Effect of Different Levels of Fertilizer (n&p) and roguing on Seed Production of BRRI dhan29

ABSTRACT

An experiment was conducted at the Farmer's Field, Boyra village, Mymensingh, Bangladesh during the period from February to May 2016 to study the yield performance of boro rice seed production as influenced by nitrogen and phosphorus fertilization with different levels of roguing. The experiment comprised three levels of roguing *viz*. no roguing (R_0), roguing one time (R_1) and roguing two times (R_2) and five doses of N and P fertilizers *viz*. Farmer practice (F_1: 250 kg urea and 260 kg TSP), Optimum/recommended (F_2: 187 kg urea and 200 kg TSP), High N (F_3: 200 kg urea and 200 kg TSP), High P (F_4: 187 kg urea and 240 kg TSP) and High N + High P (F_5: 200 kg urea and 240 kg TSP). The experiment was laid out in a randomized complete block design with three replications. Results revealed that the Optimum doses of fertilizer applications significantly produced the highest grain yield among the treatments. All the yield contributing characters showed the best performance in this treatment. Though roguing did not produce significant yield variation but the interaction effects did. Here, The Optimum doses of fertilizer without roguing (F_2R_0) produced highest grain yield but it was at per with F_3R_1, F_2R_2, F_2R_1, F_4R_1 and F_5R_2 treatments. Among the five statistically alike treatments F_2R_2 i.e. optimum fertilizer dose with two rougings produced the highest number of filled grains per panicle and highest seed germination and appreciably higher percentage of pure seed. Based on this experimental result, it appears that optimum fertilizer dose with two times rouging treatment performed the best for seed production in BRRI dhan29.

Keywords: Roguing, seed production, rice, nitrogen and phosphorus fertilizer

1. INTRODUCTION

Rice is one of the most important food crops and feeds more than half of the world's population specially heavily populated Asian countries as well as many African countries. Food security issues have moved to the top of the global agricultural agenda in response to recent rising global food prices and are a long-term concern for humans worldwide. To meet the population increasing demands by 2025, rice production must increase by 24% IRRI (2006). Bangladesh is one of the highly populated country occupies 4^{th} place in the rice production over the world. In Bangladesh, rice cultivated area of 10.5 million hectare and contributes 25 million tons of grain production BRRI (2013). It provides nearly 48% of rural employment and about two-third of total calorie supply. The farmers have been cultivating rice in different growing seasons namely Aus, Aman and Boro.

In the year 1970-71, the population of Bangladesh was 71.21 million and the rice production was 10.97 million tons. In the year 2008-2009, for the population of 150 million the rice production increased to 30.34 tons BRRI (2010). Rice covers about 75% of the total cropped area, more than 80% of the total irrigated area. At present, 11.37 million hectares of land produces 34.53 million tons of rice BBS (2014). Most of the rice yield comes from high yielding rice variety (HYV).

Because of continuous growing of HYV rice and injudicious fertilizer management, many soils are getting exhausted.

Fertilizer is very important input for intensive rice production the profitability of rice production systems depends on yield and input quantities. Since fertilizer is an expensive and precious input, determination of an appropriate dosage of application that would be both economical and suitable to enhance productivity and consequent profit of the grower under given situation needs intensive study. At present the world is facing the problem of shortage of major fertilizer nutrients especially Nitrogen and Phosphorous. So the appropriate fertilizer input that is not only for getting higher grain yield but also for attaining maximum profitability Khuang et al. (2008).
Nitrogen is one of the most important nutrients for plant growth and a major factor that limits agricultural yields Xia et al. (2011). Nitrogen is the integral part of protoplasm, protein and chlorophyll that resulting in increasing cell size which inhibits plant height and crop yield. Besides, nitrogen absorbed by rice during the vegetative growth stages contributed in growth during reproduction and grain-filling through translocation Fageria et al. (2014), and Ida et al. (2009). The application of nitrogen fertilizer either in excess or less than optimum rate affects both yield and quality of rice. Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice Alam et al. (2009).

