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Effect of different techniques of urea application on rice production

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ABSTRACT

A research work was carried out in order to determine the economic and effective method of urea application in rice crop (BINA Dhan-7). The experiment was conducted at Hajee Mohammad Danesh Science & Technology University (HSTU) Farm, Dinajpur during Aman season of 2016 (June-November). The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments and three replications. The treatments were: T_1 (194 kg/ ha urea at two equal splits), T_2 (Urea Super Granules @ 81.5 kg/ha), T_3 (2% foliar urea spray solution @ 45 kg/ha), T_4 (Prilled urea 138kg/ha). Both the growth and yield was significantly affected by different methods of urea application. In all of the cases for yield, plant height and straw yield, T_2 gave the highest result. Application of USG @ 81.5 kg/ha produced 14.38% higher grain yield than traditional method T_1 (194 kg/ ha urea at two equal splits). Foliar spray of urea produced the lowest yield components and yield in this study.Form this study it can be concluded that Urea Super Granules @ 81.5 kg/ha may be used to obtain the best performance on growth and yield of transplant Aman rice cv. Binadhan-7. Therefore, the treatment T_2 (USG @ 81.5 kg/ha) can be recommended is the best management practice for obtaining higher yield in transplant Aman rice.

INTRODUCTION

The population of Bangladesh is increasing day by day and horizontal expansion of rice area is not possible due to high population pressure. Total rice production in Bangladesh was about 10.97 million tons in the year 1971 when the country's population was only about 70.88 millions. At present the country is now producing about 34.71 million tons to feed her 156.6 million people (BBS, 2016). Population growth rate in Bangladesh is two million people per year and the population will reach 233.2 million by 2050, going by the current trend (BBS, 2012). Bangladesh will require more than 55.0 million tons of rice per year to feed its people by the year 2050. Bangladesh will require about 31.3 to 42.0 million tons of rice for the year 2030 (IFPRI, 2012). During this time total rice area will also shrink to 10.68 million hectares. Therefore, it is an urgent need of the time to increase rice production through increasing the yield. 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 per hill, 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. Nitrogen is a major 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 (Miah et al., 2012). Optimum dose of nitrogen fertilization plays a vital role in growth and development of rice plant. BRRI (1990) reported that nitrogen has a positive influence on the production of effective

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tillers. 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. Total N uptake by rice plant varies among rice varieties. Nitrogen is required in adequate amount at early, at mid-tillering and panicle initiation stage for better grain development (Ahmed et al., 2005). Urea is the most frequently used N fertilizer globally. Urea can be applied in different ways. In Bangladesh, farmer uses urea fertilizer by broadcast method during cultivation and most of the applied fertilizers are lost through volatilization, de-nitrification, and run-off and leaching. These result in low crop yield and reduced efficiency of applied nutrients. However, heavy application of nitrogen does not always give higher yield. According to Craswell et al. (1980) broadcast application of urea on the surface soil causes losses up to 50% but point placement of USG in 10 cm depth results negligible loss. The nitrogen efficiency especially of urea fertilizer is very low (30-35%) in rice cultivation. Urea Super Granules (USG) can minimize the loss of N from soil and hence the affectivity increase up to 20-25% (BRRI, 2008). Urea can also be supplied to plants through the foliage, facilitating optimal N management, which minimizes N losses to the environment without affecting yield (Millard et al., 1990). Most plants absorb foliar applied urea rapidly (Nicoulaud et al., 1996) and hydrolyze the urea in the cytosol.

However, there is an ample need to find out the relative efficiency of different application methods ofN-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 Hajee Mohammad Danesh Science & Technology University (HSTU) Farm, Dinajpur during Aman season of 2016 (June-November). Geologically, the experimental zone is located at 25^0 37'16"N latitude and 88°38' 4" E longitude at the elevation of above 37.50 m the sea level. There was different urea application treatments names T_1 (194 kg/ ha urea at two equal splits traditional hand broadcast), T_2 (Urea Super Granules @ 81.5 kg/ha), T_3 (2% foliar spray solution @ 45 kg/ha), T_4 (Prilled urea 138kg/ha using prilled urea applicator). Urea was applied in two equal splits for T_1. The first spilt of urea was top dressed after 11 days of transplanting and the second spilt of urea was top dressed after 33 days of transplanting (panicle initiation stage). As per experimental specification, USG were placed at 8-10 cm depth after 7 days of transplanting in the middle of four hills in alternate rows. In the same process prilled urea was also applied in the middle of four hills. Foliar urea was also applied in three equal splits after 9 days, 24 days and 41 days of transplanting. The experiment was carried out in a Randomized Complete Block Design (RCBD) with 3 replications as factorial arrangement.

