhan29 gave the higher grain yield (7.671 t ha^{-1}) and straw yield (8.66 t ha^{-1}) compared to Binadhan-5.Varietal differences regarding grain yield was reported elsewhere (Khisha, 2002; Tyeb*et al.* 2013 and Islam *et al*. 2014).

Effect of level of USG

Plant height, yield contributing characters and yield of *Boro* rice were significantly affected by different levels of USG (Table 2). The plant height ranged from 102.2 cm to 106.2 cm. The highest plant height (106.2cm) was recorded when USG 3.6g/4 hills was applied in every alternate row with 5cm depth of placement and lowest plant height (102.2 cm) was recorded when fertilized with PU @ 280 kg ha^{-1}. The highest number of total tillers $hill^{-1}$ (16.10) was produced when USG was applied 3.6g/4 hills in every alternate row applied at 10 cm depth of placement. The lowest number of total tillers $hill^{-1}$ (13.93) was recorded when PU 280 kg ha^{-1} was applied. The number of total tillers $hill^{-1}$ was increased as the USG

level increased. Total tillers hill^{-1} was positively correlated with applied N as reported by Singh and Shivay (2003) and BRRI (2000). The highest number of effective tillers hill^{-1}(14.07),total spikelets panicle^{-1} (183.0), grains panicle^{-1} (170.0), 1000-grains (25.31g)was produced when USG @ 3.6g/4 hills in every alternate row applied at 5cm depth of placement performed and the lowest number of effective tillers hill^{-1} (11.43), total spikelets panicle^{-1} (168.8), grains panicle^{-1}(152.7), 1000-grains (24.56g) was obtained when PU 280 kg ha^{-1}was applied. Thakur (1999) reported that the number of grains panicle^{-1} increased significantly with increments in levels of USG. Baligar and Ganin (2001) who reported that the weight of 1000-grain increased significantly and quardratically with increasing USG levels. The grain yield (7.59 t ha^{-1}) and straw yield (8.49 t ha^{-1}) were the highest with the application of USG 3.6g/4 hills in every alternate row applied at 5 cm depth of placement and the lowest grain yield (5.32 t ha^{-1})and straw yield (7.13 t ha^{-1}) were obtained from PU applied at 280 kg ha^{-1}. Due to application of different level of USG, grain yield increased from 28.95% to 42.67% over PU. Placement of USG in root zone increased grain yield was reported elsewhere (Sharma, 1985 and Savant *et al.* 1991). The highest harvest index (47.19 %) was recorded from USG 2.7g/4 hills in every alternate row with 10 cm depth of placement and the lowest one (42.73 %) was obtained when PU was applied. Hasan (2007) reported that harvest index increased with increasing USG up to a certain level and then decreased.

Table 1. Effect of variety on the yield contributing characters and yield of *Boro* rice

Variety	Plant height (cm)	Total Tillers hill^{-1} (No.)	Effective tillers hill^{-1} (No.)	Total spikelets panicle^{-1} (No.)	Grains panicle^{-1} (No.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Binadhan-5	112.4a	14.33b	11.91b	169.2b	153.6b	24.65b	6.52b	7.43b	46.74
BRRI dhan29	97.37b	16.16a	14.00a	184.0a	170.7a	25.32a	7.67a	8.66a	46.96
$LSD_{0.05}$	0.694	0.259	0.280	2.32	2.45	0.195	0.170	0.178	-
Level of sig.	**	**	**	**	**	**	**	**	NS

In a column, figures having dissimilar letter(s) differ significantly as per DMRT
** = Significant at 1% level of probability
NS = Not significant

Table 2. Effect of level of USG on the yield contributing characters and yield of *Boro* rice

Urea doses	Plant height (cm)	Total tillers hill^{-1} (No.)	Effective tillers hill^{-1} (No.)	Total spikelets panicle^{-1} (No.)	Grains panicle^{-1} (No.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Yield (%) increase over control (PU)
U_0	102.2c	13.93d	11.43e	168.8c	152.7c	24.56c	5.32d	7.13d	42.73c	-
U_1	104.4b	14.43c	11.99d	170.7c	155.0c	24.70c	6.86c	7.79c	46.75a	28.95
U_2	105.0ab	15.56b	13.12b	175.4b	161.6b	24.87c	6.94c	8.22ab	45.89b	30.45
U_3	105.4ab	14.70c	12.55c	175.6b	159.9b	24.91bc	7.12bc	8.00bc	47.06a	33.83
U_4	105.3ab	16.07a	13.89a	180.2a	166.4a	25.27ab	7.39ab	8.26ab	47.19a	38.91
U_5	106.2a	15.95ab	14.07a	183.0a	170.0a	25.31a	7.59a	8.49a	47.14a	42.67
U_6	105.8ab	16.10a	13.65a	182.6a	169.6a	25.27ab	7.47a	8.43a	46.93a	40.41
$LSD_{0.05}$	1.30	0.485	0.524	4.34	4.59	0.365	0.318	0.333	0.712	-
Level of sig.	**	**	**	**	**	**	**	**	**	-
CV (%)	1.05	2.68	3.41	2.07	2.39	1.23	3.77	3.50	1.28	-

In a column, figures having dissimilar letter(s) differ significantly as per DMRT
** = Significant at 1% level of probability,
U_0 = Prilled urea 280 kg ha^{-1},
U_1 = USG 1.8g/4 hills of alternate row applied at 5 cm depth,
U_2 = USG 1.8g/4 hills of alternate row applied at 10 cm depth,
U_3 = USG 2.7g/4 hills of alternate row applied at 5 cm depth,
U_4 = USG 2.7g/4 hills of alternate row applied at 10 cm depth,
U_5 = USG 3.6g/4 hills of alternate row applied at 5 cm depth,
U_6 = USG 3.6g/4 hills of alternate row applied at 10 cm depth.

