Morpho-physiological attributes of transplant *Aman* rice as influenced by variety, age of tiller seedlings and nitrogen management

B. Kirttania, M.A.R. Sarkar, S.K. Paul and M. S. Islam
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: skpaull@gmail.com

Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2012 to observe the effect of variety, age of tiller seedling and nitrogen management on the morpho-physiological attributes of transplant *Aman* rice. Two variety viz. BRRI dhan49 and BRRI dhan51, two ages of tiller seedlings viz. 25 and 35-day old tiller seedlings, and five levels nitrogen management viz. control (no urea application), application of prilled urea @ 215 kg ha^{-1} in two splits (1/2 at 15 DAT+1/2 at 30 DAT), application of prilled urea @ 215 kg ha^{-1} in three splits (1/3 at 15 DAT+1/3 at 30 DAT+1/3 at 45 DAT), application of USG 1.8 g and application of USG 2.7 g were included in the experiment using randomized complete block design with three replications. Morpho-physiological attributes of transplant *Aman* rice were influenced by variety, age of tiller seedling, nitrogen management and their interactions. Higher plant height (61.30cm, 30 DAT) and (76.87cm, 45 DAT), number of tillers hill^{-1} (10.02, 30 DAT) and (10.81, 45 DAT), leaf area index (LAI) (0.36, 15 DAT), (0.69, 30 DAT) and (1.85, 45 DAT), total dry matter (TDM) (1.97g, 30 DAT) and (6.20g, 45 DAT) were obtained in BRRI dhan49 compared to BRRI dhan51. In case of age of tiller seedlings older seedlings (35-day old) produced higher plant height (60.37cm, 30 DAT), tillers hill^{-1} (10.38, 30 DAT), while younger seedling (25-day old) produced higher plant height (72.56 cm, 45 DAT) and tillers hill^{-1} (10.57, 45 DAT). Relatively older seedlings (35-day old) produced higher LAI and TDM at 15, 30 and 45 DAT compared to younger seedlings. The highest plant height (43.74 cm, 30 DAT) and (60.53 cm, 45 DAT) tillers hill^{-1} were found when prilled urea was applied in three splits. The highest LAI (1.93, 45 DAT) was found when USG 1.8 g was applied per four hill in every alternate rows and the lowest LAI (1.52, 45 DAT) when USG 1.8 g was applied. Total dry matter production hill^{-1} (11.19 g, 45 DAT) was found when prilled urea was applied in two splits and the lowest total dry matter production hill^{-1} (9.24 g) was found when USG 2.7g was applied. The highest total dry matter production hill^{-1} (9.94 g, 30 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 were fertilized with prilled urea in three splits.
Keywords: Morpho-physiology, tiller seedling, nitrogen management.

Introduction

Rice (*Oryza sativa* L.) is the most extensively cultivated and major food grain crop of Bangladesh. It is grown under diverse ecosystems-irrigated, rainfed and deep water conditions in the three distinct rice growing seasons, namely *Aus, Aman* and *Boro*. The average yield of rice is still very low, approximately it is 2.91 tons per hectare (BBS, 2011). The crop yield is much lower than that of other rice growing countries of the world. Natural hazards viz. early and flash flood are very common in Bangladesh. Farmers and agricultural scientists are diverting their attention towards mitigation of crop loss through crop management practices. Double transplanting practice has also be suggested for transplant aman areas where transplanting is delayed due to flood water inundation (Sarkar *et al.* 2011; Alam *et al.,* 1962). Rice has a unique ability to tiller profusely as each leaf axil has the potential to produce a tiller (Langer, 1979). In rice, many of the late tillers do not produce panicles due to higher population (Hanada, 1979). Removal of some tillers from the mother hill could make room for future development of the remaining tillers attached with mother hill. Separated tiller can be used as the tiller seedlings to replant a new area when scarcity of seedlings after post floods or other natural hazards. Paul *et al.* (2002) reported that tillers can be separated at 25 or 35 days after transplanting (DAT) without hampering grain yield of mother plants. Sarkar *et al.* (2011) opined that 25-day old tiller seedlings were found to be suitable in respect of grain yield.

