

## VARIETAL PERFORMANCE OF TRANSPLANT AMAN RICE AS INFLUENCED BY NUMBER OF SEEDLINGS HILL<sup>-1</sup> UNDER SUBMERGENCE CONDITION

M. S. Khanam<sup>1</sup>, A. S. M. I. Hossain<sup>2</sup>, N. Jahan<sup>3</sup> and M. K. Islam<sup>4</sup>

### ABSTRACT

The research work was carried out at the Agronomy Field Laboratory of Patuakhali Science and Technology University, Patuakhali during the Aman season (July to December, 2016) for optimizing number of seedlings hill<sup>-1</sup> of rice varieties grown under submerged condition. The experiment was laid out in a randomized complete block design with three replications. Three levels of seedling numbers viz. 2 seedlings hill<sup>-1</sup>, 4 seedlings hill<sup>-1</sup> and 6 seedlings hill<sup>-1</sup> with three varieties viz. BRRI dhan41, BRRI dhan53 and BRRI dhan54 were considered in the study. The number of seedlings hill<sup>-1</sup> did not significantly influence all the parameters. The highest grain yield (5.54 t ha<sup>-1</sup>), straw yield (5.30 t ha<sup>-1</sup>), total tillers hill<sup>-1</sup> (9.06), effective tillers (8.98) and 1000 grain weight (23.29g) were obtained at 4 seedlings hill<sup>-1</sup>. The lowest grain yield (5.43 t ha<sup>-1</sup>), 1000 grain weight (23.15g), total tillers (8.36), effective tillers (8.33) and plant height (132.11cm) were obtained from 2 seedlings hill<sup>-1</sup>. Variety showed significant differences for plant height, total tillers hill<sup>-1</sup>, effective tillers hill<sup>-1</sup>, grains panicle<sup>-1</sup>, sterile spikelets panicle<sup>-1</sup> and 1000-grain weight. BRRI dhan54 showed with the highest grain yield (5.75 t ha<sup>-1</sup>), straw yield (5.30 t ha<sup>-1</sup>), grains panicle<sup>-1</sup> (150.0), plant height (151.33cm) and higher harvest index (52.00%). BRRI dhan41 produced lower grain yield (5.32 t ha<sup>-1</sup>), grains panicle<sup>-1</sup> (131.5), total tillers (7.50), effective tillers (7.58) and sterile spikelets panicle<sup>-1</sup> (40.31). The interaction of variety and number of seedlings hill<sup>-1</sup> had significant effect on plant height, total tillers hill<sup>-1</sup>, number of grain panicle<sup>-1</sup>, number of sterile spikelets panicle<sup>-1</sup> and 1000 grain weight. BRRI dhan54 with 4 seedlings hill<sup>-1</sup> gave highest yield (6.06 t ha<sup>-1</sup>), straw yield (5.45 t ha<sup>-1</sup>), 1000 grain weight (23.34g), total tillers (10.50) and effective tillers (10.33).

**Keywords:** Varietal performance, Transplant Aman rice, Number of seedling hill<sup>-1</sup>, Submergence condition.

### INTRODUCTION

Bangladesh is the fourth rice producing country in the world. Rice covers about 81% of total cropped area in the country and the total rice production stands at 34.5 m. metric tons (BBS, 2016). There are three distinct growing seasons of rice namely, *Aus*, *Aman* and *Boro* in Bangladesh. The productions of rice from these seasons are 2.47, 13.58 and 18.90 million tons, respectively (AIS, 2017). The agro-climatic conditions of the country are suitable for growing rice year-round. However, the national average rice yield is much lower (2.94 t/ha) than that of other rice-growing countries (BBS, 2012). Flash flood is a common phenomenon in Northwestern and Southern regions of Bangladesh. It is one of the natural hazards of rice production which is becoming more abundant due to global climate change. In some areas, farmers plant land races that are moderately tolerant of submergence but have low yield. In areas where high-yielding but submergence-intolerant rice varieties have been cultivated, farmers suffer from crop losses caused by periodic flash floods during the monsoon season. Recently, the extent of submergence stress has increased due to extreme weather events such as unexpected heavy rains that have inundated wider areas across many regions in Asia. More sustainable and permanent solutions are needed to overcome this problem. One of the most promising solutions is to develop high-yielding varieties that are submergence tolerant and more likely to be rapidly adopted by the farmers in the target regions. The horizontal expansion of rice area in the country is not possible due to heavy population pressure. The only avenue left is to increase the production of rice through good agronomic practices. Therefore, attempts should be focused on quality seed, high yielding

