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Effects of prilled urea and urea super granule on growth, yield and quality of BRRI dhan28

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Abstract: Slow release nitrogenous has been studied recently due to their increasing nutrient use efficiency in crops. A field experiment was carried out at Bangladesh Agricultural Development Corporation (BADC) Farm, Baradi, Meherpur during *boro* season of 2012 (January- May) to study the effects of two slow release nitrogenous fertilizer named prilled urea (PU) and urea super granule (USG) on growth, yield and quality of BRRI dhan28. The experiment was laid out in a randomized complete block design (RCBD) with three replications. There were ten treatment combinations consisting of two forms of urea *viz.*, PU and USG and five levels of each form (0, 110, 180, 240 and 300 kg ha^{-1}). Besides, TSP, MOP, gypsum and zinc sulphate were applied @ 100, 70, 60 and 5 kg ha^{-1}, respectively as basal dose. Application of different forms and doses of urea had significant effect on total tillers, grain and straw yield of BRRI dhan28. The highest grain yield (5.77 t ha^{-1}) was found in USG_{240} and straw yield (12.11 t ha^{-1}) was found in USG_{300} and the lowest grain (4.12 t ha^{-1}) and straw yield (8.33 t ha^{-1}) were found in control. The content of protein in grain was influenced significantly due to different doses, whereas the content of starch was not affected significantly by the different forms and doses of urea. The highest protein and starch contents were observed in USG_{300} treatment and lowest were found in control. A positive and significant correlation was found between grain yield and yield attributes in grain. The results suggest that urea super granule @ 240 kg ha^{-1} may be suitable for better growth and yield of *boro* rice cv. BRRI dhan28 in the agroclimatic condition of the study area.
Key words: Prilled urea, Urea super granule, Growth, Yield, Quality and BRRI dhan28.

Introduction

Bangladesh is a humid tropical country. This country is an excellent habitat for evolution of rice. It is the staple food for the people of Bangladesh intrinsically associated with their culture, rites and rituals. Rice is grown over 10.37 million hectares (BBS, 2006) under the diverse ecosystems subject to irrigated, rainfed and deep water conditions in three distinct seasons in Bangladesh. Among the three rice crops, *boro* rice covers about 35.72% of total rice and it contributes to 44.13% of the total rice production (BBS, 2003).

Food scarcity has been and will remain as a major concern for Bangladesh. Although the soil and climatic conditions of Bangladesh are favourable for rice cultivation throughout the year, the unit area yield is much below to those of other leading rice growing countries of the world. Therefore, emphasis should be given to increase the yield of rice (specially *boro* rice) through adaptation of proper and intensive fertilizer management along with other improved technology and management practices.

Plant nutrients are essential for cultivation of crops. Among the nutrients, nitrogen 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, nitrogen fertilizer is one of the major nutrient elements for crop production that can contribute a lot for higher rice yield. It is a fact that rice plants require more nutrients to produce more yield. The efficiency of nitrogen fertilizer especially urea is very low in rice but 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 in Bangladesh. However, the nature and magnitude of N loss largely depend upon the sources of N fertilizer and methods of N fertilizer application.

Prilled urea (PU) is the most commonly used nitrogenous fertilizer for rice cultivation in Bangladesh. The efficiency of nitrogenous fertilizer especially, PU in rice culture is about 25-30 per cent and rest 70-75 percent is lost for many reasons after application (BRRI, 2008). PU is a very fast releasing nitrogenous fertilizer that usually broadcasted in splits, can cause a considerable loss as ammonia volatilization, denitrification, surface run off and leaching etc (De Datta, 1978).

Slow release nitrogenous fertilizer increases the yield and N uptake by rice due to less loss of nitrogen from the soil (Ramaswamy *et al.* l987; Rao and Ghai, 1987). Moreover, placement of USG in the root zone is the most effective method for increasing the nitrogen use efficiency and rice yield (Prasad *et al*. 1982; Sharma, 1985). The loss of nitrogen can considerably be reduced by deep placement of USG. Deep placement of USG stops denitrification process and minimizes urea concentration in irrigation water. As a result, it reduces nitrogen loss and improves nitrogen use efficiency by 20-25 per cent for better grain production (Craswell and De Datta, 1980 and Pillai, 1981). Therefore, the present study was undertaken to determine the optimum dose of PU and USG for maximum yield and yield attributes and quality of *boro* rice cv. BRRI dhan28.

