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Response of Transplanted Rice to Different Application Methods of Urea Fertilizer

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Abstract: The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during *boro* season (November, 2008 to May, 2009) to find out the economic and effective method of urea application in rice crop. There was different urea application treatments were T_1 (200 kg ha^{-1} at urea two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg ha^{-1} urea at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT), T_3= Urea supergranules (USG) @ 50 kg ha^{-1}, T_4= Urea supergranules @ 75 kg ha^{-1}, T_5= 0.5% foliar spray @ 20 kg ha^{-1}, T_6= 1% foliar spray @ 40 kg ha^{-1}. Both the growth and yield was significantly affected by different methods of urea application. In all of the case except plant height and straw yield T4 gave the highest result. Application of USG @ 75 kg ha^{-1} produced 22.03% 5.88% more yield than granular urea application at 2 and 3 equal splits. Foliar spray of urea produced the lowest yield components and yield in this study.

Key words: Urea supergranules % Foliar spray % Nitrogen fertilizer % Paddy yield

INTRODUCTION

In Bangladesh majority of food grain come from rice. About 80% of cropped area of this country is used for rice production, with annual production of 43.50 million metric tons in total acreage of 11.20 million ha [1]. The average yield of rice in Bangladesh is 3.90 t ha^{-1} [2]. This yield of rice is much lower than world average. At present it is observed that rice yields are in stagnant condition, because farmers do not follow fully the improved techniques in an integrated way, which creates a yield gap. In this situation, farmers, researchers and scientists are looking for new methods or technologies to get higher yield of rice. New, front-line agronomic packages such as optimum plant population, seedling number hill^{-1}, optimum dose of N, split application of fertilizers and irrigation management, have a decisive effect on the yield potential of modern rice. Judicious application of fertilizer is one of the most effective means for maximizing yield of rice. The fact is that rice plants require more nutrients to produce more yields. Nitrogen is a mojor essential plant nutrient and a key input for increasing crop yield. Yield increase (70-80%) of field rice could be obtained by the application of nitrogen fertilizer [3]. Optimum dose of nitrogen fertilization plays a vital role in growth and development of rice plant. Its growth is seriously hampered when lower dose of nitrogen is applied which drastically reduces yield. Nitrogen has a positive influence on the production of effective tillers per plant, yield and yield attributes [4,5].

Nitrogen plays a key role in rice production and it is required in large amount. Nitrogen is the most important limiting nutrient in rice production and has heavy system losses when applied as inorganic sources in puddle field [6]. It is necessary to find out the suitable rate of nitrogen fertilizer for efficient management and better yield of rice. Urea is the most frequently used N fertilizer globally. Urea can be applied in different ways. In Bangladesh crystal urea is applied mostly as top dressing. But topdressing sometimes induces imbalance in yield components and decreases yield. It was observed that urea super granules (USG) can minimize the loss of N from soil and hence the affectivity increased up to 20-25% [7]. Urea can also be supplied to plants through the foliage, facilitating optimal N management, which minimizes N losses to the environment without affecting yield [8,9]. Most plants absorb foliar applied urea rapidly [10,11] and hydrolyze the urea in the cytosol. The NH_3 released may be

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transported into the chloroplast and be assimilated by the chloroplastidic Gln synthetase [12]. Alternatively, $NH4^+$ may be assimilated directly by the cytosolic Gln synthetase, which has been reported to be limited to the phloem parenchyma cells in leaves [13].

However, there is an ample need to find out the relative efficiency of different application methods of N-fertilizers on the performance of rice crop. Thus the present study was undertaken to find out the effect of different methods of application of urea fertilizer.