<sup>1</sup> Lecturer <sup>2</sup> Professor <sup>3</sup>MS student, Department of Agronomy, Faculty of Agriculture, <sup>4</sup>Deputy Registrar, Patuakhali University of Science & Technology, Dumki, Patuakhali.

varieties, adopting plant protection measures, optimum seedling age, optimum number of seedling hill<sup>-1</sup>, seedling raising technique, judicious application of fertilizers, etc. Among the improved cultural practices number of seedlings hill<sup>-1</sup> is an important factor for improving rice yield because it influences the tiller number, solar radiation interception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena affecting the growth and development of rice plant (Islam et al., 2014). In densely populated rice field the inter specific competition between the plants is high in which sometimes results in gradual shading and lodging and thus favour increased production of straw instead of grain (Basvaraja and Dushyanthakumar, 2014). Considering the above fact, the present study was undertaken to compare the performance of three recently developed submergence stress tolerant varieties BRRi dhan41, BRRi dhan53 and BRRi dhan54 and to observe the effect of seedling number per hill on yield of submergence stress tolerant T. Aman rice varieties.

## MATERIALS AND METHODS

The experiment was conducted at the Agronomy field laboratory of Patuakhali Science and Technology University, Patuakhali from July to December, 2016. The experimental field belongs to the Agro-ecological zone of AEZ-13 (UNDP, 1988). This region occupies an extensive area of tidal floodplain land in the south-west of the country. The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar & Islam, 2004). Two factors were included in the experiment namely number of seedlings hill<sup>-1</sup> and variety designated A and B respectively. In factor A; 3 levels of treatment of which were; 2 seedlings hill<sup>-1</sup> (T<sub>1</sub>), 4 seedlings hill<sup>-1</sup> (T<sub>2</sub>), 6 seedlings hill<sup>-1</sup> (T<sub>3</sub>) and in factor B; three submergence stress tolerant varieties namely BRRi dhan41, BRRi dhan53 and BRRi dhan54 were used. The experiment was laid out in a randomized complete block design with three replications. Total number of unit plots were 27 and each plot size was 6m<sup>2</sup> (3m × 2m). The experimental plot was divided into three blocks each representing a replication. Again, each replication was divided into 9 unit plots where the treatment combinations were allocated at random. Seeds of rice varieties were collected from Agronomy field laboratory of Patuakhali Science and Technology University, Patuakhali. Sprouted seeds were sown in the nursery bed on 1 July 2016. The experimental plots were prepared properly before transplanting. Recommended doses of fertilizers (urea, TSP, MoP and gypsum) were applied to the plots. The full doses of all fertilizers except urea were applied as basal dose to the individual plot during final land preparation. The first split of Urea was applied at 10 days after transplanting. The second split of urea was applied at 35 days after transplanting i.e., at maximum tillering stage and the third split of urea was applied 60 days after transplanting i.e., at panicle initiation stage. Seedlings were transplanted into the main field on 13 August 2016 as per treatment combinations. Harvesting was done when 80–90% of the grains became golden in color. Data on plant height (cm), number of total tillers hill<sup>-1</sup>, number of effective tiller hill<sup>-1</sup>, number of non-effective tiller hill<sup>-1</sup>, number of grain panicle<sup>-1</sup>, number of sterile spikelets panicle<sup>-1</sup>, length of panicle (cm), 1000 grain's weight (g), grain yield (t ha<sup>-1</sup>) and straw yield (t ha<sup>-1</sup>) were recorded and statistically analyzed with MSTAT-C computer program (Russel, 1986). The treatment mean values for all the parameters were tested by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Plant height (cm)

Plant height was not significantly affected by seedlings number hill<sup>-1</sup> (Table 1). The highest plant height (132.89cm) was observed in 6 seedling hill<sup>-1</sup> and shortest plant height (132.11 cm) was found in 2 seedling hill<sup>-1</sup>. Plant height was significantly affected by variety (Table 2). The highest plant height (151.33cm) was observed in V<sub>3</sub> (BRRi dhan54) and shortest plant height (117.44 cm) was found in V<sub>2</sub> (BRRi dhan53). The variation in plant height was found to be due to the genetic variation of rice

varieties. The result were similar to Samsuddin *et al.* (1988) who reported that plant height varied among the varieties.