Materials and Methods

The experiment was conducted at Bangladesh Agricultural Development Corporation (BADC) Farm, Baradi, Meherpur during *boro* season of 2012 (January to May). BRRI dhan28 was used as test crop. The experimental field belongs to calcareous Dark Grey Floodplain soil and it was a medium high land of silty loam soils having pH 6.4, 1.10% organic matter, 0.102% total N, 27.0 µg g^{-1} soil available P, 18.0 µg g^{-1} soil available S and 0.026 me 100 g^{-1} soil exchangeable K. The experiment was laid out in a randomized complete block design (RCBD) with three replications. There were ten treatment combinations consisting of two forms of urea *viz.*, PU and USG and five levels of each form (0, 110, 180, 240 and 300 kg ha^{-1}). Besides, TSP, MOP, gypsum and zinc sulphate were applied @ 100, 70, 60 and 5 kg ha^{-1}, respectively as basal dose. Seeds of BRRI dhan28 were collected from BADC Seed Production Farm, Baradi, Meherpur. The collected seeds were sprouted by soaking in distilled water for 48 hours and seedlings were raised in wet nursery bed. Thirty five days old seedlings were uprooted from the seedbed very carefully and were transplanted in the experimental plots on 26 January, 2012. Two seedlings $hill^{-l}$ was planted maintaining hill spacing of 20 cm and row spacing of 20 cm. Intercultural operations were done as and when necessary. The crop was harvested on 10 May, 2012. Data on plant height and number of total tillers hill^{-1} were observed from five randomly selected hills from each plot at 20, 35 and 50 days after transplanting (DAT) and average values were calculated for each unit plot. Grain and straw yields and other yield contributing characters were recorded from each plot. Rice grain was biochemically analyzed for the determination of protein and starch content. Data were analyzed with the help of MSTAT-C developed by Russel (1986) and least significance difference (LSD) test was used to find out the difference among the mean values as outlined by Gomez and Gomez (1984).

Results and Discussion

Effects of different forms and doses of urea on growth, yield, yield contributing parameters and quality of *boro* rice cv. BRRI dhan28

i) Growth and yield contributing parameters: Various growth and yield contributing parameters were studied in the present study. Among the growth contributing characters, plant height was not significantly influenced by the forms and doses of urea (Table 1). USG produced tallest plant (90.78 cm) at 240 kg ha^{-1} dose among the all treatments when PU produced its tallest plant (86.17 cm) at the same dose. All the doses of USG produced taller plants than the respective doses of PU. But numerically, the highest plant height (90.78 cm) produced when urea was used @ 240 kg ha^{-1} and the shortest plant height was obtained at control. Nitrogen fertilizers are essential for vegetative growth of plant. So, the higher dose of urea helps to increase plant height. These findings are in agreement with the findings of Singh and Singh (1986) who have reported that plant height increased with the increase of nitrogen level.

Total number of tillers hill^{-1} was slightly influenced by the forms of nitrogen (Table 1). Urea super granules produced significantly highest number of tillers hill^{-1} (20.50) when prilled urea produced 18.79 tillers hill^{-1} (both @ 240 kg ha^{-1} dose). The other doses of USG produced more number of tiller hill^{-1} than the respective doses of PU but the differences were statistically insignificant. This finding was commensurated with the observation made by Hasan (2007). Number of tillers hill^{-1} differed significantly with @ 240 kg ha^{-1} dose of nitrogen (Table 1). The highest number of tillers hill^{-1} (20.50) was produced with application of 240 kg urea ha^{-1} and the lowest number of tillers hill^{-1} (10.63) was produced in control, as the vegetative phases of plant was influenced by the increase of nitrogen level. Bayan and Kandasamy (2002) reported that tillers hill^{-1} increased with the application of nitrogen fertilizer.