Variety and age of tiller seedling is another important factor because it has tremendous influence on the growth and development, tiller production, grain formation and other yield contributing characters. Age of tiller seedlings has remarkable influences on plant growth (Hossain *et al.,* 2011). Generally the farmers of Bangladesh do not give due attention to varietal potentiality and the age of tiller seedlings at transplanting. For maximizing yield, age of tiller seedlings at transplanting of a suitable variety at a particular season may not be suitable for other varieties at other season. Nitrogen management is another important factor that influences the growth attributes of transplant *Aman* rice. Balanced fertilization ensures the plant to grow properly with their aerial and underground parts and help to increase the dry matter of the plant. Both application of less and more fertilizer than the optimum are not economic i.e., both of this situation disturb their proper growth ultimately give lower yield. Urea super granules, a slower release nitrogenous fertilizer dissolves slowly in the soil providing a steady supply of available nitrogen throughout the growing period which can save 30% nitrogen compared to prilled urea. Fertilizer application in right time in right dose and in right form has to be ensured. Therefore, an experiment was conducted to observe the influence of variety, age of tiller seedlings and nitrogen management on the morpho-physiological attributes of transplant *Aman* rice.

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of variety, age of tiller seedling and nitrogen management on the growth and yield of transplant *Aman* rice. The experimental area belongs to the non-calcareous dark grey soil under Agro-ecological Zone of the Old Brahmaputra Floodplain (AEZ-9). The land was silty loam in texture having a soil pH 6.42, moderate in organic matter content. The experiment consisted of three sets of treatments viz. variety (2) BRRI dhan49 and BRRI dhan51, age of tiller seedlings (2) 25 and 35-day old, nitrogen management (5) i. Control, ii. Application of prilled urea @ 215 kg ha^{-1} (1/2 at 15 DAT+1/2 at 30 DAT), iii. Application of prilled urea @

215 kg ha^{-1} (1/3 at 15DAT +1/3 at 30DAT +1/3 at 45DAT), iv Application of USG 1.8g per four hill in every alternate row, v. Application of USG 2.7g per four hill in every alternate row. The experiment was laid out in a randomized complete block design with three replications. Plot size was 4.0 m x 2.5 m (10 m^2) and total number of plots was 60. Tillers were separated at 25 and 35 days after transplanting from previously transplanted rice field and then retransplanted in the main field according to experimental plan. The experimental plots were fertilized with triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 100, 70, 60 and 10 kg ha^{-1}, respectively. The entire amount of triple super phosphate, muriate of potash, gypsum and zinc sulphate was applied at final land preparation. Prilled urea and urea super granules (USG) was applied as per experimental treatments. Five hills were randomly selected hills in each unit plot excluding boarder rows to record the data on plant height and tiller numbers. Plant height and number of tillers hill^{-1} were recorded at 15 days intervals beginning at 15 DAT. For leaf area index, leaves of two hills were separated and their areas were measured by an automatic leaf area meter. Leaf area index (LAI) was calculated by the ratio of leaf area to its ground area, i.e., LAI= LA/P, where L = Leaf area and P = Ground area. To determine total dry matter (TDM) destructive plant samples were packed in labeled brown paper bags and dried in the oven at 80 ± 5°C for 72 hours until constant weight was reached. The samples were weighed carefully after oven drying to measure the dry weight of plant.