#### **Total number of tillers hill<sup>-1</sup>**

Production of total number of tillers hill<sup>-1</sup> was significantly affected by the number of seedlings hill<sup>-1</sup> (Table 1). The highest number of total tillers hill<sup>-1</sup> (9.06) was produced by 4 seedlings hill<sup>-1</sup> and the lowest number of tillers hill<sup>-1</sup> (8.36) was produced by 2 seedlings hill<sup>-1</sup>. It was evident from (Table 2) that the total number of tillers hill<sup>-1</sup> was significantly influenced by variety. BRRRI dhan54 (V<sub>3</sub>) produced the maximum number of total tillers hill<sup>-1</sup> (10.25) and minimum (7.50) was BRRRI dhan41 (V<sub>1</sub>). The effect of variety on number of total tillers hill<sup>-1</sup> were also reported by Hussain *et al.* (1989).

#### **Number of effective tillers hill<sup>-1</sup>**

The number of effective tillers hill<sup>-1</sup> was not significantly influenced by the effect of seedlings number hill<sup>-1</sup> (Table 1). The highest number of effective tillers hill<sup>-1</sup> (8.98) was found in 4 seedling hill<sup>-1</sup>. The lowest number of effective tillers hill<sup>-1</sup> (8.33) was found in 2 seedling hill<sup>-1</sup>. The number of effective tillers hill<sup>-1</sup> was significantly influenced by the effect of variety under submergence condition (Table 2). The highest number of effective tillers hill<sup>-1</sup> (10.13) was found in V<sub>3</sub> (BRRRI dhan54). The lowest number of effective tillers hill<sup>-1</sup> (7.50) was found in V<sub>1</sub> (BRRRI dhan41).

#### **Number of non-effective tillers hill<sup>-1</sup>**

Number of non-effective tillers hill<sup>-1</sup> was not significantly affected by number of seedlings hill<sup>-1</sup> (Table 1). The highest number of non-effective tillers hill<sup>-1</sup> (2.81) was produced by the 4 seedlings hill<sup>-1</sup> and the lowest number of non-effective tillers hill<sup>-1</sup> (2.38) was produced by 2 seedlings hill<sup>-1</sup>. The result revealed that variety had no significant effect on non-effective tillers hill<sup>-1</sup> (Table 2). The variety BRRRI dhan54 produced the highest number of non-effective tillers hill<sup>-1</sup> (3.04) followed by variety BRRRI dhan53 (2.60) and BRRRI dhan41 (1.96).

#### **Panicle length (cm)**

Panicle length was not significantly affected by number of seedlings hill<sup>-1</sup> (Table 1). Two seedlings hill<sup>-1</sup> showed the tallest panicle (29.00 cm) and 4 seedlings hill<sup>-1</sup> yielded the shortest panicle (28.36 cm). Panicle length was significantly influenced by the variety (Table 2). BRRRI dhan54 produced tallest panicle (31.53 cm) and BRRRI dhan53 produced shortest panicle (26.73 cm) that is statistically similar to BRRRI dhan41 (27.64 cm). The results were similar to BINA (1993) which reported that panicle length was significantly influenced due to variety.

#### **Number of grains panicle<sup>-1</sup>**

Number of seedlings hill<sup>-1</sup> had significant effect on number of grains panicle<sup>-1</sup>. Table 1 indicated that 2 seedlings hill<sup>-1</sup> produced maximum number of grains panicle<sup>-1</sup> (142.0), while the minimum number of grains panicle<sup>-1</sup> (137.2) was found with 6 seedlings hill<sup>-1</sup>. The result revealed that variety had shown significant effect on number of grains panicle<sup>-1</sup> (table 2). The variety BRRRI dhan54 produced the highest number of grains panicle<sup>-1</sup> (150.0) and the lowest number of grains panicle<sup>-1</sup> from variety BRRRI dhan41 (131.50).