Table 1. Effect of different forms and doses of urea on the yield attributes of boro rice cv. BRRI dhan28

Treatments	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Total grains panicle^{-1}	Filled grains panicle^{-1}	1000 grain weight (gm)
Control	77.88	10.63d	7.05d	19.57	195.57c	185.66b	22.45
PU_{110}	85.13	14.31cd	10.59c	21.41	203.20bc	194.77ab	23.51
PU_{180}	85.35	16.55abc	12.92bc	22.44	207.63abc	197.79ab	23.64
PU_{240}	86.03	18.79ab	15.04ab	23.17	221.09ab	210.25a	23.69
PU_{300}	86.17	18.03abc	14.47abc	22.25	216.56ab	206.21ab	23.66
USG_{110}	85.83	15.47bcd	12.02bc	22.63	207.60abc	196.80ab	23.57
USG_{180}	87.37	17.75abc	14.01abc	22.72	213.83abc	203.83ab	23.72
USG_{240}	90.78	20.50a	17.32a	23.43	225.24a	214.75a	23.91
USG_{300}	88.07	18.49abc	14.58ab	23.07	219.57ab	208.11a	23.75
LSD	10.17	3.75	3.63	3.13	17.60	7.82	1.06

In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with different letters differ at 1% level of significance; USG-Urea super granule; PU- Prilled urea

Forms of nitrogen fertilizer had insignificant influence on the number of effective tillers hill^{-1} (Table 1). But numerically, USG produced higher number of effective tiller than PU of respective doses. The results obtained for bearing tillers hill^{-1} are in conformity with the findings of Chander and Pandey (1996) and Jee and Mahapatra (1989) who have mentioned that the deep placement of USG produced higher number of bearing tillers hill^{-1} than PU application. Effective tillers hill^{-1} was slightly affected by the doses of nitrogen (Table 1). The highest number of effective tillers hill^{-1} (17.32) was produced @ 240 kg urea ha^{-1} as USG. The lowest number of effective tillers hill^{-1} (7.05) was produced at control. Chopra and Chopra (2000) reported that effective tillers hill^{-1} increased with the application of 80 or 120 kg N ha^{-1}.

Results of the Table 1 indicated that the panicle length showed insignificant variation due to forms of urea. The longest panicle (23.43 cm) was recorded with USG at 240 kg ha^{-1} whereas PU produced relatively shorter panicle (22.25 cm) at 300 kg ha^{-1} dose which was highest among the PU treatments. Both of the lengths were statistically similar. These results were similar with the findings of Sen and Pandey (1990) who have found that there were no significant difference in panicle length due to application of USG and PU. Effect of doses of nitrogen was not significant on panicle length. The longest panicle (23.43 cm) was measured with 240 kg urea ha^{-1} while the shortest 19.57 cm) with control (Table 1). This was conformed to Sarder *et al.* (1988) who have observed that the panicle length increased up to 120 kg N ha^{-1}.

Total number of grains panicle^{-1} was not affected by the forms of urea (Table 1). But numerically, deep placement of USG gave higher number of filled grains panicle^{-1} while PU gave lower number of panicle^{-1} at 110 and 240 kg ha^{-1}. At 180 and 240 kg ha^{-1} doses both USG and PU produced same number of grain per panicle. Rama *et al.* (1989) reported that the number of grains panicle^{-1} was higher due to deep placement of USG than PU application.The doses of urea did not affect total number of grains panicle^{-1} (Table 1). Number of grains panicle^{-1} ranged from 195.57 to 225.24. The use of 240 kg urea ha^{-1} produced highest number of grains panicle^{-1} (225.24). The lowest number of grains panicle^{-1} (195.57) was produced at control.

The forms of urea had no significant influence filled grains panicle^{-1} (Table 1). Both USG and PU produced similar number of filled grain per panicle except 300 kg ha^{-1} dose. Filled grains panicle^{-1} was not affected by the doses of urea (Table 1). The use of 240 kg urea ha^{-1} as USG produced the highest number of filled grains panicle^{-1} (214.75) and the lowest number of filled grains panicle^{-1} (195.57) was produced at control. Castro and Sarker (2000) stated that number of filled grain panicle^{-1} increased with increase dose of nitrogen fertilizer.

