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EFFECT OF SPACING ON THE PERFORMANCE OF NEWLY DEVELOPED AUS RICE VAR. Binadhan-19

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An experiment was conducted at the experimental farm of BINA Sub-station, Gopalganj to determine the effect of spacing on the yield and yield attributing parameters of rice. Four spacings viz. 15 cm × 15 cm, 20 cm × 15 cm, 20 cm × 20 cm and 25 cm × 20 cm were included in the study. The experimental design was a randomized completely block with three replications. Spacing's 15 cm × 15 cm, 20 cm × 15 cm, 20 cm × 20 cm and 25 cm × 20 cm were adopted 49, 42, 36 and 30 hills per square meter, respectively. Results revealed that different spacing performed significantly differed yield contributing characters (plant height, panicle length, number of effective and non-effective tillers, number of filled and unfilled grain, grain and straw yield of rice. Results indicated that the highest plant height (83.40 cm), panicle length (19.73), number of effective tillers per hill (11.00), number of total grains per panicle (87.73), number of filled grains per panicle (70.53), root length (16.07 cm), root weight (38.00 g per five plants), harvest index (38%), grain yield (4.19 t ha^{-1}) and straw yield (4.50 t ha^{-1}) were found with 25 cm × 20 cm spacing. On the other hand, maximum number of non-effective tillers per hill (1.60) was found in 15 cm × 15 cm spacing. Results of the present study revealed that 25 cm × 20 cm spacing was found to be the best for obtaining maximum grain yield of aus var. Binadhan-19.

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INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal food crop of the developing countries as the staple food of more than 3 billion people or more than half of the world's population. In Bangladesh, researchers are developed new rice varieties to feed our over growing people. For achieving this goal, Scientist of Bangladesh Institute of Nuclear Agriculture (BINA) has developed new rice variety (Binadhan-19) for aus season. Rice production is depended on varietal performance and management practices. Spacing is one the most important factor of management practices to increase rice production because rice growth is known to be affected both qualitatively and quantitatively by plant population densities. Many authors (Chandrakar and Khan, 1981; Uddin *et al*., 2011; Rasool *et al*., 2013) have indicated that closer spacing of 15 cm × 10 cm, 15 cm × 15 cm and 15 cm × 20 cm were superior to wider spacing of 30 cm × 10 cm, 20 cm × 20 cm and 15 cm × 25 cm by producing more effective tillers per unit area, higher plant height, higher leaf area index and total dry matter accumulation. Other authors (Weewaroth *et al*., 1979; Bishnu *et al*., 2013) have reported that wider spacing (25 cm × 25 cm, and 30 cm × 30 cm) produced significantly higher rice tillers, panicles per square meter, longer and weighty panicles, and higher grain yield than closer spacing (15 cm × 15 cm).

Therefore, research is needed to determine the effective spacing for increasing yield of Binadhan-19 rice. Keeping in mind, therefore a field experiment was conducted to determine the optimum spacing to popularize the newly developed rice variety (Binadhan-19) among the farmers of Bangladesh.

MATERIALS AND METHODS

Field experiment of rice was conducted at the experimental farm of BINA Sub-station, Gopalganj to determine the effect of different spacings on the yield and yield attributing characters of rice. Four spacing's viz. 15 cm × 15 cm, 20 cm × 15 cm, 20 cm × 20 cm and 25 cm × 20 cm were included in the study. The experimental design was a randomized completely block with three replications. The site was initially slashed and vegetative cover removed. The area was then ploughed using a power tiller. The ploughed site was then divided into three main blocks using bunds to represent three replications. Each block was then divided into four plots by using bunds to represent the above mentioned spacings. The four different planting geometries between hills and rows were kept for growing the crop and to identify their effect on grain-straw and yield contributing parameters of rice. Three weeks old rice seedlings were manually transplanted to each plot. Seedlings were transplanted at two per stand (hill) for all the different spacing adopted. Spacing's 15 cm × 15 cm, 20 cm × 15 cm, 20 cm × 20 cm and 25 cm × 20 cm were adopted 49, 42, 36 and 30 hills per square meter, respectively. Mineral fertilizer was applied at 90 kg N ha^{-1} as urea, 60 kg P_2O_5 ha^{-1} as triple super phosphates and 60 kg K_2O ha^{-1} as muriate of potash. All P and K and 1/3 N were applied immediately after transplanting. The remaining 2/3 N was applied at maximum vegetative and panicle initiation stages of rice.

