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Effect of variety and depth of placement of urea super granule on the yield and yield components of *boro* rice

Md. Anowerul Islam[1], Md. Faridul Islam[2], Jubaidur Rahman[3], Md. Abdur Rahman Sarkar[4], Md. Razibur Rahman[5]

[1]Department of Agricultural Extension, Kaliganj, Satkhira-9440, Bangladesh
[2]Agronomy Division, Regional Agricultural Research Station, Akbarpur, Moulvibazar-3210, Bangladesh
[3]Agronomy Division, Regional Agricultural Research Station, Jamalpur-2000, Bangladesh
[4]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[5]Department of Agricultural Extension, Bagmara, Rajshahi-6250, Bangladesh

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Corresponding Author

Md. Anowerul Islam
E-mail: anowerdae28@gmail.com

ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from December 2008 to May 2009 to study the effect of variety and depth of placement of urea super granules (USG) on the yield and yield components of *Boro* rice. The experiment consisted of two variety namely, BRRI dhan28 and BRRI dhan29 and three depths of placement of USG viz. 3 cm, 6 cm and 9 cm. The experiment was laid out in a randomized complete block design with three replications. Higher grain yield (5.03 t ha^{-1}) was obtained from BRRI dhan29 than from BRRI dhan28 (4.30 t ha^{-1}). The highest grain yield (5.16 t ha^{-1}) was obtained with the placement of USG at 6 cm depth and the lowest (4.11 t ha^{-1}) at 3 cm depth. Grain yield was also affected by the interaction of variety and depth of placement of USG. The highest grain yield (5.95 t ha^{-1}) was found in BRRI dhan29 fertilized with 6 cm depth of placement of USG and the lowest grain yield (3.15 t ha^{-1}) was found in BRRI dhan28 with 3 cm depth of placement of USG. Performance of BRRI dhan29 was better than that of BRRI dhan28 in the *Boro* season. USG gave better performance in respect of grain yield when placed at 6 cm depth. Hence, it is expected that USG may enable small scale rice farmers to apply one granule in the centre of 4 hills of two adjacent rows. Among the depth of placement of USG, 6 cm depth gave better performance in respect of grain yield.

Introduction

Bangladesh is mainly agro-based country. Agriculture plays an important role here in the national economy contributing 20.60% of her Gross Domestic Product (GDP) (ER, 2009). The area and production of rice in Bangladesh were about 10.37 million hectares and 25.13 million tons, respectively with an average yield of only 2.43 t ha^{-1} (BBS, 2006).It is mainly due to lack of potential varieties and management practices. Among different management practices, optimum rate and judicious application method of fertilizer are considered to be the major determinants for maximizing the yield of transplant Aman rice. Variety is one of the most important factors to be considered for getting increased rice production. Use of high yielding varieties and hybrid varieties in 2 Bangladesh has been increased remarkably in recent years. As a result, the country has almost reached a level of self-sufficiency in rice grain. Selection of potential variety and application of optimum amount of nutrient elements can play an important role in increasing yield and national income. Nitrogen is one of the essential plant nutrients which can augment the production of rice to a great extent. Application of urea-N plays a vital role in vegetative growth, development of yield components and yield of rice (BRRI, 1990). The importance of the role of nitrogenous fertilizer in increasing rice yields has been widely recognized, particularly after the development of modern varieties. But N-use efficiency is very low and the recovery of N in wetland rice seldom exceeds 40% (De Datta & Buresh, 1989). Farmers of Bangladesh generally apply nitrogenous fertilizers in several split applications and the efficiency of applied nitrogen uptake by the rice plant ranges between 25 and 35% (Singh & Yadav, 1985). The savings in applied N reached 70 and 35 kg ha volatilization, denitrification, and other process; consequently N fertilizer use efficiency decreases. Besides these deficiency of nitrogen also hampers the growth and yield of rice. Modifying urea material is an important aspect of nitrogen management in rice from the viewpoints of its efficient utilization. To maximize the losses of N, the slower release nitrogenous fertilizer has been advocated with deep placement. Deep placement of USG effectively increases N use efficiency (31.7%) compared to conventionally applied prilled urea (Jaiswal & Singh, 2001).