#### **Number of sterile spikelets panicle<sup>-1</sup>**

Number of seedlings hill<sup>-1</sup> had significant effect on number of sterile spikelets panicle<sup>-1</sup>. Table 1 indicated that 2 seedlings hill<sup>-1</sup> produce maximum number of sterile spikelets panicle<sup>-1</sup> (45.96) and the minimum number of grains panicle<sup>-1</sup> (40.76) with 6 seedlings hill<sup>-1</sup>. The result revealed that variety had significant effect on number of sterile spikelets panicle<sup>-1</sup> (Table 2). The variety BRRRI dhan53 produced the maximum number of sterile spikelets panicle<sup>-1</sup> (45.38), that is statistically similar to BRRRI dhan54 (44.38) and the variety BRRRI dhan41 produced the minimum number of sterile spikelets panicle<sup>-1</sup> (40.31).

#### **Number of filled grains panicle<sup>-1</sup>**

Number of filled grains panicle<sup>-1</sup> was significantly influenced by seedling number hill<sup>-1</sup>. Two seedling hill<sup>-1</sup> produced the highest number (142.0) of grains panicle<sup>-1</sup>. The lowest number of filled grains

panicle<sup>-1</sup> (137.2) was found in 6 seedling hill<sup>-1</sup>. Number of filled grains panicle<sup>-1</sup> was also influenced by varieties under submergence condition. V<sub>3</sub> (BRRIdhan54) produced the highest number (150.0) of grains panicle<sup>-1</sup>. The lowest number of filled grains panicle<sup>-1</sup> (131.5) was found in V<sub>1</sub> (BRRIdhan41). BRRIdhan54 reported that the number of grains panicle<sup>-1</sup> was influenced significantly due to variety.

#### **1000-grain weight (g)**

1000 grain weight was not significantly influenced by number of seedlings hill<sup>-1</sup> (Table 1). 4 seedlings hill<sup>-1</sup> (23.29 g) produce the highest 1000-grain weight followed by 2 seedlings hill<sup>-1</sup>(23.15 g) and 6 seedlings hill<sup>-1</sup>(23.26 g).The results showed 1000-grain weight had significant effect on variety (Table2). It was revealed that BRRIdhan54 produced the heaviest grain (26.14g), the variety BRRIdhan53 produced a weight of 24.11g and lowest grain weight produced from the variety BRRIdhan41(22.12).

#### **Grain yield (t ha<sup>-1</sup>)**

Number of seedling hill<sup>-1</sup> had no significant effect on grain yield. Table 1 indicated that grain yield (5.54 t ha<sup>-1</sup>) was highest at 4 seedlings hill<sup>-1</sup> than the grain yield (5.43 t ha<sup>-1</sup>) obtained with 2 seedlings hill<sup>-1</sup> and the grain yield (5.48 t ha<sup>-1</sup>) obtained with 6 seedlings hill<sup>-1</sup>. Grain yield was not significantly influenced by the variety (Table 2). The highest grain yield (5.75 t ha<sup>-1</sup>) was produced by the variety BRRIdhan54 compared to the variety BRRIdhan41 (5.32 t ha<sup>-1</sup>) and the variety BRRIdhan53 (5.38 t ha<sup>-1</sup>). Similar findings were observed by Spanu *et al.* (2004) who indicated that grain yields were satisfactory both in quantity and quality under well-watered conditions. Similar result was found by Islam *et al.* (1985) who reported that better yields were possible with continuous irrigation. Dwivedi (1997) and BRRIdhan54 (2000) also reported similar results.

#### **Straw yield (t ha<sup>-1</sup>)**

Straw yield was not significantly influenced by seedling number hill<sup>-1</sup> under submergence condition (Table 1). The highest straw yield (5.30 t ha<sup>-1</sup>) was obtained in 4 seedling hill<sup>-1</sup>. The lowest straw yield (5.19 t ha<sup>-1</sup>) was obtained in 6 seedling hill<sup>-1</sup>. Straw yield was not significantly influenced by variety under submergence condition (Table 2). The highest straw yield (5.30 t ha<sup>-1</sup>) was obtained in V<sub>3</sub> (BRRIdhan54). The lowest straw yield (5.07 t ha<sup>-1</sup>) was obtained in V<sub>2</sub> (BRRIdhan53). Similar results were also obtained by Chowdhury *et al.* (1993) where rice varieties had no significant effect on straw yield.