MATERIALS AND METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during *boro* season (November, 2008 to May, 2009). Geographically, the experimental area is located at 24°75N N and 90°50N E longitude at the elevation of above 18 m the sea level. There was different urea application treatments were T_1 (200 kg haG^1 urea at two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg haG^1 urea at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT), T_3= Urea supergranules @ 50 kg haG^1, T_4= Urea supergranules @ 75 kg haG^1, T_5= 0.5% foliar spray @ 20 kg haG^1, T_6= 1% foliar spray @ 40 kg haG^1. About 1.8 gm and 2.7 g urea granules were used for this experiment which made the rate of 50 kg haG^1 and 75 kg haG^1, respectively. Urea granules were placed in the middle of 4 hills. Urea spray volumes were prepared by mixing 0.5 kg and 1.0 kg of urea in 100 L of water as per treatments. This liquid was sprayed by a knapsack sprayer at 33 DAT and 55 DAT. The experiment was carried out in a Randomized Complete Block Design (RCBD) with 4 replications as factorial arrangement.

The size of the each experimental pot was 4 m × 3 m. A basal dose of triple super phosphate (TSP), muriate of potash (MP) and gypsum were used at the source of phosphorus, potassium and gypsum applied at the rate of 180 kg haG^1, 100 kg haG^1 and 20 kg haG^1, respectively at the time of final land preparation. Rice cv. BRRI dhan29 was used in this experiment. Pregerminated seeds were sown in wet nursery bed and proper care was taken to raise the seedlings in seedbed. Thirty five (35) day old 2 seedlings were transplanted in each hill maintaining the spacing of 15 cm × 20 cm. Intercultural operations were done properly. About 5-6 cm water layer was maintained in the pot until the crop attained maturity.

Data on plant height and tillers were collected at 30, 60 and 90 days after transplanting (DAT). The data were analysed following Analysis of Variance (ANOVA) technique and mean differences were adjusted by the Multiple Comparison test [14] using the statistical computer based programme CoStat v.6.400 [15]. Means were compared by using DMRT test.

RESULTS AND DISCUSSION

Growth of rice pant was greatly influenced by different methods of application of urea fertilizer. In this study plant height was significantly affected by urea application methods (Fig. 1). At all of the growth stages (30, 60 and 90 DAT) maximum plant height was observed with T_2 (200 kg haG^1 at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT). Maximum influences of urea fertilizer application methods were observed at 60 DAT because in this stage crop growth was highest. At maturity (90 DAT) the highest plant height was (95.4 cm) which was 10.41% higher than the plant height obtained from 0.5% foliar spray of urea (Fig. 1). At maturity T_2 and T_4 showed statistically similar results. The lowest plant height with foliar spray of urea might be due to the reduced uptake of N through foliage. Application of granular urea at higher rate facilitated higher vegetative growth and hence maximum plant height attained. This result was supported by Islam *et al.* [16].

Number of tillers of rice plant was also significantly affected by different urea treatments (Fig. 2). At initial stage of growth application of granular urea with 3 equal splits produced the highest number of tillers (7.6). But at later stages (60 and 90 DAT) maximum number of tillers was produced with the application of urea supergranules @ 75 kg haG^1. However, at every cases T_5 (0.5% urea foliar spray @ 20 kg haG^1) produced the lowest number of tillers. At 60 DAT and 90 DAT no significant differences were observed between recommended urea application (3 splits of granular urea) and application of urea supergranules (75 kg haG^1). Deep placement of USG showed highest number of tillers might be due to little loss of N from soil and slowly releasing process. Application of granular urea also produced remarkable number of tillers due to its higher application rate compared to USG but in this case 3 splits produced significantly more tillers than 2 splits. Rana *et al.* [17] observed similar results.

Application methods of urea significantly influenced the yield components of *boro* rice cv. BRRI dhan29. Highest number of panicles per hill was observed with T_4 which was significantly different from other treatments (Table 1). In this study T_2 and T_3 produced identical number of panicles per hill. Significantly lowest number of

Table 1: Effect of different methods of urea fertilizer application on the yield components of *boro* rice cv. BRRI dhan 29

Treatments	No. of panicles hill^{-1}	Panicle length (cm)	No. of spikelets panicles^{-1}	1000-grain weight (g)
T_1	7.7bc	18.7cd	89.2c	21.4bc
T_2	8.1b	19.5bc	94.5b	22.3abc
T_3	7.8b	20.1b	93.4b	22.8ab
T_4	9.9a	22.3a	98.5a	23.7a
T_5	5.6d	17.1e	78.6d	20.3c
T_6	6.9c	17.8de	81.2d	20.9bc
$LSD_{0.05}$	0.81	1.02	3.15	2.02
CV (%)	6.78	8.12	10.11	4.45