USG is a fertilizer that can be applied in the rice root zone at 8-10 cm depth of soil (reduced zone of rice soil) which can save 30% nitrogen than prilled urea, increase absorption rate, improve soil health and ultimately increase the rice yield (Savant *et al.*, 1991). The recent literature on nitrogen use efficiency of rice, in general, would indicate the superiority of root zone placement of USG as it would reduce the magnitude of nitrogen losses to a considerable extent and increase its use efficiency for better grain production (Crasswell & De Datta, 1980; Pillai, 1981). Moreover, a suitable combination of variety and depth of placement of USG is necessary for better yield of *Boro* rice. In view of above discussion, the present study was undertaken to evaluate the performance of two *Boro* rice varieties, to determine the optimum depth of placement of USG for the cultivation of *Boro* rice; and to find out the effect of interaction among these factors, if any, on yield and yield components of *Boro* rice.

Materials and methods

Experimental site

The experiment was conducted at the Agronomy Field laboratory, Bangladesh Agricultural University, Mymensingh, during the period from January to May 2009.

Experimental treatments and design

The experiment consisted of the following treatments- i) two varieties namely, BRRI dhan28 and BRRI dhan29, and ii) three different depths of placement of USG viz. 3 cm, 6 cm and 9 cm. Randomized complete block design was followed in this experiment with three replications. Each of the replication represented a block in the experiment. Each block was divided into 24 unit plots where 24 treatment combinations were allocated at random. There were 72 unit plots in the experiment. The size of unit plot was 4.0 m × 2.5 m. The distances between blocks and plots were 1 m and 50 cm, respectively.

Variety and cultivation

Two rice varieties (BRRI dhan28 and BRRI dhan29) were used as plant material in the experiment. In the experiment, chemical fertilizers i.e. triple superphosphate (76 kg ha^{-1}), muriate of potash (60 kg ha^{-1}), gypsum (50 kg ha^{-1}) and zinc sulphate (10 kg ha^{-1}) were applied at the time of final land preparation. Urea Super Granules (175 kg ha^{-1}) was applied in the middle of 4 hills of two adjacent rows at a time at 15 Days after Transplanting (DAT).

Data collection analysis

Data on individual plant parameters were recorded from five randomly selected hills of each plot and those on seed moisture percentage, grain yield, straw yield, biological yield and harvest index were recorded from the whole plot at harvest. All the collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez & Gomez, 1984) using a computer operated programme namely MSTAT.

Results and discussion

Effect of variety on the yield and yield contributing characters of Boro rice

Effect of variety on yield and yield contributing components of rice have been presented in Table 1. BR11 produced the tallest plant (139.20 cm) while the shortest plant (109.8cm) was obtained from Pajam and the height of BRRI dhan40 was (131.00 cm). These results were consistent to those of Om et al. (1998), Khisha (2002) and Rahman (2003). The highest number of total tillers per hill was observed in BR11 (16.60) and the lowest one (10.30) was counted in Pajam. Results indicated that the highest number of effective tillers per hill was produced by BR11 (12.4) and the lowest one (7.4) was produced by Pajam. The probable reason of the differences in producing the effective tillers per hill is the genetic make-up of the variety which is primarily influenced by heredity. This finding corroborates with those reported by BINA (1998), Om et al. (1998) and Bhowmick and Nayak (2000). The result showed that BR11 produced the longest panicle length (25.61cm). Pajam produced the shortest panicle length (23.38 cm). The highest number of grains $panicle^{-1}$ (135.1) was found from BR11 while the lowest results was observed from Pajam (96.6). These result are consisted with Srivastava and Thipathi (1998), Bhowmick and Nayak (2000), Singh and Gangwer (1989). Values for 1000-grain weight ranged from 26.16 g to 20.27 g. It can be seen that BR11 produced the highest (26.16 g) 1000-grain weight. The lowest (20.27 g) value was obtained from Pajam. These results are in agreement with Samsuddin et al. (1988) and Chowdhury et al. (1993) who reported variation in 1000-grain weight among the varieties. BR11 gave the highest grain yield (5.13 tha^{-1}). Grain yield from BRRI dhan40 was recorded 4.52 tha^{-1}. Pajam produced the lowest grain yield (3.54 tha^{-1}). Varietal differences regarding grain yield was also reported by Patel (2000) and Khisha (2002). This might be due to the genetical causes of the varieties. The highest straw yield (5.90 tha^{-1}) was produced by BR11 while the lowest straw yield (3.99 tha^{-1}) was recorded from Pajam. These results are in conformity with those obtained by Chowdhury et al. (1993) and Patel (2000). Khisha (2002) observed that the plant height was significantly influenced by variety.