The size of the each plot was 4 m x 3 m. A basal dose of Triple Super Phosphate (TSP), Muriate of Potash (MP), Gypsum and Zinc Sulphate were used as a source of phosphorus, potassium, gypsum and zinc at the rate of 148, 178, 100, 15 kg/ha respectively at the time of final land preparation. Thirty-five days old seedlings were carefully uprooted from a seedling nursery bed and transplanted in the main field at the rate of three seedlings per hill by maintaining a spacing of 15 cm x 20 cm. Intercultural operations were done properly. Natural precipitation was not found adequate. For this reason irrigation was provided to maintain 5-6 cm water layer in the plot until the crop attained maturity.

The plant height was measured three times from the ground level to the top of the plant at 25, 50 and 75 days after transplanting. The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) using a computer package program namely, SPSS version 22.0.

RESULTS AND DISCUSSION

Yield Contributing Characters

Growth of rice plant was greatly influenced by different methods of application of urea fertilizer. In this study, plant height was significantly affected by urea application methods as shown in

figure1. At all the growth stage (25, 50, 90 DAT), maximum plant height was observed with T_2 (Urea Super Granules@ 81.5 kg/ha). Maximum influences of urea fertilizer application methods were observed at 50 DAT because in this stage crop growth was highest. At maturity (90 DAT) the highest plant height was 82.07 cm with treatment T_2 which is 2.73% higher than the plant height obtained from treatment T_1 (194 kg/ha urea at two equal splits) (Figure 1). At maturity T_2 and T_4 showed statistically similar results. The lowest plant height with treatment T_3 (2% foliar spray @ 45 kg/ha) might be due to 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 (2009).

Application methods of urea significantly influenced the yield contributing characters ofBINA-7. Highest number of panicles per hill was observed with T_2 (Urea Super Granules@ 81.5 kg/ha) which was 19.6% higher than number of panicles per hill obtained from T_1 (194 kg/ha urea at two equal splits) as shown in table-1. Lowest number of panicles per hill was observed with treatment T_3 (2% foliar spray @ 45 kg/ha) which was due to less amount of N uptake by plants, but there was no statistically significant difference between the treatments as shown in table-1.

The treatment T_2also produced the longest panicle (24.22 cm) which was statistically similar as treatment T_3 and superior to other treatments (T_1 and T_2) as shown in table-1. Urea applied as super granules 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 (1990). Lowest panicles length was observed with treatment T_1 (21.61 cm) as shown in the table-1.

The methods of application of urea fertilizer have significant effect on number of grain per panicle of rice. In this study highest number of grain per panicle was observed with treatment T_2 (149.33 grain panicle^{-1}) which was statistically similar with treatment T_4 but superior to other treatments (T_1 and T_3) as shown in table-1. Lowest number of grain per panicle was observed with treatment T_3 (121.33 grain panicle^{-1}) as shown in table-1 which was due to less amount and slow uptake of N in the grain formation stage.

Table 1: Effect of different methods of urea fertilizer application on the yield contributing characters

Treatments*	No. of panicles hill^{-1}	Panicle length (cm)	No. of grain panicle^{-1}	1000 grain weight (gm)
T_1	18.11±1.26^a	21.61±.25^c	143.66±1.85^b	23.54±0.24^b
T_2	21.66±5.03^a	24.22±1.01^a	149.33±1.85^a	24.42±0.17^a
T_3	17.33±2.02^a	24.22±0.10^a	121.33±1.85^c	22.57±0.15^c
T_4	17.55±0.50^a	22.22±0.34^b	149.20±1.7^a	24.28±0.11^a

*T_1= 194 kg/ ha urea at two equal splits, T_2 = Urea Super Granules @ 81.5 kg/ha, T_3 =2% foliar urea spray solution @ 45 kg/ha, T_4= Prilled urea 138kg/ha. Figures having similar letter in a column indicate non- significant difference whereas figures having different letter in a column indicate significant differences.

Table 2: Cost and production ratio based on treatment methods with urea fertilizer application

Treatment*	Amount of urea applied ha^{-1}	Cost of urea fertilizer, ha^{-1} (Tk)	Yield (t/ha)	Paddy price (Tk)	CPR	Cost of urea for paddy production, (Tk Kg^{-1})
T_1	190	3800	2.99	59800	15.73	1.27
T_2	81.5	1630	3.42	68400	41.96	0.47
T_3	45	765	2.68	53600	70.06	0.28
T_4	138	2346	3.18	63600	27.10	0.74

*T_1= 194 kg/ ha urea at two equal splits, T_2 = Urea Super Granules @ 81.5 kg/ha, T_3 =2% foliar urea spray solution @ 45 kg/ha, T_4= Prilled urea 138kg/ha.