Thousand grains weight was not significantly influenced by the forms of nitrogen (Table 4.1). As it is a genetic character of a variety. So, there was no effect of the forms of urea on 1000 grain weight. There was no significant difference in 1000 grain weight of the doses of urea (Table 4.1). Hasan (2007) and Alom (2002) showed that different levels of nitrogen fertilizer did not have any significant effect on 1000 grain weight.

ii) Grain yield: Grains yield was significantly influenced by the forms of urea (Table 2). Both USG and PU gave higher grain yield than control. Urea super granules produced significantly higher grain yield than PU in case of 180 and 240 kg ha^{-1} dose while in case of rest two doses the yield were similar. USG produced the higher number of effective tiller hill^{-1} and filled grains panicle^{-1} which ultimately gave high yield. This finding was similar with the observations made by Bowen *et al.* (2005), Miah *et al.* (2004) and Rahman (2003).

The doses of urea expressively affected grain yield (Table 2). The highest grain yield (5.77 t ha^{-1}) was found @ 240 kg USG ha^{-1} and the lowest grain yield was found at control. Increased doses of urea helped to increase panicle length, total tillers hill^{-1}, effective tillers hill^{-1} and filled grains panicle^{-1}. So, ultimately the grain yield was increased. Singh *et al.* (2005) stated that each increment dose of nitrogen significantly increased grain yield.

iii) Straw yield

The effect of forms of nitrogen fertilizer was significant in respect of straw yield. PU and USG both gave higher yield than control. The highest straw yield (12.11 t ha^{-1}) was obtained from USG at 300 kg ha^{-1} dose (Table 2). The results were also in agreement with the findings of Singh and Singh (1991), Mohanty *et al.* (1989) who have observed that USG application in rice gave significantly higher straw yield than PU application. Bowen *et al.* (2005) stated deep placement of urea super granules increased yield by 1120 kg ha^{-1} and 890 kg ha^{-1} during *boro* season and *aman* season, respectively.

Straw yield significantly influenced by the doses of nitrogen. The highest straw yield (12.11 t ha^{-1}) was obtained from 300 kg urea ha^{-1}. Higher doses of nitrogen ultimately increase the availability of nitrogen that might enhance vegetative growth and increased straw yield (Table 2). The lowest straw yield was obtained in control. This result are in an agreement with the findings of Dhane *et al.* (1989) who reported that straw yield increases with increasing nitrogen level.

Table 2. Effect of different forms and doses of urea on the yield and harvest index of *boro* rice cv. BRRI dhan28

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Control	4.12e	8.33f	12.44e	33.08b
PU_{110}	4.75d	9.60e	14.34d	33.09b
PU_{180}	5.14c	10.33d	15.48c	33.23b
PU_{240}	5.55ab	10.94c	16.50b	33.67b
PU_{300}	5.36b	11.74b	17.11ab	31.35d
USG_{110}	4.84d	10.17d	15.01c	32.25c
USG_{180}	5.43b	10.87c	16.30b	33.29b
USG_{240}	5.77a	10.96	16.73bc	34.49a
USG_{300}	5.47b	12.11a	17.58a	31.11d
LSD	0.22	0.35	0.53	0.68

In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with different letters differ at 1% level of significance;
USG - Urea super granule; PU- Prilled urea.

iv) Biological yield: The forms of urea influenced biological yield (Table 2) significantly. With the use of urea super granules the significantly highest biological yield (17.58 t ha^{-1}) was observed when prilled urea produced 17.11 t ha^{-1}. Ahmed *et al.* (2002) stated that USG was most efficient form of nitrogen in producing all yield components and in turn, grain and straw yields.