Effect of variety on yield and yield contributing characters of *Boro* rice (cv. BRRI dhan28 and BRRI dhan29) have been presented in Table 1. The plants of BRRI dhan29 were taller than BRRI dhan28. It was observed that BRRI dhan29 produced the tallest plant (88.86 cm) at maturity than BRRI dhan28 (83.16 cm).Variety show significant variation on total number of tillers $hill^{-1}$. From the experimental results it was found that BRRI dhan29 produced higher number of tillers $hill^{-1}$ (15.08) than BRRI dhan28 (14.22). The results indicated that BRRI dhan29 produced higher number of effective tillers $hill^{-1}$ (11.49) than BRRI dhan28.

Number of non-effective tillers hill^{-1} was significantly influenced by variety. Variety BRRI dhan29 produced higher number of non-effective tillers hill^{-1} (3.59) than variety BRRI dhan28. The results showed that BRRI dhan29 produced longer panicle (23.98 cm) than BRRI dhan28. Variety had significant effect on the number of grains panicle^{-1}. The results indicated that variety BRRI dhan29 produced higher number of grains panicle^{-1} (140.63) than BRRI dhan28 (123.36). Sterile spikelets panicle^{-1} was significantly influenced by variety. The result indicated that higher number of sterile spikelets panicle^{-1} (17.19) was obtained from BRRI dhan29 than that of BRRI dhan29. It was found that variety BRRI dhan29 produced higher 1000-grain weight (22.74 g) than the variety BRRI dhan28. Variety had highly significant effect on grain yield. The results showed that variety BRRI dhan29 produced higher grain yield (5.03 tha^{-1}) than variety BRRI dhan28 (4.30 tha^{-1}). The variety BRRI dhan29 produced higher straw yield (6.82 tha^{-1}) than variety BRRI dhan28 (5.82 tha^{-1}). Variety had statistically significant effect on biological yield. The results indicated that BRRI dhan29 produced higher biological yield (11.85 tha^{-1}) than variety BRRI dhan28 (10.12 tha^{-1}). BRRI dhan29 produced higher harvest index (42.54%) than that of BRRI dhan28.

Effect of USG placement depth on the yield and yield contributing characters of Boro rice

USG placement depth showed significant influence on the yield and yield contributing characters of Boro rice (Table 2). The plant height was the highest (87.10 cm) at 9 cm depth of placement of USG and the lowest (85.37 cm) was obtained at 6 cm depth of placement of USG which was statistically identical with 3 cm depth of placement of USG. The highest total tillers hill^{-1} (14.92) was found at the depth of 6 cm and the lowest total tillers hill^{-1} (14.32) was found at 3 cm depth of placement of USG. The highest number of effective tillers hill^{-1} (I 1.39) was recorded at 6 cm depth of placement of USG and the lowest one (7.78) at 9 cm depth which was statistically identical with 3 cm depth. The highest number of non effective tillers hill^{-1} (3.73) was obtained from 6 cm depth of placement of USG and lowest one (3.28) was obtained by 3 cm depth of placement of USG. Apparently, the longest panicle (22.69 cm) was obtained from 9 cm depth of placement of USG and the shortest panicle (22.66 cm) was obtained from 6 cm depth placement of USG. The results indicated that the highest number of grains panicle^{-1} (134.48) was produced from 9 cm depth of placement of USG which was statistically identical with 6 cm depth of placement of USG and the lowest (128.27) was produced from 3 cm depth of placement of USG.

Rahman (2006) found that number of effective and non-effective tillers hill^{-1}, panicle length and 1000-grain failed to show any significant difference in BRRI dhan28 and BRRI dhan29 varieties of rice. Rahman (2003) found that plant height, effective tillers hill^{-1}, panicle length and grain panicle^{-1} differed significantly between the varieties. Hasan (2007) found that the effect of level of USG significantly influenced all the yield attributes except weight of 1000-grain Thakur (1991) observed that yield attributes and grain yield differed significantly due to levels and sources of nitrogen at 60 kg N ha^{-1} through USG produced the highest number of panicle unit^{-1} area, panicle weight, number of grains panicle^{-1}, 1000-grain weight ultimately gave the highest grain yield. Rahman (2003) found that two USG per 4 hills produced the higher grain and straw yields (5.22 and 6.09 tha^{-1}, respectively). Bhardwaj and Singh (1993) reported that placement of 84 kg N as USG at 10 cm depth on flooded rice produced a grain yield of 6.8 t ha^{-1} which was similar to 112 kg USG placing. Ahmed et al. (2000) revealed that USG was more efficient than PU at all levels of nitrogen in producing all yield components and in turn, grain and straw yields. Placement of USG @ 160 kg N ha^{-1} produced the highest grain yield Zaman et al. (1993) found that USG consistently produced significantly higher yield than PU. The total N uptake, apparent N recovery and agronomic efficiency of N were higher with USG than PU. Setty et al. (1987) reported that grain yield increased significantly with the increase N rate up to 87 kg ha^{-1} as USG. A similar effect of nitrogen as USG was reported by Tomar (1987).