The recorded data were statistically analyzed using the "Analysis of Variance" technique and the differences among treatment means were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Effect of variety: Plant height was significantly influenced by variety at 30 and 45 DAT. The higher plant height (61.30 cm, 30 DAT) and (76.87 cm, 45 DAT) was found in BRRI dhan49 and the lower plant height (56.97 cm, 30 DAT) and (64.91 cm, 45 DAT) was found in BRRI dhan51 (Table 1). Varietal differences regarding the number of plant height might be due to differences in genetic constituents. Number of tillers hill^{-1} was significantly influenced by variety at 30 and 45 DAT. The higher number of tillers hill^{-1} (10.02, 30 DAT) and (10.81, 45 DAT) was found in BRRI dhan49 and the lower number of tillers hill^{-1} (7.92, 30 DAT) and (9.72, 45 DAT) was found in BRRI dhan51 (Table 1). Varietal potentiality affects the tiller production of rice crop. Leaf area index (LAI) was significantly influenced by variety at 15, 30 and 45 DAT. The higher LAI (0.36, 15 DAT) was found in BRRI dhan51 and the lower leaf area index (0.32, 15 DAT) was found in BRRI dhan49. While at 30 and 45 DAT the higher leaf area index (0.94, 30 DAT) and (1.85, 45 DAT) were found in BRRI dhan49 and the lower LAI (0.69, 30 DAT) and (1.70, 45 DAT) was found in BRRI dhan51 (Table 1). Tyeb *et al*. (2013) reported that rice crop could attain various leaf area values due to varietal difference. Total dry matter (TDM) production hill^{-1} was significantly influenced by variety at 30 and 45 DAT. The higher TDM production hill^{-1} (1.97 g, 30 DAT) was found in BRRI dhan51 and the lower total dry matter production hill^{-1} (1.68 g, 30 DAT) was found in BRRI dhan49. While higher TDM production hill^{-1} (6.20 g, 45DAT) was found in BRRI dhan49 and the lower TDM production hill^{-1} (4.43, 45 DAT) was found in BRRI dhan51 (Table 1).

Effect of age of tiller seedling: Effect of age of tiller seedling on plant height was significant at 30 and 45 DAT. Plant height (60.37 cm, 30 DAT) was found when 35-day old tiller seedlings were planted and the lower plant height (57.89 cm, 30 DAT) was found when 25-day old tiller seedlings were planted. While plant height (72.56 cm, 45 DAT) was found when 25-day old tiller seedlings were planted and the lower plant height (69.22 cm, 45 DAT) was found when 35-day old tiller seedlings were planted (Table 2). Effect of age of tiller seedling on number of tillers hill^{-1} was significant at 30 and 45 DAT. At 30 DAT the higher number of tillers hill^{-1} (10.38) was found when 35-day old tiller seedlings were planted and the lower number of tillers hill^{-1} (7.57) was found when 25-day old tiller seedlings were planted. At 45 DAT the higher number of tillers hill^{-1} (10.57) was found when 25-day old tiller seedlings were planted and the lower number of tillers hill^{-1} (9.96) was found when 35-day old tiller seedlings were planted (Table 2). Effect of age of tiller seedling on LAI was significant at 15, 30 and 45 DAT. LAI (0.37, 15 DAT), (0.91, 30 DAT) and (2.01, 45 DAT) were found when 35-day old tiller seedlings were planted and the lower leaf area index (0.32, 15 DAT), (0.73, 30 DAT) were (1.55, 45 DAT) found when 25-day old tiller seedlings were planted (Table 2). Effect of age of tiller seedling on total dry matter (TDM) production hill^{-1} was significant at 15, 30 and 45 DAT. The higher TDM production hill^{-1} (1.98 g, 15 DAT), (6.13 g, 30 DAT) and (11.43 g, 45 DAT) were found when 35-day old tiller seedlings were planted and the lower TDM production hill^{-1} (1.67 g, 15 DAT), (4.50 g, 30 DAT) and (9.52 g, 45 DAT) was found when 25-day old tiller seedlings were planted (Table 2). Older tiller seedlings produced higher number of tillers hill^{-1} that might enhanced total leaf production hill^{-1} and thus increased leaf area index (LAI) and total dry matter production (TDM) of transplant *Aman* rice. This result is contradictory with Paul *et al*. 2003. They reported that younger tiller seedlings produced higher leaf and culm dry matter than older (35-day old) tiller seedling.