Phosphorus is the second key plant nutrient that is needed in adequate quantity and in available form for the growth, reproduction and yield of crop. Phosphorus deficit is a most important restrictive factor in plant growth and recognition of mechanisms that increase plant phosphorus use efficiency is important Alinajoati and Mirshekari (2011). Phosphorus fertilizer is a costly agricultural input for rice framers of the developing world Saleqe et al. (2004). Furthermore, due to its low mobility and high fixation in soils, low P availability is a worldwide constraint for crop growth Sánchez-Calderón et al. (2010). The phosphorus content of Bangladesh soils is being depleted gradually due to crop removal particularly, in intensive cultivation. Application of phosphorus fertilizers is recommended for all soils and crops in Bangladesh to obtain better yield BARC (2012). Moreover, P reserves are being exhausted globally at a higher rate and estimated no soil P reserve by the year 2050 Cordell et al. (2011). Raising rice yields beyond the present level of yield will require P in crop production Lan et al. (2012) and Singh et al. (2002).Sustainable increases in rice yield with efficient utilization of irreplaceable P resources will entail better management.

Quality Seed production is one of the important factors, as farmers realize crop growth even from traditional seed. Off type rice reduces yield and quality of white commercial rice production causing economic loss Smith (1979) and it was recognized as a weed of rice earlier in the rice production area Leon (2005). Off type rice plants resemble those of white rice cultivars but they produced tillers more profusely, showed grain shattering, different in heading date Smith et al. (1977). Gross morphological feature easily differentiate off type rice from white rice in the field. So, roguing is important to produce quality seed production.

However, rice farmers usually do not apply balanced doses of N, P, K and other fertilizers. Improper management of fertilizers is one of the major causes of low yield because fertilizer plays an important role in influencing yield of rice. According to importance NP containing fertilizer and roguing on growth and yield of pure seed production, this study was conducted to determine the effect of nitrogen and phosphorus fertilizer and roguing on seed production of boro rice BRRI dhan29.

2. MATERIALS AND METHODS

The experiment was conducted at the Boyra village, Mymensingh Sadar, Mymensingh during the period from February to May 2016. The experimental area belongs to Non Calcareous Dark Gray Flood plain soil under the Sonatola soil series of Old Brahmaputra Flood plain in Agro Ecological Zone (AEZ) 9. The region occupies a long area of Brahmaputra sediments which were laid down before the river shifted into its present Jhamuna channel about 200 years ago FAO and UNDP (1988). The land was medium high, fairly leveled with well drained soils. The soils of this series are pre-dominantly silty loam, dark grey in color with pH value around 6.5, low in organic matter and its general fertility level is low.

The experiment consisted boro rice variety BRRI dhan29, three rouging *viz.* no rouging (R_0), one rouging (R_1) and two rouging (R_2) with five fertilizer doses *viz.* Farmer practice *(*250 kg urea and 260 kg TSP), Optimum (187 kg urea and 200 kg TSP), High N (200 kg urea and 200 kg TSP), High P (187 kg urea and 240 kg TSP) and High N + High P (200 kg urea and 240 kg TSP). The experiment was laid out in a randomized complete block design (RCBD) with 3 replications. The unit plot size was 5.0m × 4.0m. Therefore, the total numbers of treatments (15) were distributed in 45 unit plots randomly. The spacing between block to block and plot to plot was 1 m and 0.5 m, respectively. The land was prepared by ploughing and cross ploughing with country plough. All kind of Weeds, stubbles and crop residues were removed from the field before transplanting of the seedlings. The fertilizers were measured and applied separately in the unit plots. During final land preparation, the land was fertilized with full dose of triple super phosphate (TSP), Muriate of potash (MP), Gypsum and Zinc Sulphate fertilizers were applied according to the treatments. The fertilizers were incorporated into the soil by ploughing. Urea was applied as top-dressing in three equal splits after 15, 35 and 55 days of transplanting. The seedling was grown in seedbed and transplanted forty five days old seedlings of BRRI dhan29 with 3 seedlings hill^{-1} with spacing 25 cm × 15 cm. Different intercultural operations were done when needed for ensuring proper growth and development of the rice like Gap filling, Weeding, Irrigation and drainage and Pest and Disease management.