Weeds were manually controlled through occasional hand picking. Plant height, panicle length, number of effective and non-effective tillers were counted at harvest stage. At maturity, an area of 1.0 square meter excluding border rows was measured out in each plot, number of panicles counted and harvested (grain and straw). Grain and straw yield were measured and yield per ha estimated. Plant height, panicle length, tillers were also collected from non-border rows and mean data were determined. Harvest index (HI) was calculated as ratio of grain yield to total yield (grain + straw + root). The statistical software MSTA-C was used to analyze the data and LSD at 5% probability level was used as the mean separator.

RESULTS AND DISCUSSION

Effects of spacing on plant height results are presented (Table 1). Results showed that plant height increased with decreasing row spacing. Plant height ranged from 83.40 cm to 74.67 cm in spacing 15 cm × 15 cm and 25 cm × 20 cm. The tallest plant height was recorded at 25 cm × 20 cm spacing while shortest plant was recorded at 15 cm × 15 cm spacing. The second highest plant height (79.53 cm) was observed in 20 cm × 15 cm. Ogbodo *et al*. (2010) observed that plant height was significantly higher when crops were transplanted at wider spacing (30 cm × 30 cm) than at closer spacing (10 cm × 10 cm and 20 cm × 20 cm). Panicle length ranged from 17.87 cm to 19.53 in 20 cm × 20 cm and 25 cm × 20 cm. The highest panicle length (19.73 cm) was obtained from 25 cm × 20 cm and the lowest panicle length (17.87 cm) was found in 20 cm × 20 cm. The number of effective and non-effective tillers produced per stand under the different spacings adopted is presented in Table 1. Tiller number was significantly affected by spacing. The productive and nonproductive tillers per stand were estimated during maturity stage of rice growth. Number of effective tillers per stand was ranged from 7.87 to 11.00 in 20 cm × 20 cm and 25 cm × 20 cm plant spacing, respectively. Highest effective mean tiller number per hill (11.00) was recorded in the 25 cm × 20 cm spacing and the lowest mean effective tiller number per hill (7.87) was recorded in the 20 cm × 20 cm spacing. The 15 cm × 15 cm spacing (1.60) produced significantly higher non-effective tillers per stand than all the spacing (20 cm × 20 cm; 20 cm × 15 cm and 15 cm × 15 cm).

Table 1. Effect of different spacing on yield and yield attributing characters of rice

Spacing (cm)	Plant height (cm)	Panicle length (cm)	Effective tiller/hill (no.)	Non-effective tiller/hill (no.)	Root length (cm)	Root weight (g/5plant)	Total grain (no.)	Filled grain (no.)	Unfilled grain (no.)	Harvest index (%)
15 × 15	74.67	19.60	7.87	1.60	16.07	18.83	81.00	63.27	17.73	36
20 × 15	79.53	19.53	8.87	0.80	14.67	19.83	82.20	64.27	16.20	38
20 × 20	77.20	17.87	8.40	0.87	15.27	24.00	77.67	61.33	16.33	37
25 × 20	83.40	19.73	11.00	1.00	16.07	38.00	87.73	70.53	16.40	38
CV (%)	4.08	7.75	13.93	19.41	3.22	6.18	1.22	1.48	5.20	3.20
Sig. level	NS	NS	NS	**	*	**	**	**	NS	NS
LSD	5.78	2.70	2.26	0.36	0.90	2.79	1.80	2.19	1.56	2.10