Effect of nitrogen management: Effect of nitrogen management on plant height was significant at 15 and 30 DAT. The highest plant height (43.74 cm, 15 DAT) was found when prilled urea was applied in three splits (1/3 at 15 DAT+1/3 at 30 DAT+1/3 at 45 DAT) and the lowest plant height (39.80 cm) was found when prilled urea was applied in two splits (1/2 at 15 DAT+1/2 at 30 DAT). Plant height (60.53 cm, 30 DAT) was found when prilled urea was applied in three splits (1/3 at 15 DAT+1/3 at 30 DAT+1/3 at 45 DAT) and the lowest plant height (56.55 cm, 30 DAT) was found when urea super granule (USG) 2.7 g was applied per four hill in every alternate rows (Table 3). Number of tillers hill^{-1} was also affected by nitrogen management at 30 and 45 DAT. The highest number of tillers hill^{-1} (9.45, 30 DAT) was found when prilled urea was applied in two splits and the lowest

number of tillers hill^{-1} (8.80, 30 DAT) was found in control. Number of tillers hill^{-1} (11.22, 45 DAT) was found when prilled urea was applied in three splits and the lowest number of tillers hill^{-1} (8.91, 45 DAT) was found when prilled urea was applied in two splits (Table 3). Effect of nitrogen management on LAI was significant at 15, 45 and 30 DAT. The highest LAI (0.42, 15 DAT) was found when USG 2.7 g was applied per four hill in every alternate rows and the lowest LAI (0.26, 15 DAT) was found when prilled urea was applied in two split. Leaf area index (0.98, 30 DAT) was recorded in control and LAI (0.69, 30 DAT) was found when prilled urea was applied in three splits (Table 3). Effect of nitrogen management on TDM production hill^{-1} was significant at 15, 30 and 45 DAT. The highest TDM production hill^{-1} (2.19 g, 15 DAT) was found when USG 2.7 g was applied per four hill in every alternate row and the lowest total dry matter production hill^{-1} (1.44 g, 15 TDM) was found when prilled urea was applied in two splits. TDM production hill^{-1} (6.49 g, 30 DAT) was recorded in control and TDM production hill^{-1} (5.03 g, 30 DAT) was found when USG 2.7 g was applied.

Table 1. Effect of variety on growth parameters at different days after transplanting (DAT)

Variety	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
V_1	45.84	61.30a	76.87a	3.94	10.02a	10.81a	0.32a	0.94a	1.85a	1.68a	6.20a	10.83
V_2	39.21	56.97b	64.91b	3.72	7.92b	9.72b	0.36b	0.69b	1.70b	1.97b	4.43b	10.12
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	*	*	NS	*	*	**	*	*	**	*	NS

Table 2. Effect of age of tiller seedling on growth parameters at different days after transplanting (DAT)

Age of tiller seedlings	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
A_1	39.43	57.89b	72.56a	3.68	7.57b	10.57a	0.32b	0.73b	1.55b	1.67b	4.50b	9.52a
A_2	45.62	60.37a	69.22b	3.97	10.38a	9.96b	0.37a	0.91a	2.01a	1.98a	6.13a	11.43b
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	*	**	NS	**	*	*	*	*	*	**	**

Table 3. Effect of nitrogen management on growth parameters at different days after transplanting (DAT)

Nitrogen management	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
Application of no urea	42.68a	60.46a	71.54	4.033	8.80b	10.10b	0.35ab	0.98a	1.78b	1.84b	6.49a	10.65a
Prilled urea (1/2 at 15 DAT+1/2 at 30 DAT)	39.80 b	61.05a	70.27	3.450	9.45a	8.91c	0.26c	0.86b	1.89a	1.44c	5.40b	11.19a
Prilled urea (1/3 at15 DAT+1/3 at 30 DAT+1/3 at 45DAT)	43.74a	60.53a	70.00	3.900	9.36a	11.22a	0.32bc	0.69c	1.77b	1.84b	4.31d	10.70a
Application of USG 1. 8g	43.56a	57.09b	72.06	4.000	8.45b	10.30b	0.35ab	0.86b	1.93a	1.81b	5.35b	10.59a
Application of USG 2.7g	42.87a	56.55b	70.58	3.767	8.81b	10.82a	0.42a	0.70c	1.52c	2.19a	5.03c	9.24b
CV (%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	**	*	NS	NS	*	**	*	**	*	*	*	*

Table 4. Effect of interaction of variety and age of tiller seedlings on growth parameters at different days after transplanting (DAT)