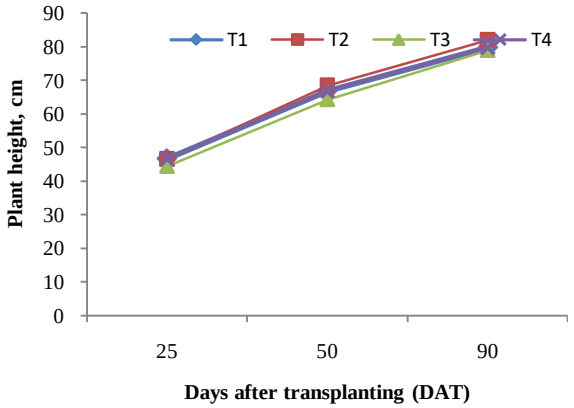

Figure 1: Effect of different methods of urea application on plant height

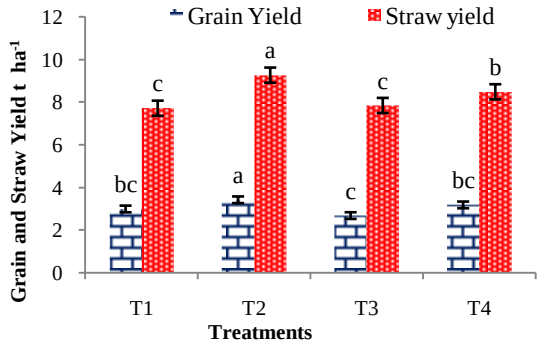

Figure 2: Effect of different methods of urea fertilizer application on the grain yield and straw yield. The bars with the same letter(s) are not significantly different at P=0.05.

1000 Grain weight was also highest (24.42 gm) with the treatment T_2 which was statistically similar with treatment T_4 as shown in table-1. Lowest grain weight was observed with treatment T_3 (22.57 gm). It showed that application of USG produced more yield components compared to other methods of urea fertilizer application.

Grain and Straw Yield

Both the grain yield and straw yield of Binadhan-7 was significantly influenced by different application methods of urea fertilizer as shown in fig. 2.In this study, the highest grain yield (3.42 t/ha) was observed from T_2 (Urea Super Granules@ 81.5 kg/ha) which was statistically similar with grain yield obtained from treatment $T_1$and T_4. The lowest grain yield (2.68 t/ha) was observed with treatments T_3 (2% foliar spray @ 45 kg/ha) which was statistically different from other treatments. The grain yields due to different treatments may be ranked in the order of T_2>T_4> T_1> T_3 as shown in the figure 2. Treatment T_2 and T_4 produced 14.38% and 6.35% higher grain yield than traditional method T_1 (194 kg/ha urea at two equal splits) respectively and on the other hand treatment T_3 produced 10.36% lower grain yield than the traditional methods of urea application. Deep placement of urea produced highest yield by reducing the adverse effects of urea, this is because deep placement of urea can reduce nitrogen loss by ammonia volatilization. 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% (BRRI, 2008).

Straw yield also significantly affected by different methods of application of urea fertilizer as shown in the fig. 2. In this study, the highest straw yield (9.26 t/ha) was observed from T_2 (Urea Super Granules@ 81.5 kg/ha) which was statistically different from straw yield obtained from other treatment T_1, 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 photosynthesis was trans-located to grain compared to straw (Senet al., 1990). The lowest straw yield (7.71t/ha) was observed with treatments T_1 which was statistically different from treatments T_2 and T_4 but similar to treatments T_3. The straw yields due to different treatments may be ranked in the order of T_2>T_4> T_3> T_1 as shown in the figure 2. Treatment T_2, T_3 and T_4 produced 20.10%, 4.04% and 9.98% higher straw yield than traditional method T_1 (194 kg/ha urea at two equal splits) respectively.

Cost Production Ratio (CPR)

From table 2, it could be seen that the cost of urea application is lowest for treatment T_3also cost production ratio (CPR) is highest at that treatment. On the other hand, the highest cost of urea application was found for treatment $T_1$and also the cost production ratio (CPR) was lowest for that treatment. The cost production ratio due to different treatment may be ranked in the order of T_3>T_2>T_4>T_1. It was also seen that the cost of per

kg paddy production was highest at treatment T_1 and lowest at treatment T_3.

CONCLUSION

Form this study it was found that Urea Super Granules @ 81.5 kg/ha maybe used to obtain the best performance on growth and yield of transplant Aman rice cv. Binadhan-7. Therefore, the treatment T_2 (USG @ 81.5 kg/ha) can be recommended is the best management practice for obtaining higher yield in transplant Aman rice.

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