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Variations of growth parameters in transplanted *Aman* rice (cv. BRRI dhan39) in response to plant spacing and fertilizer management

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ABSTRACT

The experiments were carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh during June to December 2015 to investigate the effect of spacing and fertilizer management on the growth parameters of transplant *Aman* rice cv. BRRI dhan39. The experiment comprised of five spacing's viz. 25 cm × 5 cm, 25 cm × 10 cm, 25 cm × 15 cm, 25 cm × 20 cm, 25 cm × 25 cm, and four fertilizer treatments viz. no manure and no fertilizer (control), recommended dose of chemical fertilizer (80-60-40 kg N, P₂O₅, K₂O ha⁻¹, respectively + 60 kg ha⁻¹ gypsum + 10 kg ha⁻¹ ZnSO₄), 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹, 75% recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹. The highest and lowest plant height was found in spacing 25 cm × 15 cm, and 25 cm × 5 cm, respectively at all dates of observations. Spacing 25 cm × 15 cm, produced the highest number of tillers hill⁻¹ at 80 DAT. Leaf area index (LAI) and total dry matter (TDM) hill⁻¹ were the highest in 25 cm × 15 cm spacing and lowest in 25 cm × 5 cm spacing. The highest plant height, LAI and total TDM hill⁻¹ were recorded in 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹ and the lowest values were observed in control treatment. In case of interaction, the highest number of tillers hill⁻¹, leaf area index and total dry matter hill⁻¹ were obtained in spacing 25 cm × 15 cm fertilized with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha⁻¹. Therefore, 25 cm × 15 cm spacing combined with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha⁻¹ appeared as the promising practice in transplant *Aman* rice cv. BRRI dhan39 cultivation in terms of growth parameters.

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INTRODUCTION

Rice (*Oryza sativa*) is the most extensively cultivated and major food grain crop of Bangladesh. Bangladesh has three rice crops/seasons within a year; the *Boro* crop, the *Aman* crop, and the *Aus* crop. The growth of rice plants is influenced genetically and environmentally. Plant spacing is an important factor, which plays a significant role on growth, development, and yield of rice at its optimum level, which provides scope to the plants for efficient utilization of solar radiation and nutrients. Closer spacing hampers intercultural operations and as such additional competition take places among the plants for nutrients, air, and light. As a result, plant becomes weaker, thinner and consequently reduces yield. A suitable combination of organic and inorganic supplies of nutrients is essential for sustainable agriculture that will provide food with superior

quality. Sengar *et al.* (2000) stated that the application of chemical fertilizers in combination with manures sustained/improved the fertility status of the soil. The long term research of BRRI reveals that the addition of cow dung @ 5 t ha⁻¹ yr⁻¹ improves the rice productivity as well as prevents the soil resources from degradation (Bhuiyan, 1994). An upgrading and continuation of a good supply of organic matter is essential for sustenance of soil fertility and crop productivity. The growth parameter, leaf area index (LAI) is a dimensionless variable and was first defined as the total one-sided area of photosynthetic tissue per unit ground surface area (Inge *et al.*, 2004). Leaf area index (LAI) can have importance in many areas of agronomy and crop production through its influence: light interception, crop growth, weed control, crop-weed competition, crop water use and soil erosion (Sonnetag *et al.*, 2007 and Paul *et al.*, 2014). Therefore, this study was undertaken