The rice plant was harvested when 90% of the grains became golden yellow in color. Prior to harvesting 5 randomly selected plants per plot excluding border rows were taken from each plot to collect data on yield contributing characters and then the rice of the full plot was harvested. Grain yield was then recorded at 10.93% moisture content and converted to ton per hectare (ha). The straw was also sun dried to record the straw yield per plot. Grain and straw yield plot were converted to ton per ha. Data on yield and yield contributing characters and seed quality were collected.

Harvest index is the ratio of economic yield to biological yield and was calculated using the following formula Gardner et al. (1985).

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Purity test was conducted using the seeds from each plot by mixing properly and 25g seed from each sample was taken separately and purity was analyzed by dividing the seeds into four categories (pure seed, other seed, weed seed and inert matter) and then the weight of each fraction was taken and purity percentage (%) was measured by the following formula.

$$\text{Purity \%} = \frac{\text{Weight of pure seed fraction}}{\text{Weight of total sample}} \times 100$$

Seeds were collected randomly from each plot and placed in Petridis (with 100 seeds per Petridis) with wetly sandy soil. The sprouted seeds were first counted after 4 days and continued up to 11 days and then calculated the germination percentage. The collected data were analyzed with the ANOVA technique and the mean differences were adjudged by Duncan's Multiple Range Test Gomez and Gomez (1984) using a statistical computer packages MSTAT.

3. RESULTS AND DISCUSSION

3.1 Effect of fertilizer

The N&P fertilizers had significant effect on yield and contributing characters such as plant height, grain per panicle, 1000 seed weight, grain yield and harvest index. The highest plant height was observed in farmer practice and the shortest plant height was observed in optimum fertilizer dose. The higher number of tiller per plant was recorded in farmer practice and the lowest number of effective tiller per plant was obtained in high N combination. The highest number of non-effective tillers per plant was found in farmer practice and the lowest was recorded from the optimum dose of fertilizer. The highest number of filled grains per panicle was obtained from the optimum dose and the lowest was recorded in high N fertilizer (Table 1). The highest number of unfilled grains per panicle was recorded in high P dose and the lowest was found in optimum dose of fertilizer. The highest 1000-grain weight was found with high P treatment and the lowest was found in the high N dose (Table 1). The highest grain yield was obtained from the optimum dose of fertilizer. Besides, the lowest grain yield was obtained from the farmer practice (Table 1). The highest grain yield was obtained from optimum dose of fertilizer and it could be attributed mainly to its more number of effective tillers plant^{-1}, effective spikelets per panicle^{-1} and higher 1000-grain weight. Yoseftabar (2013) also reported that spikelet number, fertile spikelet, fertile spikelet percentage, Spikelet sterility percentage, biological and grain yield increased significantly with optimum nitrogen and phosphorus fertilizer. The highest HI observed in optimum fertilizer dose. The lowest harvest index was produced by high N treatment (Table 1).

Different fertilizer combinations affected significantly in respect to pure seed production. The collected seeds were divided into four categories namely, pure seed, other seed, weed seed and inert matter. Interestingly, all the data showed significant difference with different fertilizer dose. The highest pure seed was found with high P treatment and the lowest was found in the high N dose (Table 2). Alinajoat and Mirshekari (2011), and Alam et al. (2009) found that nitrogen and phosphorus fertilizer is a major essential plant nutrient and key input for in increasing crop yield. The effect of different fertilizer doses on the seed germination percentage (%) was statistically significant. The highest percentage of germinated seed was obtained from the optimum dose and the lowest was recorded in farmer practiced dose of fertilizer application (Fig. 1).