Interaction effect of variety and level of USG

Interaction of variety and level of USG showed significant influence on yield contributing characters and yield of *Boro* rice. Interaction between BRRI dhan29 and USG 3.6g/4 hills in every alternate row applied at 5cm depth of placement produced the highest number of total tillers hill^{-1} (17.03),effective tillers hill^{-1} (15.46), grainspanicle^{-1} (184.0) and the lowest number of total tillers hill^{-1} (13.02), effective tillers hill^{-1} (10.48), grainspanicle^{-1} (145.0)were obtained due to the interaction of Binadhan-5 and 280 kg ha^{-1} as PU. Interaction between BRRI dhan29 and USG 3.6g/4 hills in every alternate row applied at 5 cm depth of placement was found to be the best in respect of number of total spikelets panicle^{-1} (194.0) and the lowest number of total spikelets panicle^{-1} (162.1) was obtained from the interaction between Binadhan-5 and PU @ 280 kg ha^{-1}. The highest grain yield (8.38 t ha^{-1}), straw yield (9.26 t ha^{-1}) and harvest index (47.51%)was recorded in the treatment combination of BRRI dhan29 fertilized with USG 3.6g/4 hills in every alternate row applied at 5 cm depth of placement and the lowest grain yield (5.92 t ha^{-1}) and straw yield (6.81 t ha^{-1}) were found in the treatment combination of Binadhan-5 fertilized with PU @ 280 kg ha^{-1}. The lowest harvest index (44.63) was obtained in the combination of BRRI dhan29 with USG 1.8g/ 4 hills in every alternate row applied at 10 cm depth.

Table 3. Effect of interaction of variety and level of USG on the yield contributing characters and yield of *Boro* rice

Interaction (Variety x Urea doses)	Plant height (cm)	Total tillers hill^{-1} (No.)	Effective tillers hill^{-1}(No.)	Total spikelets panicle^{-1} (No.)	Grains panicle^{-1} (No.)	1000-grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$V_1 \times U_0$	109.9	13.02e	10.48f	162.1i	145.0i	24.17	5.92i	6.81h	46.50ab
$V_1 \times U_1$	111.2	13.18e	10.79f	164.2hi	147.6hi	24.43	6.19hi	7.18gh	46.30b
$V_1 \times U_2$	113.3	14.80d	12.31e	168.2ghi	152.9gh	24.68	6.48gh	7.26fgh	47.16ab
$V_1 \times U_3$	112.3	13.28e	11.01f	169.1fgh	153.1gh	24.52	6.33ghi	7.14gh	46.99ab
$V_1 \times U_4$	113.1	15.96b	13.80bc	176.2cde	163.1cde	25.06	7.09ef	8.03cd	46.89ab
$V_1 \times U_5$	113.2	14.87d	12.69de	171.2efg	155.3fg	24.85	6.78fg	7.73def	46.77ab
$V_1 \times U_6$	114.1	15.20cd	12.30e	173.3efg	158.3efg	24.85	6.82fg	7.83de	46.55ab
$V_2 \times U_0$	94.51	14.83d	12.37e	175.5def	160.4def	24.95	6.71fg	7.45efg	47.40ab
$V_2 \times U_1$	97.67	15.67bc	13.19cd	177.1cde	162.4de	24.98	7.52cde	8.41bc	47.21ab
$V_2 \times U_2$	96.78	16.32ab	13.93bc	182.6bc	170.3b	25.06	7.39de	9.17a	44.63c
$V_2 \times U_3$	98.52	16.12b	14.09b	182.1bcd	166.7bcd	25.29	7.91abc	8.87ab	47.14ab
$V_2 \times U_4$	97.49	16.18b	13.97bc	184.2b	169.6bc	25.49	7.673bcd	8.48bc	47.50a
$V_2 \times U_5$	99.17	17.03a	15.46a	194.0a	184.0a	25.76	8.38a	9.26a	47.51a
$V_2 \times U_6$	97.43	17.00a	14.99a	192.7a	181.7a	25.69	8.11ab	9.03a	47.32ab
$LSD_{0.05}$	-	0.685	0.741	6.13	6.50	-	0.450	0.471	1.01
Level of sig.	NS	**	**	*	**	NS	**	**	**
CV (%)	1.05	2.68	3.41	2.07	2.39	1.23	3.77	3.50	1.28

In a column, figures having dissimilar letter(s) differ significantly as per DMRT
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

V_1 = BINA dhan5 V_2 = BRRI dhan29
U_0 = Prilled urea 280 kg ha^{-1},
U_1 = USG 1.8g/4 hills of alternate row applied at 5 cm depth,
U_2 = USG 1.8g/4 hills of alternate row applied at 10 cm depth,
U_3 = USG 2.7g/4 hills of alternate row applied at 5 cm depth,
U_4 = USG 2.7g/4 hills of alternate row applied at 10 cm depth,
U_5 = USG 3.6g/4 hills of alternate row applied at 5 cm depth,
U_6 = USG 3.6g/4 hills of alternate row applied at 10 cm depth.

Conclusion

According to the result of the experiment, it can be concluded that grain yield of BRRI dhan29 was higher than that of Binadhan-5 in the *Boro* season. Among the different level of USG with depth of placement, USG 3.6g/4 hills in every alternate row applied at 5 cm depth of placement showed the best performance. USG level of 3.6g/4 hills in every alternate row applied at 5 cm depth in BRRI dhan29 appeared as the best practice in terms of grain yield in *Boro* season. Our results suggest that BRRI dhan29 if fertilized with USG 3.6g/4 hills in every alternate row at 5cm depth would be the best performance in respect of grain yield.

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