to analyze the growth parameters of transplant *Aman* rice in respect to appropriate spacing and proper fertilizer management.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh, during the period from July to December 2015 to study the effect of spacing of transplanting and fertilizer management on the growth of transplant *Aman*-rice. The experimental sites belongs to the Sonatola Soil Series of Old Brahmaputra Floodplain (AEZ 9) having non calcareous dark grey floodplain soil. The land was medium high with sandy loam texture having pH 5.9. BRR dhan39, a high yielding modern rice variety of transplant *Aman*rice, developed by the Bangladesh Rice Research Institute, has been used as the test crop. The experiment comprised five spacings *viz.*, 25 cm × 5 cm (S₁), 25 cm × 10cm (S₂), 25 cm × 15 cm (S₃), 25 cm × 20 cm (S₄), 25 cm × 25 cm (S₅) and four fertilizer treatments *viz.* no manure and no fertilizer (control) (N₀), recommended dose of chemical fertilizer (80-60-40 kg N, P₂O₅, K₂O ha⁻¹, respectively + 60 kg ha⁻¹ gypsum + 10 kg ha⁻¹ ZnSO₄) (N₁), 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹ (N₂), 75% recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹ (N₃). The experiment was laid out in a Randomized Complete Block Design with three replications. There were 60 unit plots in the experiment. The size of unit plot was 4m × 2.5m. The experimental plots were fertilized according to the treatments during final land preparation. Nitrogen was applied accordingly experimental specification in the form of urea at three splits application. Five hills were randomly selected and marked with the bamboo sticks in each unit plot excluding border rows to record the data on plant height and tiller number. Plant height and number of total tillers hill⁻¹ were recorded five times at 20, 35, 50, 65 and 80 days after transplanting (DAT). Leaf area index and total dry matter hill⁻¹ were determined at 60 DAT. For total dry matter determination, five hills were randomly selected in each plot excluding border rows. The plant samples were destructed and packed in labeled brown paper bags and dried in the oven at 80±5°C for 72 hours until constant weight was reached. Recorded data were analyzed statistically using "Analysis of Variance Technique and the differences among treatment means were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Plant height: The plant height was significantly influenced due to spacing at 20, 35, 50, 65 and 80 days after transplanting (DAT) (Table 1). The highest plant height was obtained at all sampling dates in 25 cm × 15 cm spacing and lowest one was found in 25 cm × 5 cm spacing. Ray *et al.* (2014) also found that closer spacing produced shorter plant in rice. This result was due to maximum number of plant population as well as higher competition for space, solar radiation, water and other resources in 25 cm × 5 cm (S₁) spacing compared to 25 cm

× 15 cm (S₃) spacing. Fertilizer management had significant effect on plant height at 20, 35, 50, 65 and 80 days after transplanting (DAT) (Table 2). At all sampling dates the highest plant height was found when fertilized with 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹ (N₂) and lowest one was found in control application.

Interaction between plant spacing and fertilizer management had no significant effect on plant height at different days after transplanting of T. *Aman* rice cv. BRR dhan39 (Table 3). Visually, At 20, 35, 50, 65 and 80 DAT, the highest plant height (31.67 cm, 57.33 cm, 89.00 cm, 103.30 cm and 109.20cm) was observed in S₃ × N₂ and the lowest ones (28.00 cm, 51.13 cm, 77.07 cm and 92.33 cm) was obtained from S₁ × N₀.

Number of total tillers hill⁻¹: Spacing had significant effect on the number of tillers hill⁻¹ at different sampling dates up to harvesting (Table 1). The maximum number of tillers hill⁻¹ (6.00, 9.00, 12.75, 10.80 and 11.20) was observed in the spacing 25 cm × 15 cm while the minimum ones (4.68, 5.76, 6.50, 5.55 and 5.50) were observed in the closest spacing 25 cm × 5 cm at 20, 35, 50, 65 and 80 DAT. The reason might be wide spaced plants received more nutrients; moisture and light thus produced higher number of tillers hill⁻¹. Mobasser *et al.* (2007) and Ray *et al.* (2014) also reported that wider spacing produced maximum number of total tillers than closer spacing in rice. Total tillers hill⁻¹ was significantly influenced due to application of manure and fertilizer (Table 2). The maximum number of tillers hill⁻¹ (5.73, 8.30, 10.95, 9.46, 9.12) was observed at N₂ (75% recommended dose of inorganic fertilizer + cow dung 5 t ha⁻¹), at 20, 35, 50, 65 and 80 DAT and while the minimum ones (5.14, 6.92, 8.06, 7.62, 7.61) were observed at N₀ (Control) at 20, 35, 50, 65 and 80 DAT. The result was in agreement with that of Marzia (2015) who reported that combined application of manure with 75% recommended dose of inorganic fertilizer produced maximum number of tillers hill⁻¹. The lowest total tillers hill⁻¹ occurred due to lack of proper nutrient uptake. At 20 DAT total tillers hill⁻¹ was not significantly influenced by the interaction effect between spacing and manure and fertilizer (Table 3). But at 35, 50, 65 and 80 DAT total tillers hill⁻¹ was significantly influenced by the interaction effect between spacing and manure and fertilizer (Table 3). At 35, 50, 65 and 80 DAT, the highest number of tillers hill⁻¹ was recorded from S₃ × N₂ and the lowest number of total tiller hill⁻¹ was recorded from S₁ × N₀ treatment.