3.2 Effect of roguing

The purity, seed germination, yield and yield contributing characters were significantly affected by the different levels of rouging. It was observed that roguing was not influenced the plant height significantly but the highest plant height was found in roguing^2 condition and the lowest plant height was observed in no roguing conditions. The highest number of filled grains per panicle was observed in roguing2 and the lowest was found in roguing^0 (Table 3). Besides, the highest number of unfilled grains produced in roguing^0 and the lowest number was recorded in roguing^2 (Table 3). The higher 1000-grain weight was obtained from roguing^2 and the lowest was recorded from roguing^0. There was no significant difference observed in grain yield production but the highest grain yield was obtained from roguing2 and the lowest grain yield was recorded in roguing0 (Table 3). The higher grain yield in roguing2 might be due to higher number of filled grains and higher number of effective tillers hill^{-1}. The highest value of harvest index was obtained from roguing2 and the lowest value was obtained from no roguing (Table 3).

The highest pure seed was obtained from roguing2 and the lowest was recorded in roguing0 (Table 4). There was no other seed and weed seed was found in case of roguing2. From the above discussion, it was suggested that two roguing is important for pure seed production in rice. Another research has shown that roguing increases quality of commercial pure rice seed production and reduces economic loss Smith (1979). It might be possible due to density of the plant within the same area. This data was supported by Wang and Li (2008) that Plant architecture in cereal crops is considered to be a major factor that influences grain yield through the efficient use of solar radiation and optimal partitioning of photosynthates into organs that form grain yield. The highest seed germination percentage was found in roughing^2 and the lowest seed germination was observed in roughing^0 (fig. 2). From the above results, two roughing is important for pure seed production in rice was recommended.

3.3 Interaction effect of different fertilizer doses and roguing

Most of the studied parameters were significantly influenced by the interaction between NP fertilizers and rouging except effective tillers and unfilled grains per panicle. The tallest plant was observed in F_1R_2 and F_3R_0 which was different from the other interactions, and the lowest plant height was found from the treatment of F_2R_1 (Table 5). Number of non-effective tillers per plant was significantly different by the interaction of different fertilizer combinations and roguing. The highest number of non-effective tillers per plant was observed in F_1R_0 and the lowest number of non-effective tillers per plant was observed in F_2R_2. The highest number of filled grains per panicle was obtained from the F_2R_2 and F_5R_2, whereas F_1R_0 produced the lowest (Table 5). In addition, the highest number of unfilled grains per panicle produced by the F_4R_1 combination and F_2R_2 produced the lowest number of unfilled grains per panicle (Table 5). The highest 1000-grain weight was found in F_4R_1. The lowest 1000-grain weight was obtained from the interaction of the F_2R_0. The highest grain yield was obtained from the F_2R_0 combination and the lowest grain yield was obtained from the F_1R_0 combination. The harvest index due to the interaction ranged from 49.65% to 52.81%. The highest harvest index was obtained from the F_2R_2. The lowest harvest index was found in interaction of the F_4R_2 (Table 5). The above discussion indicates that N& P containing fertilizer and roguing contributes in pure seed production in rice.

4. CONCLUSION

Results of this current study indicated that different nitrogenous and Phosphorus fertilizer dose had significant influenced almost all the studied parameters related to yield and yield contributing characters of BRRI dhan29. The highest plant height, number of effective tillers, non-effective tillers and unfilled grains was found in farmer practice treatment that is negatively related to yield of seed production. The optimum fertilizer dose contributed significantly in increasing filled grain per panicle which ultimately increased the grain yield. Rouging also had significant effect on some studied parameters; especially it contributed on pure seed production. The interaction between the rouging and fertilizer dose had significant effect on all studied parameters linked to yield and yield contributing characters. Finally, we recognized that the optimum fertilizer dose compare to other dose of fertilizer application with two roguing at flowering to maturity stage was significantly influenced the pure seed production of BRRI dhan29.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Table 1. Effect of different combinations of fertilizer on yield contributing characters and yield of BRRI dhan29