Numerically, the highest number of sterile spikelets panicle^{-1} (17.29) was found from 6 cm depth of placement of USG and the lowest (14.23) was found from 3 cm depth of placement of USG. Different depths of placement of USG had no significant effect on 1000-grain weight. The results indicated that the highest grain yield (5.16tha^{-1}) was produced by 6 cm depth followed by 9 cm depth of placement of USG and the lowest grain yield (4.11tha^{-1}) was found from 3 cm depth of placement of USG. Straw yield was the highest (7.18 tha^{-1}) at 6 cm depth of placement of USG and the lowest (5.44 tha^{-1}) was obtained from 3 cm depth of placement of USG. The highest biological yield (12.33 t ha^{-1}) was observed from 6 cm depth of placement of USG and the lowest one (9.55 tha^{-1}) was observed from 3 cm depth of placement of USG. It was found that the highest harvest index (42.94%) was found from 3 cm depth of placement of USG which was statistically identical with 9 cm depth of placement of USG and the lowest harvest index (41.80%) was found from 3 cm depth of placement of USG.

Table 1. Effect of variety on crop characters, yield and yield components of *Boro* rice

Variety	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield(t ha^{-1})	Harvest Index (%)
V_1	83.16	14.22	10.82	3.40	21.39	123.36	13.46	22.46	4.30	5.82	10.12	42.39
V_2	88.86	15.08	11.49	3.59	23.98	140.63	17.19	22.74	5.03	6.82	11.85	42.54
S(x)	0.30	0.18	0.14	0.09	0.20	0.42	0.84	0.07	0.02	0.03	0.03	0.16
Level of sign.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

V_1 = BRRI dhan28, V_2 = BRRIdhan29

Table 2. Effect of depth of placement of USG on crop characters, yield and yield components of *Boro* rice

Depth of transplanting (cm)	Plant height (cm)	total tillers hill^{-1}	effective tillers hill^{-1}	non effective tillers hill^{-1}	panicle length (cm)	No of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 grain weight (g)	grain yield (t ha^{-1})	straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
D_1(3cm depth)	85.56b	14.32	11.05	3.28b	22.71	128.27b	14.23	22.54	4.11c	5.44c	9.55c	42.94a
D_2(6cm depth)	85.37b	14.92	11.18	3.73a	22.66	134.23a	17.29	22.69	5.16a	7.18a	12.33a	41.80b
D_3(9cm depth)	87.10a	14.72	11.24	3.47ab	22.69	133.48a	14.45	22.57	4.71b	6.34b	11.06b	42.66a
S(x)	0.36	0.21	0.17	0.11	0.24	0.51	1.02	0.09	0.02	0.04	0.04	0.19
Level of significance	0.01	NS	NS	0.01	NS	0.01	NS	NS	0.01	0.01	0.01	0.01

In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

Table 3. Interaction effect of variety and depth of placement of USG on crop characters, yield and yield components of *Boro* rice