Biological yield was expressively affected by the doses of urea (Table 2). The highest biological yield (17.58 t ha^{-1}) was obtained @ 300 kg urea ha^{-1} and the lowest biological yield (12.44 t ha^{-1}) was obtained at control. Vegetative growth was influenced due to the higher dose of urea and for the reason the grain and straw yield was also increased with the increased dose of nitrogenous fertilizer. Singh *et al.* (2005) stated that each increment dose of N significantly increased grain and straw yields (biological yield) over its preceding dose.

v) Harvest index (%): The forms of urea slightly influenced harvest index (Table 2). Highest harvest index (34.49%) was obtained by USG application whereas lower with PU application (33.67).

Harvest index was not significantly affected by the doses of urea (Table 2). Harvest index was found higher in USG than PU in some treatments. In case of PU, the harvest index was not affected up to 240 kg ha^{-1} while in case of USG, the harvest index was found different at different doses. The highest harvest index was found at 300 kg ha^{-1} in case of USG and in case of PU it was 240 kg ha^{-1}.

vi) B**iochemical parameters:**

a) Starch content: The starch content was not influenced by the forms of nitrogen in grains (Table 3). The highest starch content (71.20%) was found with the application of USG_{300} and PU obtained 69.08% starch at the same dose which was statistically similar. All the doses of USG obtained insignificant higher starch content than the respective doses of PU.

Table 3. Effect of different forms and doses of urea on protein and starch contents of *boro* rice grain cv. BRRI dhan28

Treatments	Protein (%)	Starch (%)
Control	3.21d	57.68
PU_{110}	5.64c	61.31
PU_{180}	6.72bc	63.89
PU_{240}	8.01abc	67.31
PU_{300}	9.16ab	69.08
USG_{110}	6.38c	62.58
USG_{180}	7.86abc	65.27
USG_{240}	8.91ab	70.24
USG_{300}	9.72a	71.20
$LSD_{(0.05)}$	0.43	2.09

In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with different letters differ at 1% level of significance; USG-Urea super granule; PU- Prilled urea.

There was no significant effect on the starch content in grain of the different doses of urea (Table 3). The highest starch content (71.20%) was obtained in 300 kg urea ha^{-1} and the lowest (57.68%) was obtained at control which was statistically similar. Starch content was increased due to the application of urea.

b) Protein content: Application of N fertilizer highly affected the protein content in grains (Table 3). The highest protein content (9.72%) was found with the application of USG when PU obtained 9.16% protein, both at 300 kg urea ha^{-1} dose. The amount of protein contents became about three times higher than control both in USG and PU. These might be due to the zero N application at control.

The protein content in grain was slightly affected by the doses of urea (Table 3). It was apparent from the result that the application of nitrogen fertilizer increased protein content in grain. The highest protein content (9.72%) was obtained at USG_{300}, which was statistically identical to USG_{240}, while the lowest protein content (3.21%) was obtained at control. Protein content was increased due to the application of nitrogen as it is the source of protein. Farinelli *et al.* (2004) reported that protein content increased in rice grain due to the application of nitrogen.