LSD: least significant difference; NS-not significant; *, ** indicate significant at 5% and 1% level of probability, respectively

The lowest number of non-effective tillers (0.80) per stand was recorded under 20 cm × 15 cm spacing. Moro *et al*. (2016) reported that growth attributes were significantly affected by spacing. Wider spacing resulted in the production of more tillers per stand than closer spacing. There was a significant increase in the number of tillers per stand with increased spacing. Mirza *et al*. (2009) also observed that closer spacing reduced the number of effective tillers and increased tiller mortality, hence lower number of panicles. In this study, the more vigorous plants and greater tiller numbers produced under wider spacing would have a better photosynthetic ability with a wider feeding area, more accessibility to soil nutrients and increased availability of nutrient. While under closer spacing, plants were denied more access to solar radiation due to closeness of plant canopies, wider spacing provided a more conducive environment where plants are exposed to more solar radiation which promotes more photosynthetic production and better growth due to increased nutrient availability and uptake. The analysis was carried out to find out whether there is a significant difference in the number of total grains per panicle among the four treatments. The results have shown that spacing of 25 cm ×

20 cm, 20 cm × 20 cm and 20 cm × 15 cm treatments performed significantly higher total grain number per panicle as compared to 15 cm × 15 cm. The mean number of total grains per panicle was found to be 87.73, 80.67, 82.20 and 81.00 for the spacing of 25 cm × 20 cm, 20 cm × 20 cm, 20 cm × 15 cm and 15 cm × 15 cm, respectively. The trend shows that the number of total grains per panicle increases with the increasing of spacing except 20 cm × 20 cm. In respect of filled grains, spacing 25 cm × 20 cm produced the highest filled grain per panicle of rice and the lowest filled grain per panicle was found in 15 cm × 15 cm spacing. Rajesh and Thanunathan (2003) reported that the use of wider spacing led to lesser below and above ground competition for better grain filling, higher grain weight and more number of filled grains per panicle. On the other hand, the highest unfilled grains per panicle were found in 15 cm × 15 cm spacing. Generally it can be concluded that higher spacing had better performance in terms of number grains per panicle as compared to lower spacing due to less competition of nutrients, air and light creating better environment for crop growth (Moro *et al*., 2016).

The effect of spacing on root length and weight produced per square meter is presented in Table 1. Maximum root length was found in 15 cm × 15 cm and 25 cm × 20 cm spacing and the lowest root length was obtained from 20 cm × 15 cm spacing. Root weight was significantly influenced by spacing (Table 1). Root weight of rice plant ranged from 18.83 to 38.00 g per five plants. Highest root weight was found in 25 cm × 20 cm spacing and the lowest root weight was observed in 15 cm × 15 cm spacing. Harvest index was significantly influenced by spacing (Table 1). Maximum harvest index (38%) was observed in 20 cm × 15 cm and 25 cm × 20 cm and the minimum harvest index was obtained from 15 cm × 15 cm. Harvest index ranged from 36% to 38%. Grain yield was significantly influenced by spacing (Fig. 1). The highest grain yield (4.19 t ha^{-1}) was recorded in 25 cm × 20 cm spacing and the lowest grain yield (3.04 t ha^{-1}) in closer spacing of 15 cm × 15 cm. Spacing (25 cm × 20 cm) produced the highest grain yield of rice due to good performance of yield attributing characters of rice. Straw yield was also significantly influenced by spacing (Figure 1).