Interaction (variety × depth of placement of USG)	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillers hill^{-1}	panicle length (cm)	No of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
$V_1 \times D_1$	82.89c	13.60c	10.33c	3.27	21.89b	121.20e	11.99	22.39	3.65f	4.94	8.60f	42.41bc
$V_1 \times D_2$	81.72c	14.30bc	10.63c	3.67	21.37b	123.98d	16.04	22.58	4.98c	6.68	11.65c	42.60bc
$V_1 \times D_3$	84.88b	14.77ab	11.50ab	3.27	20.92b	124.89d	12.35	22.41	4.26e	5.84	10.10e	42.17c
$V_2 \times D_1$	88.23a	15.05ab	11.77a	3.28	23.53a	135.34c	16.48	22.68	4.57d	5.94	10.51d	43.48a
$V_2 \times D_2$	89.03a	15.53a	11.73a	3.80	23.95a	144.49a	18.55	22.81	5.33a	7.68	13.01a	41.00d
$V_2 \times D_3$	89.33a	14.67ab	10.98bc	3.68	24.46a	142.08b	16.55	22.73	5.17b	6.84	12.02b	43.14ab
S(x)	0.51	0.30	0.24	0.16	0.35	0.73	1.45	0.12	0.03	0.05	0.06	0.27
Level of significance	0.01	0.01	0.01	NS	0.01	0.01	NS	NS	0.01	NS	0.01	0.01

V_1 = BRRI dhan28, V_2 = BRRIdhan29; D_1= 3cm depth, D_2= 6cm depth , D_3 = 9cm depth
In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

Effect of interaction of variety and USG placement depth on the yield and yield contributing characters of Boro rice

Interaction effect of variety and depth of placement of USG on crop characters, yield and yield components of *Boro* rice showed significant influence (Table 3). Interaction between BRRI dhan29 with 9 cm depth of placement of USG produced the tallest plant (89.33 cm) which was statistically identical with a combination of BRRI dhan29 and 3 cm depth of placement of USG and also BRRI dhan29 with 6 cm depth of placement of USG. The shortest plant (81.72 cm) was recorded from the interaction of BRRI dhan28 with 6 cm depth of placement of USG which was statistically with BRRI dhan28 and 6 cm depth of placement of USG. It was observed that BRRI dhan29 produced the highest number (15.53) of total tillers hill^{-1} with 6 cm depth of placement of USG. Variety BRRI dhan28 × 3 cm depth produced the lowest number of total tillers hill^{-1} (13.60).The highest number of effective tillers hill^{-1} (11.77) was recorded from interaction of BRRI dhan29 with 3 cm depth of placement of USG which was statistically identical with the interaction between BRRI dhan29 with 6 cm depth of placement of USG and the lowest one (10.33) was produced by BRRI dhan28 with 3 cm depth which was statistically identical with the interaction between BRRI dhan28 with 6 cm depth of placement of USG. There is no significant variation between the interaction of variety and depth of placement of USG in terms of non-effective tillers hill^{-1}. Interaction between BRRI dhan29 with 9 cm depth of placement of USG show the highest panicle length which was statistically identical with BRRI dhan29 with 6 cm depth and BRRI dhan29 with 3 cm depth of placement of USG and the lowest panicle length was found combination of BRRI dhan28 with 9 cm depth which was also statistically identical with BRRI dhan28 with 3 cm and 6 cm depth of placement of USG. The results indicated that the highest number of grains panicle^{-1} (144.49) was produced from BRRI dhan29 with 6 cm depth of placement of USG and the lowest (121.20) was produced from BRRI dhan28 with 3 cm depth of placement of USG. The interaction of variety and depth of placement of USG did not show any significant variation in terms of sterile spikelets panicle^{-1}.Variety and depth of placement of USG did not interact with each other to produce any significant variation on the 1000-grain weight. Combination of BRRI dhan29 with 6 cm depth of placement of USG produced the highest grain yield (5.33tha^{-1}) and the lowest grain yield (3.70 tha^{-1}) was produced by the combination of BRRI dhan28 with 3 cm depth of placement of USG. The interaction between variety and depth of placement of USG had no significant effect on straw yield. Combination of BRRI dhan29 with 6 cm depth of placement of USG produced the highest biological yield (13.01tha^{-1}) and the lowest biological yield (8.60tha^{-1}) was produced by the combination of BRRI dhan28 with 3 cm depth of placement of USG. Interaction of BRRI dhan29 with 3 cm depth showed the highest harvest index (43.48%) and the lowest harvest index (41.00%) was found between BRRI dhan29 with 6 cm depth of placement of USG.

Conclusion

According to the result of the experiment, it can be concluded that the performance of BRRI dhan29 was better than that of BRRI dhan28 in the *Boro* season. USG gave better performance in respect of grain yield when placed at 6 cm depth. Hence, it is expected that USG may enable small scale rice farmers to apply one granule in the centre of 4 hills of two adjacent rows. Among the depth of placement of USG, 6 cm depth gave better performance in respect of grain yield.

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