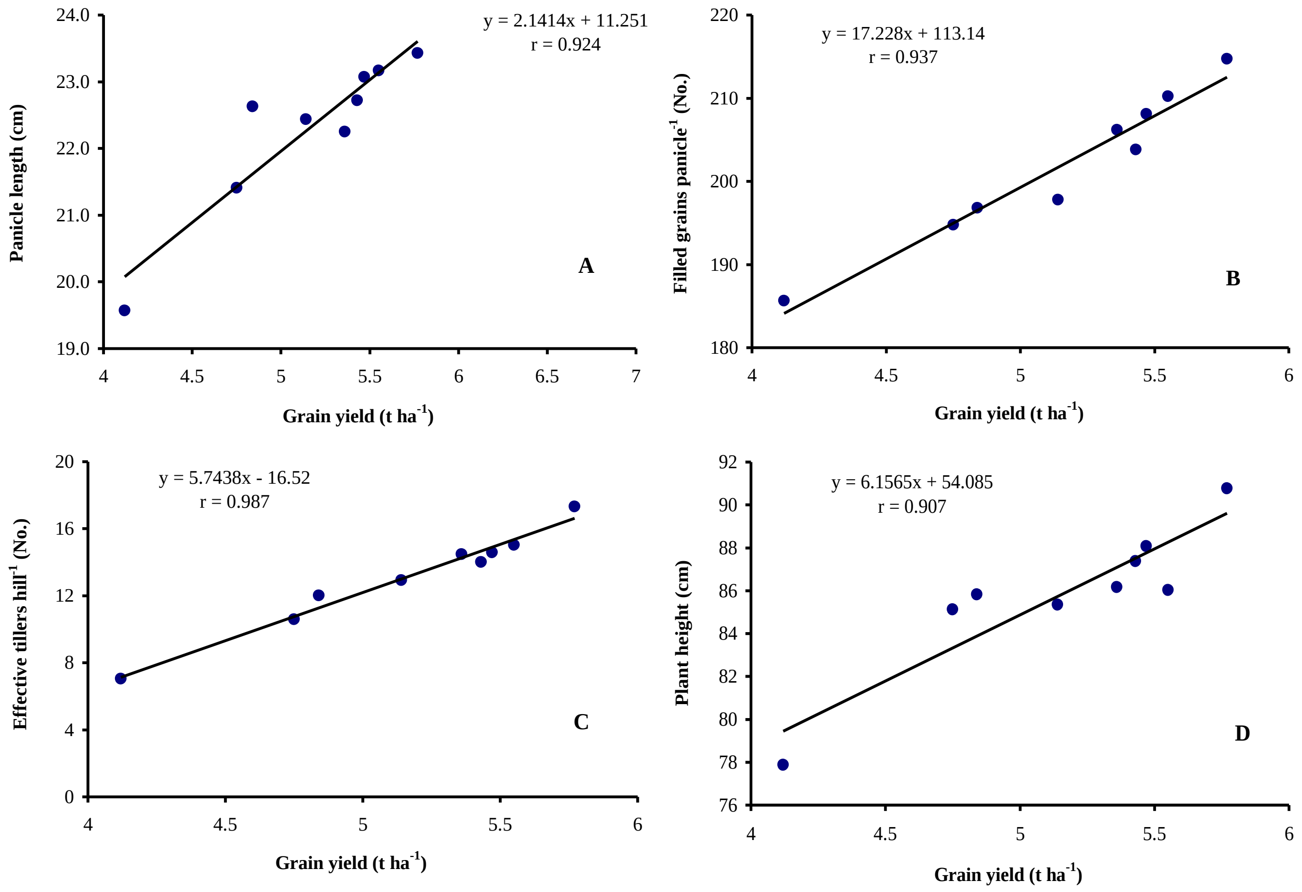

Fig. 1 Relationships between (A) grain yield and panicle length (B) grain yield and filled grain panicle-1 (C) grain yield and effective tillers hill-1 and (D) grain yield and plant height.

Relationship between the grain yield and yield attributes

Statistical relationship between grain yield and yield attributes of *boro* rice cv. BRRI dhan28 has been found out. The correlation and regression lines of these parameters have been shown in Fig. 1.

The results showed that the grain yield and other yield attributes were significantly and positively correlated where correlation coefficients (r) are 0.907**, 0.924**, 0.987** and 0.937** for plant height, panicle length, effective tillers hill^{-1} and filled grains panicle^{-1}, respectively. It was expected that the yield attributing characters especially filled grain panicle^{-1} would positively correlate with the yield of rice. The finding of the present study was not exception of this.

The present study investigated the effect of different forms and doses of PU and USG on growth, yield and quality of rice cv. BRRI dhan28. In most of the cases, use of USG_{240} and in the case of protein content and straw yield USG_{300} showed better performance. The result showed that *boro* rice cv. BRRI dhan28 significantly responded to different forms and levels of N fertilizer. From the results, it may be concluded that, use of 240 kg urea ha^{-1} as USG ventilated beneficial effects on yield attributes that ultimately results in higher yields. However, further trails should be conducted at different agroecological zones to decide the exact dose of nitrogen in specific area of Bangladesh.

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