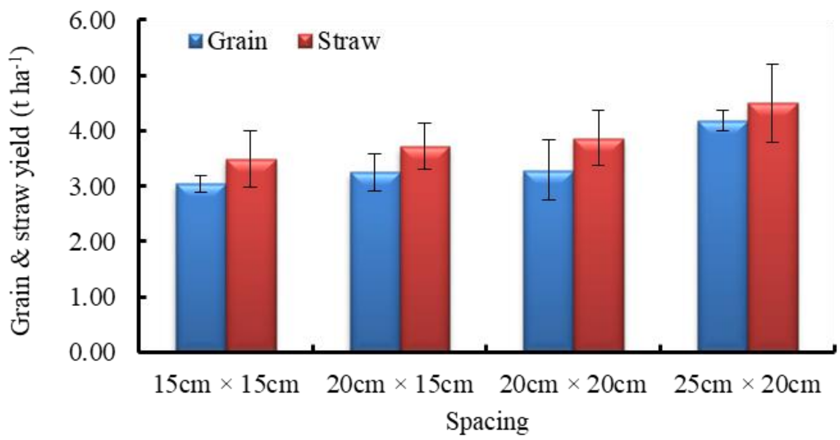

Figure 1. Effect of different spacing on grain and straw yield of rice

The highest straw yield (4.50 t ha^{-1}) was recorded in 25 cm × 20 cm spacing and the lowest grain yield (3.50 t ha^{-1}) in closer spacing of 15 cm × 15 cm. From these results, it may be concluded that wider spacing (25 cm × 20 cm) performed better results on rice. The result is consistent with the findings of Moro *et al*. (2016). Correlation co-efficient and regression of yield attributes were worked out (Table 2) in order to evaluate their influence on rice yield. Plant height, effective tiller, root weight, total filled grain performed positive and significant correlation with rice yield to indicate that rice yield was increased with the increase of above mentioned parameters. On the other hand, panicle length, non-effective tiller, root length and unfilled grain had no effect on rice yield due to non-significant results.

Table 2. Correlation coefficient between grain and straw yield between yield attributing parameters of rice

Parameter	Grain yield		Straw yield	
	Correlation coefficient	Regression equation	Correlation coefficient	Regression equation
Plant height	0.867**	Y=0.1269x-6.5352	0.820**	Y=0.1049x-4.3551
Panicle length	0.085^{NS}	Y=0.1676x+0.2378	0.015^{NS}	Y=0.0597x+2.7525
Effective tiller	0.980**	Y=0.3646x+0.1581	0.918**	Y=0.2998x+1.1885
Non-effective tiller	0.123^{NS}	Y=0.4863x+3.9716	0.180^{NS}	Y=0.5002x+4.4315
Root length	0.120^{NS}	Y=0.2572x-0.5392	0.085^{NS}	Y=0.1946x+0.8772
Root weight	0.959**	Y=0.0560x+2.044	0.971**	Y=0.0479x+2.6933
Total grain	0.699**	Y=0.1011x-4.8506	0.532**	Y=0.0749x-2.2536
Filled grain	0.833**	Y=0.1160x-4.0683	0.688**	Y=0.0895x-1.9066
Unfilled grain	0.217*	Y=0.3293x+8.9399	0.285*	Y=-0.3205x+9.2381

Correlation co-efficient and regression of yield attributes on straw yield were worked out (Table 2) in order to evaluate their influence on straw yield. Plant height, total tiller, effective tiller, root weight, total grain weight and filled grain weight performed positive and significant correlation with straw yield to indicate that straw yield was increased with the increase of above mentioned parameters. On the other hand, panicle length, non-effective tiller, root length and unfilled grain had no effect on straw yield due to non-significant results.

CONCLUSION

Transplanting at wider spacing produced significantly higher panicles per square meter, heavier individual panicle weights and higher yields than closer spacing due to more leaves exposed to sunlight, higher and more effective mobilization of photosynthetic matter and better grain filling compared to closer spacing. The spacing of 25 cm × 20 cm produced significantly higher grain yields and therefore we recommended this spacing for Binadhan-19 as aus season.

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CONFLICT OF INTEREST

There is no conflict of interest between the authors about the research.

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