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05. T_1 (200 kg ha^{-1} two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg ha^{-1} at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT), T_3= Urea supergranules @ 50 kg ha^{-1}, T_4= Urea supergranules @ 75 kg ha^{-1}, T_5= 0.5% foliar spray @ 20 kg ha^{-1}, T_6= 1% foliar spray @ 40 kg ha^{-1}.

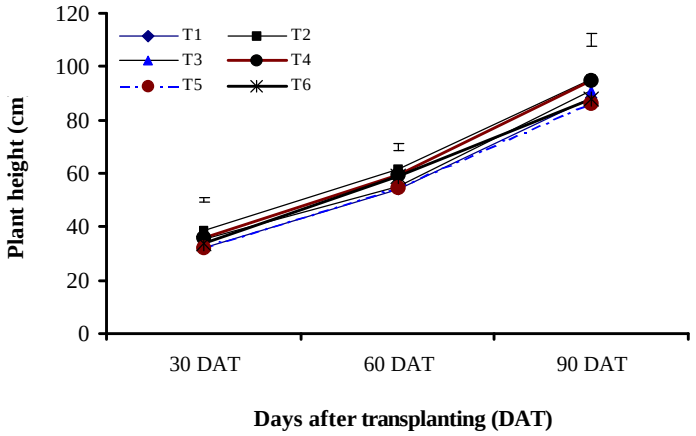

Fig. 1: Effect of different methods of urea fertilizer application on the plant height of *boro* rice cv. BRRI dhan 29 (Vertical bars indicate the LSD at P=0.05) [T_1 (200 kg ha^{-1} two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg ha^{-1} at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT), T_3= Urea supergranules @ 50 kg ha^{-1}, T_4= Urea supergranules @ 75 kg ha^{-1}, T_5= 0.5% foliar spray @ 20 kg ha^{-1}, T_6= 1% foliar spray @ 40 kg ha^{-1}].

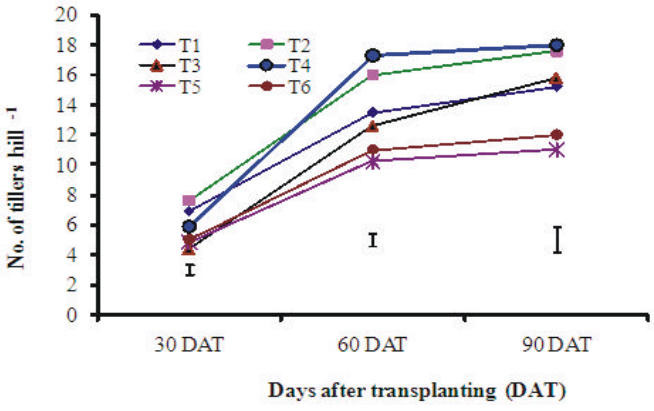

Fig. 2: Effect of different methods of urea fertilizer application on the tiller production of *boro* rice cv. BRRI dhan 29 (Vertical bars indicate the LSD at P=0.05) [T_1 (200 kg ha^{-1} two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg ha^{-1} at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT), T_3= Urea supergranules @ 50 kg ha^{-1}, T_4= Urea supergranules @ 75 kg ha^{-1}, T_5= 0.5% foliar spray @ 20 kg ha^{-1}, T_6= 1% foliar spray @ 40 kg ha^{-1}].