#### **Harvest index (%)**

Harvest index was not significantly influenced by number of seedlings hill<sup>-1</sup>(Table 1). However, 2 seedlings hill<sup>-1</sup> had the harvest index (50.98 %), 4 seedlings hill<sup>-1</sup> showed the harvest index of 51.10% and 6 seedlings hill<sup>-1</sup> showed the harvest index of 51.45%.The variation due to variety was not significant in terms of harvest index (Table 2). It was evident that BRRIdhan41 had the harvest index (50.42%), BRRIdhan53 showed the harvest index of 51.48% and BRRIdhan54 showed the harvest index of 52.00%.

#### **Interaction effect of number of seedling hill<sup>-1</sup> and variety**

The results presented in the Table 3 exhibited that there were significant influences in terms of plant height, total tillers hill<sup>-1</sup>, number of grain panicle<sup>-1</sup>, number of sterile spikelets panicle<sup>-1</sup> and 1000 grain weight due to interaction effect of number of seedling hill<sup>-1</sup> and variety. In variety and seedlings hill<sup>-1</sup> interaction (Table 3), the tallest plant (151.67cm) was obtained from BRRIdhan41 with 2 seedlings hill<sup>-1</sup> that is statistically similar to BRRIdhan41 (151.33) with 4 seedlings hill<sup>-1</sup> and BRRIdhan41 (151.00) with 6 seedlings hill<sup>-1</sup> and shortest plant (116.33 cm) from BRRIdhan53 with 4 seedlings hill<sup>-1</sup>. The highest number of total tillers hill<sup>-1</sup> (10.33) was obtained from BRRIdhan54 with 4 seedlings hill<sup>-1</sup> and the lowest number of total tillers hill<sup>-1</sup> (7.33) was obtained from BRRIdhan41 with 2 seedlings hill<sup>-1</sup>. In variety and seedlings hill<sup>-1</sup> interaction (Table 3), the highest number of effective tillers hill<sup>-1</sup> (10.33) was obtained from BRRIdhan54 with 4 seedlings hill<sup>-1</sup> and the lowest number of effective tillers hill<sup>-1</sup> (7.50) was obtained from BRRIdhan41 with 2 seedlings hill<sup>-1</sup>. The highest panicle length (32.20 cm) was obtained from BRRIdhan54 with 2 seedlings hill<sup>-1</sup> and shortest panicle length (26.40cm) was obtained from BRRIdhan53 with 6 seedlings hill<sup>-1</sup>. The highest number of grains

panicle<sup>-1</sup> (154.4) was obtained from BRR dhan54 with 2 seedlings hill<sup>-1</sup> and lowest (131.30) was obtained from BRR dhan41 with 4 seedlings hill<sup>-1</sup>. In variety and seedlings hill<sup>-1</sup> interaction (Table 3) the highest grain yield (6.06 t ha<sup>-1</sup>) was recorded from BRR dhan54 with 4 seedlings hill<sup>-1</sup> and the lowest grain yield (4.92 t ha<sup>-1</sup>) was recorded from BRR dhan41 with 2 seedlings hill<sup>-1</sup>.

**Table 1. Effect of number of seedlings hill<sup>-1</sup> on the yield and yield attributes of rice**

Seedling number hill <sup>-1</sup>	Plant height (cm)	Total tillers hill <sup>-1</sup> no.	Effective tillers hill <sup>-1</sup> no.	Non effective tillers hill <sup>-1</sup> no.	Panicle length (cm)	Grains panicle <sup>-1</sup> (no.)	Sterile spikelets panicle <sup>-1</sup> no.	1000 grain weight (g)	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	HI (%)
2seedlings	132.11a	8.36c	8.33a	2.38a	29.00a	142.0a	45.96a	23.15a	5.22a	5.43a	50.98a
4seedlings	132.67a	9.06a	8.98a	2.81a	28.36a	139.1b	42.75b	23.29a	5.30a	5.54a	51.10a
6seedlings	132.89a	8.66b	8.63a	2.61a	28.56a	137.2c	40.76b	23.26a	5.19a	5.48a	51.45a
LSD <sub>0.05</sub>	4.34	1.25	0.57	0.058	1.85	2.10	1.06	0.18	0.19	0.71	2.51
CV%	2.94	3.89	9.55	11.11	2.49	2.93	5.45	3.53	7.74	9.34	8.48

Note: Different letters a, b and c in a column indicates statistically significant different at 5% level by DMRT