Treatment	Plant height (cm)	No. of effective tiller	No. of non-effective tiller	No. of filled grains	No. of unfilled grains	1000 seed weight	Yield/ ha (t)	Harvest Index (HI)
Farmer practice (F_1)	97.35a	11.98	1.31a	159.30a	22.16b	23.64c	6.29b	52.02a
Optimum (F_2)	93.52b	11.36	0.53d	160.40a	20.64b	25.11a	6.78a	52.23a
High N (F_3)	97.38a	10.78	1.09ab	150.50b	21.11b	23.28d	6.33b	50.49b
High P (F_4)	93.78b	10.91	0.90c	155.40ab	28.07a	25.41a	6.43b	50.73b
High N+P (F_5)	96.47ab	11.51	1.18ab	157.60ab	27.42a	24.77b	6.45b	51.67a
CV (%)	8.8	3.51	5.40	6.50	12.66	1.86	4.80	1.75

In a column, similar letter do not differ significantly whereas the dissimilar letter differ significantly as per DMRT

Table 2. Effect of different levels of fertilizer combinations on pure seed production of BRRI dhan29

Treatment	Pure seed (%)	Other seed (%)	Weed seed (%)	Inert matter (%)
Farmer practice (F_1)	98.40d	0.16b	0.32b	0.96b
Optimum (F_2)	98.56b	0.20b	0.24c	0.88c
High N (F_3)	98.36d	0.24a	0.24c	0.84c
High P (F_4)	98.60a	0.16b	0.40a	1.08a
High N&P (F_5)	98.44c	0.04c	0.32b	0.88c
CV (%)	9.64	5.20	3.10	7.64

In a column, similar letter do not differ significantly whereas the dissimilar letter differ significantly as per DMRT.

Table 3. Effect of different levels of Roguing on yield contributing characters and yield of BRRI dhan29

Treatment	Plant height (cm)	No. of effective tiller	No. of non-effective tiller	No. of filled grains	No. of unfilled grains	1000 seed weight	Yield/ha (t)	Harvest Index (HI)
Roguing 0	95.27	11.32	1.09	153.20	25.19a	24.29b	6.48	52.50a
Roguing 1	95.50	11.17	1.01	155.20	22.97ab	24.36ab	6.54	50.74b
Roguing 2	96.34	11.43	0.91	158.10	18.48b	24.70a	6.64	52.81a
CV (%)	8.8	3.51	5.40	6.50	12.66	1.86	4.80	1.75

In a column, similar letter do not differ significantly whereas the dissimilar letter differ significantly as per DMRT

Table 4. Effect of roguing on pure seed production of BRRI dhan29

Treatment	Pure seed (%)	Other seed (%)	Weed seed (%)	Inert matter (%)
Roguing 0	97.32c	0.52a	0.48a	1.64a
Roguing 1	98.56b	0.00b	0.40b	0.80b
Roguing 2	99.12a	0.00b	0.00c	0.48c
CV (%)	9.64	5.20	3.10	7.64

In a column, similar letter do not differ significantly whereas the dissimilar letter differ significantly as per DMRT

Table 5. Interaction effect of fertilizers and Roguing on Phenotypic characters of BRRI dhan29