Leaf area index (LAI): Spacing had significant effect on leaf area index (Table 1). At 60DAT, leaf area index was found highest (7.45) in the spacing 25 cm × 15 cm and the lowest LAI (2.80) was found in the closest spacing (25 cm × 5 cm). The result was in agreement with that of Aziz (2014) who observed that LAI reduced due closer spacing in rice. Fertilizer management had significant effect on LAI (Table 2). At 60DAT, LAI (6.16) was found highest in N₂ (75% recommended dose of inorganic fertilizer + cow dung 5 t ha⁻¹) and the lowest LAI (4.33) was found in N₀ (Control). The treatment having combination of organic

Table 1. Effect of plant spacing on plant height, number of tiller hill⁻¹, leaf area index and total dry matter production hill⁻¹.

Plant spacing	Plant height (cm)			No. of total tillers hill ⁻¹			Leaf area index		Total dry matter production (g hill ⁻¹)	
	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)
25cm × 5cm(S ₁)	20	35	50	65	80	80	60	60	60	60
25cm × 10cm (S ₂)	28.93b	53.38b	81.42c	95.20b	97.10c	99.20bc	4.68d	5.55e	5.50e	14.34e
25cm × 15cm(S ₃)	29.15b	54.53ab	82.15bc	97.30ab	99.20bc	103.20a	5.16c	7.78d	7.00d	16.34d
25cm × 20cm (S ₄)	30.67a	55.68a	85.38a	99.63a	103.20a	101.90ab	6.03a	10.80a	11.2 a	21.01a
25cm × 25cm (S ₅)	30.52a	55.27a	84.51ab	98.77a	101.90ab	99.82bc	5.73ab	9.983b	10.0b	18.83b
S \bar{X}	29.90ab	55.13a	83.83abc	97.98a	99.82bc	101.90ab	5.40bc	8.700c	8.40c	17.33c
Level of significance	**	*	**	**	**	**	**	**	**	**
CV (%)	4.45	3.12	3.48	3.21	3.68	3.68	8.45	4.78	5.01	3.06

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).** =Significant at 1% level of probability. * =Significant at 5% level of probability.

Table 2. Effect of fertilizer management on plant height, number of tiller hill⁻¹, leaf area index and total dry matter production hill⁻¹.

Fertilizer management	Plant height (cm)			No. of total tillers hill ⁻¹			Leaf area index		Total dry matter production (g hill ⁻¹)	
	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)	Days after transplanting (DAT)
N ₀	20	35	50	65	80	80	60	60	60	60
N ₁	28.91b	52.53c	79.28c	94.75c	96.33c	99.21b	5.14b	8.06d	7.61c	12.48d
N ₂	29.41b	54.12b	82.67b	96.59bc	99.21b	105.40a	5.30b	9.56c	8.12b	16.40c
N ₃	31.08a	56.60a	86.59a	101.00a	105.40a	100.1b	5.73a	10.95a	9.12a	22.05a
S \bar{X}	29.93b	55.95a	85.31a	98.75ab	100.1b	100.1b	5.42ab	8.89b	8.86a	19.35b
Level of significance	**	**	**	**	**	**	**	**	**	**
CV (%)	4.45	3.12	3.48	3.21	3.68	3.68	8.45	4.78	5.01	3.06

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT). N₀= No manure and no fertilizer (control), N₁= Recommended dose of chemical fertilizer (80-60-40 kg N, P₂O₅, K₂O ha⁻¹), respectively + 60 kg ha⁻¹ gypsum + 10 kg ha⁻¹ ZnSO₄, N₂= 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹, N₃=75% recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹. ** =Significant at 1% level of probability.