Interaction Variety× age of tiller seedlings	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
$V_1 \times A_1$	42.87	61.87a	78.78	3.827	8.893c	11.16	0.31b	0.90b	1.66c	1.64b	5.37	10.11
$V_1 \times A_2$	48.83	60.73ab	74.96	4.053	11.16a	10.47	0.33b	0.98a	2.05a	1.72b	7.03	11.55
$V_2 \times A_1$	36.01	53.93c	66.34	3.547	6.25d	9.987	0.32b	0.55d	1.44d	1.70b	3.63	8.931
$V_2 \times A_2$	42.42	60.02b	63.48	3.893	9.60b	9.467	0.40a	0.84c	1.96b	2.23a	5.23	11.31
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	**	NS	NS	*	NS	**	*	*	*	NS	NS

Table 5. Effect of interaction of variety and nitrogen management on growth parameters at different days after transplanting (DAT)

Interaction Variety× nitrogen management	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
$V_1 \times N_1$	48.43	63.22	76.78	3.86	9.96b	11.40a	0.29cd	0.64e	1.30g	1.79b	4.02g	9.41cd
$V_1 \times N_2$	41.68	62.57	74.95	3.46	11.03a	8.90d	0.20d	0.97b	1.89d	1.07d	5.77d	11.69ab
$V_1 \times N_3$	45.47	62.02	77.12	4.36	9.70bc	11.30ab	0.35abc	1.13a	2.08c	1.46c	7.70a	11.37ab
$V_1 \times N_4$	46.92	59.20	78.70	4.20	10.13b	11.07ab	0.36abc	1.13a	2.39a	1.88b	7.02b	11.77a
$V_1 \times N_5$	46.73	59.50	76.80	3.80	9.30cd	11.40a	0.40ab	0.84c	1.61e	2.19a	6.49c	9.927bc
$V_2 \times N_1$	39.05	57.85	63.22	3.93	8.76de	11.03ab	0.36abc	0.73d	2.24b	1.89b	4.59f	11.99a
$V_2 \times N_2$	37.92	59.53	65.58	3.43	7.86f	8.93d	0.31bcd	0.76d	1.90d	1.80b	5.03e	10.70ab
$V_2 \times N_3$	39.90	58.90	65.97	3.70	7.90f	8.90d	0.35abc	0.83c	1.49f	2.21a	5.27e	9.94bcd
$V_2 \times N_4$	40.20	54.98	65.42	3.80	6.76g	9.53cd	0.34abc	0.59f	1.46f	1.74b	3.69gh	9.41cd
$V_2 \times N_5$	39.00	53.60	64.37	3.73	8.33ef	10.23bc	0.43a	0.56f	1.43f	2.19a	3.57h	8.56d
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	NS	NS	NS	*	*	**	*	**	*	*	**

Table 6. Effect of interaction of age of tiller seedlings and nitrogen management on growth parameters at different days after transplanting (DAT)

Interaction Age of tiller seedlings× nitrogen mgt.	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
$A_1 \times N_1$	39.95	58.65c	70.32	3.93	8.33	11.03a	0.29bc	0.64f	1.47f	1.57d	4.10e	8.27de
$A_1 \times N_2$	38.10	59.90bc	73.43	3.36	7.83	10.67ab	0.30bc	0.75e	1.59e	1.59d	4.60d	9.58cde
$A_1 \times N_3$	38.30	60.68ab	74.23	3.96	7.70	10.70ab	0.33bc	0.76e	1.67de	1.75cd	4.82d	10.49c
$A_1 \times N_4$	40.28	55.73d	73.15	3.76	6.66	9.73bc	0.32bc	0.90c	1.74d	1.70cd	5.39c	11.20bc
$A_1 \times N_5$	40.55	54.52d	71.67	3.40	7.33	10.73ab	0.34b	0.58 g	1.29g	1.74cd	3.59f	8.04e
$A_2 \times N_1$	47.53	62.42a	69.68	3.86	10.40	11.38a	0.36b	0.73e	2.07b	2.11b	4.51d	13.12a
$A_2 \times N_2$	41.50	62.20a	67.10	3.53	11.07	7.16d	0.22c	0.98b	2.20a	1.29e	6.21b	12.80ab
$A_2 \times N_3$	47.07	60.23bc	68.85	4.10	9.90	9.50c	0.37 b	1.20a	1.90c	1.93bc	8.15a	10.82c
$A_2 \times N_4$	46.83	58.45c	70.97	4.23	10.23	10.87a	0.38ab	0.82d	2.11ab	1.91bc	5.32c	9.97cd
$A_2 \times N_5$	45.18	58.58c	69.50	4.13	10.30	10.90a	0.50a	0.82d	1.75d	2.64a	6.47b	10.45c
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	**	NS	NS	NS	*	*	*	*	**	*	*