Interaction	Plant height	No. of effective tiller	No. of non-effective tiller	No. of filled grains	No. of unfilled grains	1000 seed weight	Yield/ha (t)	Harvest Index (HI)
F_1R_0	97.29a	11.60	1.47a	129.60f	22.13c	21.41f	6.10b-d	49.65d
F_1R_1	96.68a-c	12.27	1.27ab	135.30ef	21.87c	23.58de	6.53ab-d	51.67ab
F_1R_2	98.09a	12.07	1.09a-c	168.30a-c	22.47c	23.56de	6.43b-d	51.35a-c
F_2R_0	94.52b-e	12.00	0.91b-d	158.50a-d	22.87c	23.89de	7.15a	52.00a
F_2R_1	92.91e	12.33	1.01bc	165.90a-c	20.60dc	23.83de	6.64a-c	52.50a
F_2R_2	93.13e	11.73	0.06f	174.40a	18.47d	25.96a	6.80ab	52.81a
F_3R_0	98.20a	11.00	0.53de	150.80c-e	19.00d	24.08cd	6.23b-d	52.00a
F_3R_1	97.03ab	10.27	0.33ef	158.50a-d	23.67bc	25.02b	7.08a	52.43a
F_3R_2	96.92ab	11.07	0.73c-e	157.30a-d	20.67dc	24.85bc	6.00cd	52.25a
F_4R_0	94.07c-e	09.60	1.00bc	139.90d-f	21.54c	24.86bc	6.33b-d	50.00cd
F_4R_1	93.47e	11.13	1.27ab	171.70ab	32.27a	25.92a	6.67ab	51.83ab
F_4R_2	93.81de	11.00	1.00bc	154.60b-d	30.40ab	25.45ab	5.92d	51.26a-d
F_5R_0	97.61a	11.40	1.00bc	142.40d-f	25.40b	25.67ab	6.00cd	52.22a
F_5R_1	96.23a-d	11.87	0.90b-d	154.50b-d	31.47a	23.07e	6.33b-d	50.22b-d
F_5R_2	95.58a-e	11.27	0.80cd	175.90a	25.40b	25.56ab	6.57a-c	49.76cd
CV (%)	8.8	3.51	5.40	6.50	12.66	1.86	4.80	1.75

In a column, similar letter do not differ significantly whereas the dissimilar letter differ significantly as per DMRT

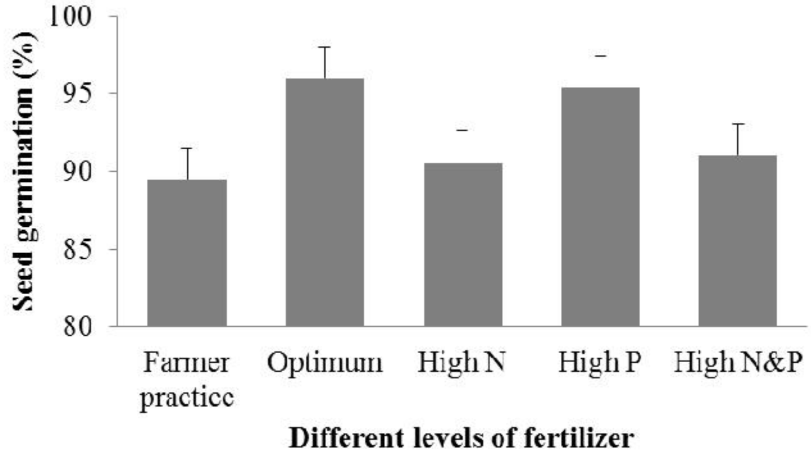

Fig. 1. Effect of different fertilizer doses on seed germination of BRRI dhan29

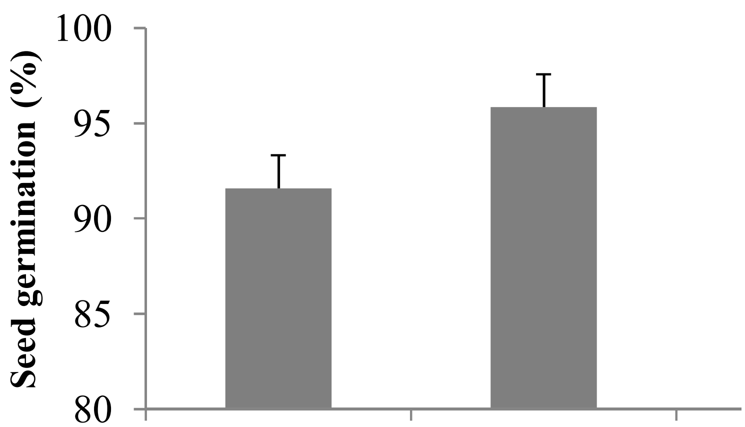

Figure 2. Effect of different levels of roguing on seed germination