Table 3. Interaction effect of plant spacing and fertilizer management on plant height, number of tiller hill⁻¹, leaf area index and total dry matter production hill⁻¹.

Interaction (Plant spacing x fertilizer management)	Plant height (cm)				No. of total tillers hill ⁻¹				Leaf area index		Total dry matter production (g hill ⁻¹)		
	Days after transplanting (DAT)				Days after transplanting (DAT)				Days after transplanting (DAT)		Days after transplanting (DAT)		
	20	35	50	65	80	80	20	35	50	65	80	60	60
S ₁ × N ₀	28.00	51.13	77.07	90.27	92.33	4.53	5.66i	6.06j	4.60 l	4.73g	2.04m	9.003l	9.003l
S ₁ × N ₁	28.93	53.40	81.67	95.27	97.80	4.60	5.73i	6.40j	5.46 k	5.53f	2.58l	12.92j	12.92j
S ₁ × N ₂	29.80	55.13	84.07	98.53	101.0	4.87	5.93hi	7.00ij	6.27j	5.87f	3.40k	18.03fg	18.03fg
S ₁ × N ₃	29.00	53.87	82.87	96.73	97.27	4.73	5.73i	6.73ij	5.87jk	5.87f	3.21k	17.40gh	17.40gh
S ₂ × N ₀	28.40	52.47	78.20	94.87	95.73	4.87	6.40gh	7.00ij	7.07i	6.00f	2.44lm	10.62k	10.62k
S ₂ × N ₁	29.00	53.93	82.27	96.07	98.47	5.07	7.00fg	8.20 h	7.67 hi	6.27f	3.34k	15.87i	15.87i
S ₂ × N ₂	30.07	56.07	84.33	99.73	103.9	5.53	7.20f	8.67gh	8.33gh	8.00de	4.66fgh	20.33d	20.33d
S ₂ × N ₃	29.13	55.67	83.80	98.53	98.73	5.20	7.13f	8.27 h	8.07gh	7.73e	4.18hij	18.53ef	18.53ef
S ₃ × N ₀	29.73	53.80	81.00	96.53	99.07	5.60	8.07de	10.07ef	9.53de	10.0bc	7.45c	17.31gh	17.31gh
S ₃ × N ₁	30.07	54.53	84.67	98.07	101.5	6.00	8.53bcd	12.40bc	10.07cd	11.2a	8.5b	18.61ef	18.61ef
S ₃ × N ₂	31.67	57.33	89.00	103.3	109.2	6.33	10.2a	14.53a	12.13a	11.8a	9.2a	25.51a	25.51a
S ₃ × N ₃	31.20	57.07	86.87	100.6	103.3	6.20	9.13b	14.00a	11.47b	11.8a	8.6b	22.59b	22.59b
S ₄ × N ₀	29.60	52.67	80.13	96.40	98.60	5.53	7.30f	9.40fg	9.00ef	9.67bc	4.02ij	13.10j	13.10j
S ₄ × N ₁	29.67	54.40	82.40	97.07	99.60	5.60	8.40cd	11.40cd	9.93cd	9.73bc	5.10 f	18.13fg	18.13fg
S ₄ × N ₂	32.27	57.33	88.73	102.5	107.7	6.13	9.93a	13.93a	10.53c	10.4b	6.66 d	24.90a	24.90a
S ₄ × N ₃	30.53	56.67	86.80	99.13	101.7	5.66	8.93bc	12.80b	10.47c	10.3b	5.99e	19.21e	19.21e
S ₅ × N ₀	28.80	52.60	80.00	95.67	95.93	5.20	7.16f	7.80hi	7.93h	7.66e	3.72jk	12.35j	12.35j
S ₅ × N ₁	29.40	54.33	82.33	96.47	98.73	5.26	7.53ef	9.40fg	8.20gh	7.86de	3.96j	16.48hi	16.48hi
S ₅ × N ₂	31.60	57.13	86.80	101.1	105.3	5.80	8.20d	10.60de	10.07cd	9.46c	4.87fg	21.49c	21.49c
S ₅ × N ₃	29.80	56.47	86.20	98.73	99.27	5.33	8.13de	10.00ef	8.60fg	8.60d	4.53ghi	19.00ef	19.00ef
$\bar{S}\bar{X}$	0.765	0.984	1.67	1.81	2.12	0.26	0.210	0.35	0.20	0.24	0.172	0.311	0.311
Level of significance	NS	NS	NS	NS	NS	NS	**	**	**	*	**	**	**
CV (%)	4.45	3.12	3.48	3.21	3.68	8.45	4.78	6.40	4.24	5.01	5.60	3.06	3.06