Table 7. Effect of interaction of variety, age of tiller seedlings and nitrogen management on growth parameters at different days after transplanting (DAT)

Interaction Variety× age of tiller seedlings× nitrogen mgt.	Plant height (cm)			No. of tillers hill^{-1}			LAI			Total dry matter production hill^{-1} (g)		
	Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)			Days after transplanting (DAT)		
	15	30	45	15	30	45	15	30	45	15	30	45
$V_1 \times A_1 \times N_1$	44.13	63.10	77.73	3.93	9.40 de	11.13 abc	0.30bcd	0.69fg	1.39ij	1.59efghij	4.47fg	8.71fgh
$V_1 \times A_1 \times N_2$	43.70	62.90	78.67	3.53	9.13 ef	9.86cde	0.26cd	0.89de	1.78fg	1.53ij	4.77 f	11.93bcd
$V_1 \times A_1 \times N_3$	38.33	63.43	79.17	4.00	8.80 ef	11.53ab	0.32bc	0.87 de	1.69gh	1.56ghij	5.47 e	9.34efgh
$V_1 \times A_1 \times N_4$	42.33	59.83	80.10	4.00	8.66 ef	10.93 abc	0.33bc	1.34a	2.14d	1.83defghi	7.64 c	12.37bcd
$V_1 \times A_1 \times N_5$	45.83	60.07	78.23	3.66	8.46 f	12.33 a	0.35bc	0.73 f	1.29jk	1.70defghij	4.53fg	8.180gh
$V_1 \times A_2 \times N_1$	52.73	63.33	75.83	3.80	10.53 c	11.67 ab	0.27cd	0.60i	1.20k	1.99cd	3.57ij	10.11defg
$V_1 \times A_2 \times N_2$	39.67	62.23	71.23	3.40	12.93 a	7.93 f	0.14 d	1.04 b	2.00de	0.62k	6.78d	11.44cde
$V_1 \times A_2 \times N_3$	52.60	60.60	75.07	4.73	10.60 c	11.07abc	0.38abc	1.39a	2.47 c	1.37j	9.94a	13.39bc
$V_1 \times A_2 \times N_4$	51.50	58.57	77.30	4.40	11.60b	11.20 abc	0.40abc	0.92cd	2.65b	1.92cdefg	6.40d	11.16cdef
$V_1 \times A_2 \times N_5$	47.63	58.93	75.37	3.93	10.13 cd	10.47bcd	0.46ab	0.96c	1.93ef	2.69 a	8.46b	11.67bcde
$V_2 \times A_1 \times N_1$	35.77	54.20	62.90	3.93	7.26 g	10.93abc	0.28cd	0.60 i	1.55 hi	1.55hij	3.74 hi	7.84gh
$V_2 \times A_1 \times N_2$	32.50	56.90	68.20	3.20	6.53gh	11.47 ab	0.33bc	0.61hi	1.40ij	1.65defghij	4.43 fg	7.24 h
$V_2 \times A_1 \times N_3$	38.27	57.93	69.30	3.93	6.60gh	9.86cde	0.35bc	0.66h	1.64gh	1.94cdef	4.17gh	11.63cde
$V_2 \times A_1 \times N_4$	38.23	51.63	66.20	3.53	4.66i	8.53ef	0.31bcd	0.45 j	1.34jk	1.58 fghij	3.14 jk	10.03defg
$V_2 \times A_1 \times N_5$	35.27	48.97	65.10	3.13	6.20 h	9.13def	0.33bc	0.44 j	1.29ij	1.77defghi	2.66 k	7.90gh
$V_2 \times A_2 \times N_1$	42.33	61.50	63.53	3.93	10.27cd	11.13abc	0.45ab	0.86 e	2.94 a	2.23bc	5.45 e	16.14 ab
$V_2 \times A_2 \times N_2$	43.33	62.17	62.97	3.66	9.20ef	6.40 g	0.29bcd	0.91cd	2.39 c	1.96cde	5.63 e	14.15a
$V_2 \times A_2 \times N_3$	41.53	59.87	62.63	3.46	9.20 ef	7.93 f	0.36bc	1.01 b	1.33 jk	2.49ab	6.37d	8.25gh
$V_2 \times A_2 \times N_4$	42.17	58.33	64.63	4.06	8.86ef	10.53bcd	0.37bc	0.73 f	1.58h	1.91defgh	4.24fg	8.79fgh
$V_2 \times A_2 \times N_5$	42.73	58.23	63.63	4.33	10.47 c	11.33abc	0.54 a	0.69 fg	1.58 h	2.60a	4.48fg	9.23efgh
CV(%)	6.40	2.64	3.74	14.90	6.26	8.91	14.02	4.25	2.65	12.63	6.29	10.45
Level of sig.	NS	NS	NS	NS	**	**	*	*	**	*	*	*