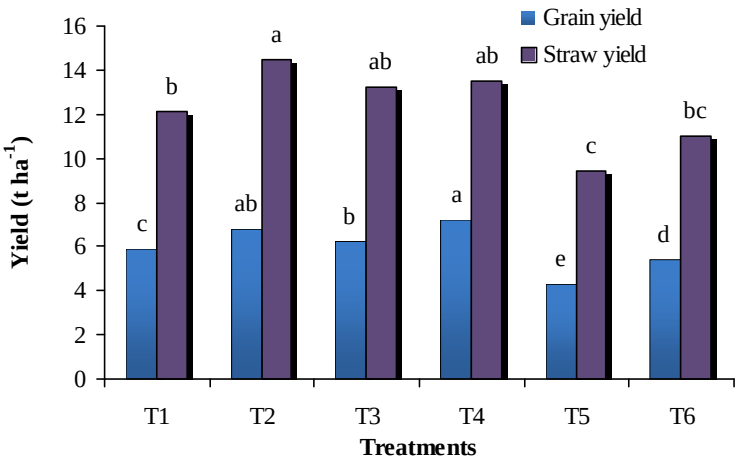

Fig. 3: Effect of different methods of urea fertilizer application on the yieldn of *boro* rice cv. BRRI dhan 29 (Vertical bars indicate the LSD at P=0.05) The bars with the same letter(s) are not significantly different at P=0.05. [T_1 (200 kg haG^1 two equal splits, ½ during final land preparation + ½ at 30 DAT), T_2 (200 kg haG^1 at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + 1/3 at 55 DAT), T_3= Urea supergranules @ 50 kg haG^1, T_4= Urea supergranules @ 75 kg haG^1, T_5= 0.5% foliar spray @ 20 kg haG^1, T_6= 1% foliar spray @ 40 kg haG^1].

panicles per hill was observed with T_5 which was due to les amount of N uptake by plants. The treatment T_4 also produced the longest panicle (22.3 cm) which was statistically superior to others. Urea applied as supergranules released nitrogen slowly which ensures sufficient N at panicle formation stage that confers the better results. This result was corroborated with the findings of Sen and Pandey [18]. In this study the spikelet number per plant was also significantly affected by urea application methods (Table 1). The highest number of panicles per hill was observed with T_4 which 4.23% to 25.31% higher than other treatments. In this study it was observed that granular urea @ 200 kg haG^1 applied at 2 equal splits gave similar results with USG applied at 50 kg haG^1. It was reported that split N supply was more effective than a single basal application under aerobic soil conditions, probably because N loss was larger in aerobic soil than in flooded conditions [19]. It revealed that USG can give more benefit to rice plant than conventional practices. However like other attributes no. of spiklets also did not benefited by foliar spray of urea and from the table it was observed that excess application of foliar urea did not show any significant result. Several researchers also showed the lower effect on foliar spray of urea in rice [20]. Grain weight was also highest with the treatment T_4 which was identical with T_2 and T_3. In this case 1% foliar spray @ 40 kg haG^1 gave similar result to granular urea application @ 200 kg haG^1. Miah *et al.* [21] showed that application of USG produced more yield components compared to granular urea.

Both the grain yield and straw yield of *boro* rice cv. BRRI dhan 29 was influenced by different application methods of urea (Fig. 3). In this study the highest grain yield (7.2 t haG^1) was observed from T_4= Urea supergranules @ 75 kg haG^1 which was followed by T_2 (200 kg haG^1 at three equal splits, $^1/_3$ during final land preparation + $^1/_3$ at 30 DAT + $^1/_3$ at 55 DAT). The lowest grain yield (4.3 t haG^1) was observed with foliar spray of urea @ 20 kg haG^1. Application of USG @ 75 kg haG^1 produced 22.03% 5.88% more yield than conventional urea application at 2 and 3 equal splits. However, foliar spray of urea at 20 and 40 kg haG^1 produced 40.27% and 25.0% lower yield compared to Urea supergranules applied at 75 kg haG^1. It was due to little loss of N which was supported by BRRI [7]. Straw yield also significantly affected by different urea application methods (Fig. 3). In this study T_2 produced the highest straw yield which was statistically at per with T_3 and T_4. It was due to more vegetative growth at maximum vegetative stage as influenced by granular urea application. With USG application more photosynthate was translocated to grain compared to straw. This result was partially supported by Sen and Pandey [18]. Miah *et al.* [21] observed that USG produced superior yield than crystalline urea applied in rice crop.

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