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT). N₀ = No manure and no fertilizer (control), N₁= Recommended dose of chemical fertilizer (80-60-40 kg N, P₂O₅, K₂O ha⁻¹, respectively + 60 kg ha⁻¹ gypsum + 10 kg ha⁻¹ ZnSO₄), N₂= 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹, N₃=75% recommended dose of inorganic fertilizer + poultry manure @ 2.5 t ha⁻¹. ** = Significant at 1% level of probability.

and inorganic fertilizers showed significant improvement of LAI. The result agreed with that of Paul *et al.* (2014). Usman *et al.* (2003) reported that maximum leaf area index (LAI) of rice obtained through application of inorganic fertilizer and manure. The interaction effect between plant spacing and fertilizer management on LAI was significant at 60 DAT (Table 3). The highest LAI was observed in the spacing 25 cm × 15 cm when fertilized with 75% recommended dose of inorganic fertilizer + cow dung 5.0 t ha⁻¹ and the lowest one was found in the closest spacing (25 cm × 5 cm) with control application.

Total dry matter (TDM): Spacing had significant effect on TDM (Table 1). At 60 DAT, total dry matter was found highest (21.01 g hill⁻¹) in the spacing 25 cm × 15 cm and the lowest total dry matter (14.34 g hill⁻¹) was found in the closest spacing (25 cm × 5 cm). Total dry matter production hill⁻¹ reduced in closer spacing was reported by Tyeb *et al.* (2013). Total dry matter production increased at wider spacing due to less competition for water, nutrient and more accumulation in plant. The result was in agreement with that of Murty and Murty (1980). Fertilizer management had significant effect on TDM (Table 2). At 60DAT, total dry matter (22.05 g hill⁻¹) was found highest in N₂ (75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹) and the lowest total dry matter (12.48 g hill⁻¹) was found in N₀ (Control). The result was in agreement with that of Marzia (2015) who mentioned that integration of manure with 75% recommended dose of inorganic fertilizer increased TDM of rice. The interaction effect between plant spacing and fertilizer management on TDM hill⁻¹ was significant at 60 DAT (Table 3). The highest total dry matter (25.51 g hill⁻¹) was observed in the spacing 25 cm × 15 cm when fertilized with 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹ and the lowest one (9.00 g hill⁻¹) was found in the closest spacing (25 cm × 5 cm) with control application.

Conclusions

From the findings of the experiment it can be concluded that tallest plant, highest number of total tiller hill⁻¹, highest leaf area index and total dry matter production hill⁻¹ were obtained in 25 cm × 15 cm spacing. The highest number of tillers hill⁻¹, leaf area index and total dry matter hill⁻¹ were observed in 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹. In case of interaction, growth parameters gave the highest values in spacing 25 cm × 15 cm fertilized with 75% recommended dose of inorganic fertilizers + cow dung at 5 t ha⁻¹. Therefore, application of 75% recommended dose of inorganic fertilizer + cow dung at 5 t ha⁻¹ in plant spacing 25 cm × 15 cm appeared as the promising practice in respect of growth of transplant *Aman* rice (cv. BRRI dhan39).

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