In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly. NS indicates not significant, * indicates significant at 5% level of probability, ** indicates significant at 1% level of probability, V_1 = BRRI dhan 49, V_2= BRRI dhan 51, A_1 = 25-day old tiller, A_2= 35-day old tiller seedling, N_1 = Application of no urea, N_2 = Application of prilled urea(1/2 at15 DAT+1/2 at 30 DAT, N_3 = Application of prilled urea (1/3 at15 DAT+1/3 at 30 DAT+1/3 at 45DAT), N_4 = Application of USG 1. 8 g, N_5 = Application of USG 2.7 g

The highest TDM production hill^{-1} (11.19 g, 45 DAT) was found when prilled urea was applied in two splits and the lowest total dry matter production hill^{-1} (9.24 g) was found when USG 2.7 g was applied (Table 3).

Interaction effect: Plant height was significantly influenced by the interaction of variety and age of tiller seedlings at 30 DAT. The highest plant height (61.87 cm, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan49 were planted and the lowest plant height (53.93 cm, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 (Table 4). Number of tillers hill^{-1} was significantly influenced by the interaction of variety and age of tiller seedlings at 30 DAT. The highest number of tillers hill^{-1} (11.16, 30 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 and the lowest number of tillers hill^{-1} (6.25, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 (Table 4). LAI was significantly influenced by the interaction of variety and age of tiller seedlings at 15, 30 and 45 DAT. The highest LAI (0.40, 15 DAT), (0.98, 30 DAT) and (2.05, 45 DAT) were recorded when 35-day old tiller seedlings of BRRI dhan51 and the lowest LAI (0.3, 15 DAT), (0.55, 30 DAT) and (1.44, 45 DAT) were found when 25-day old tiller seedlings of BRRI dhan49 were planted (Table 4). TDM production hill^{-1} was significantly influenced by the interaction between variety and age of tiller seedlings at 15 DAT. The highest total dry matter production hill^{-1} (2.23, 15 DAT) was found when 35-day old tiller seedlings of BRRI dhan51 were planted and the lowest total dry matter production hill^{-1} (1.64 g, 15 DAT) was found when 25-day old tiller seedlings of BRRI dhan49 (Table 4).