**Table 2. Effect of variety on the yield and yield attributes of rice**

Variety	Plant height (cm)	Total tillers no.	Effective tillers no.	Non effective tillers no.	Panicle length (cm)	Grains panicle <sup>-1</sup> no.	Sterile spikelets panicle <sup>-1</sup> no.	1000 grain weight (g)	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	HI (%)
V <sub>1</sub>	128.89b	7.50c	7.58b	1.96 a	27.64a	131.5 a	40.31 b	22.12a	5.23a	5.32a	50.42a
V <sub>2</sub>	117.44c	8.33b	8.18b	2.60 a	26.73a	135.6 a	45.38 a	24.11b	5.07a	5.38a	51.48a
V <sub>3</sub>	151.33a	10.25a	10.13a	3.04 a	31.53a	150.0 b	44.34 a	26.14c	5.30a	5.75a	52.00a
LSD <sub>0.05</sub>	4.34	1.25	0.57	0.058	1.85	2.10	1.06	0.18	0.19	0.71	2.51
CV%	2.94	3.89	9.55	11.11	2.49	2.93	5.45	3.53	7.74	9.34	8.48

Note: Different letters a, b and c in a column indicates statistically significant different at 5% level by DMRT

**Table 3. Interaction effect of variety and number of seedlings hill<sup>-1</sup> on the yield and yield attributes of rice**

Variety x seedlings hill <sup>-1</sup>	Plant height (cm)	Total tillers no.	Effective tillers no.	Non effective tillers no.	Panicle length (cm)	Grains panicle <sup>-1</sup> no.	Sterile spikelets panicle <sup>-1</sup> no.	1000 grain weight (g)	Straw yield (t ha <sup>-1</sup> )	Grain yield (t ha <sup>-1</sup> )	HI (%)
V <sub>1</sub> T <sub>1</sub>	127.00a	7.33a	7.50a	1.92a	27.73a	131.7a	42.02 b	22.16a	5.12a	5.74	52.85a
V <sub>1</sub> T <sub>2</sub>	130.67a	7.67a	7.67a	2.00a	27.60a	131.3a	38.59 c	21.16a	5.34a	4.92	47.95a
V <sub>1</sub> T <sub>3</sub>	129.00a	7.52a	7.59a	1.96a	27.60a	131.5a	40.01b	23.04a	5.23a	5.30	50.33a
V <sub>2</sub> T <sub>1</sub>	117.67a	7.67a	7.56a	1.65a	27.07a	133.9a	43.03 b	23.57a	5.05a	5.13	50.39a
V <sub>2</sub> T <sub>2</sub>	116.33a	9.00b	8.80a	3.55a	26.73a	137.4a	47.72 a	25.16b	5.09a	5.64	52.46a
V <sub>2</sub> T <sub>3</sub>	118.33a	8.54b	7.90a	2.50a	26.40a	135.2a	45.09a	23.60a	5.01a	5.30	51.40a
V <sub>3</sub> T <sub>1</sub>	151.67b	10.00b	9.93a	3.37a	32.20a	154.5a	49.83 a	25.94b	5.15a	5.44	50.37a
V <sub>3</sub> T <sub>2</sub>	151.00b	10.50b	10.33a	2.71a	30.73a	145.5a	48.86 a	27.34b	5.45a	6.06	52.64a
V <sub>3</sub> T <sub>3</sub>	151.33b	10.21b	10.13a	2.98a	31.67a	150.4a	41.14b	25.15b	5.25a	5.67	51.92a
LSD <sub>0.05</sub>	4.34	1.25	0.57	0.058	1.85	2.10	1.06	0.18	0.19	0.71	2.51
CV%	2.94	3.89	9.55	11.11	2.49	2.93	5.45	3.53	7.74	9.34	8.48

Note: Different letters a, b and c in a column indicates statistically significant different at 5% level by DMRT

## CONCLUSION

It may be concluded that BRRI dhan54 appears to be the best variety in the transplant Aman season regarding grain and straw yields among the varieties studied and 4 seedlings hill<sup>-1</sup> appears to be the best seedlings number hill<sup>-1</sup> in the transplant Aman season regarding grain and straw yields among the seedlings number hill<sup>-1</sup> studied. It produced the highest grain and straw yields with the recommended level of fertilizer dose (100% of the rate) under rainfed condition.

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