Plant height was not significantly influenced by the interaction between variety and nitrogen management at 15, 30 and 45 DAT (Table 5). Number of tillers hill^{-1} was significantly influenced by the interaction of variety and nitrogen management at 30 and 45 DAT. The highest number of tillers hill^{-1} (11.03, 30 DAT) was obtained when prilled urea was applied in two splits in BRRI dhan49 and lowest number of tillers hill^{-1} (6.76, 30 DAT) was obtained when urea super granule (USG) 1.8g was applied per four hill in every alternate rows in BRRI dhan51. While the highest number of tillers hill^{-1} (11.40, 45 DAT) was obtained in control of BRRI dhan49 and lowest number of tillers hill^{-1} (8.90, 45 DAT) was obtained fertilized with prilled urea in two splits in BRRI dhan49 (Table 5). LAI was significantly influenced by the interaction between

variety and nitrogen management at 15, 30 and 45 DAT. The highest LAI (0.43, 15 DAT) was obtained when fertilized with USG 2.7g in BRRI dhan51 and lowest LAI (0.20, 15 DAT) was obtained when fertilized with prilled urea in two splits in BRRI dhan49. LAI (1.13, 30 DAT) was obtained when prilled urea was applied in three splits in BRRI dhan49 and lowest LAI (0.56, 30 DAT) was obtained when USG 2.7 g was applied in BRRI dhan51. While the highest LAI (2.39, 45 DAT) was obtained when USG 1.8 g was applied in BRRI dhan49 and lowest LAI (1.30, 45 DAT) was obtained in control of BRRI dhan49 (Table 5). TDM production hill^{-1} was significantly influenced by the interaction between variety and nitrogen management at 15, 30 and 45 DAT. The highest TDM production hill^{-1} (2.21g, 15 DAT) was obtained when prilled urea was applied in three splits in BRRI dhan51 and lowest total dry matter production hill^{-1} (1.07g, 15 DAT) was obtained when prilled urea was applied in two splits in BRRI dhan49. TDM production hill^{-1} (7.70g, 30 DAT) was recorded when prilled urea was applied in three splits in BRRI dhan49 and lowest total dry matter production hill^{-1} (3.57 g, 30 DAT) was obtained when USG 2.7 g was applied in BRRI dhan51. TDM production hill^{-1} (11.99g, 45 DAT) was obtained with control in BRRI dhan51 and lowest total dry matter production hill^{-1} (8.56 g) was obtained when USG 2.7 g was applied per four hill in every alternate row in BRRI dhan51 (Table 5).

Plant height was significantly influenced by the interaction of age of tiller seedlings and nitrogen management at 30 DAT. The highest plant height (62.42 cm, 30 DAT) was found when 35-day old tiller seedlings were planted in control and the lowest plant height (54.52 cm, 30DAT) was found when 25-day old tiller seedlings were planted fertilized with USG 2.7 g (Table 6). Number of tillers hill^{-1} was significantly influenced by the interaction of age of tiller seedlings and nitrogen management at 45 DAT. The highest number of tillers hill^{-1} (11.40, 45DAT) was found when 35-day old tiller seedlings were planted applying no urea and the lowest number of tillers hill^{-1} (7.16, 45DAT) was found when 35-day old tiller seedlings fertilized with prilled urea in two splits (Table 6). LAI was significantly influenced by the interaction between age of tiller seedlings and nitrogen management at 15, 30 and 45 DAT. The highest LAI (0.50, 15 DAT), (1.20, 30 DAT) and (2.20, 45 DAT) were recorded when 35-day old tiller fertilized with USG 2.7g per four hill in every alternate row and the lowest LAI (0.22, 15 DAT), (0.58, 30 DAT) and (1.29, 45 DAT) were found when 35-day old tiller seedlings fertilized with prilled urea in two splits, three splits and applying USG 2.7g respectively (Table 6). TDM production hill^{-1} was significantly influenced by the interaction between age of tiller seedlings and nitrogen management at 15, 30 and 45 DAT. The highest total dry matter production hill^{-1} (2.64 g, 15 DAT) was found when 35-day old tiller seedlings were planted applying USG 2.7g per four hill in every alternate row and the lowest total dry matter production hill^{-1} (1.29 g) was found when 35-day old tiller seedlings fertilized with prilled urea in two splits , TDM production hill^{-1} (8.15 g, 30 DAT) was found when 35-day old tiller seedlings fertilized with prilled urea in three splits and the lowest total dry matter production hill^{-1} (3.59 g, 30 DAT) was found when 25-day old tiller seedlings fertilized with USG 2.7 g per four hill. TDM production hill^{-1} (13.12 g, 45 DAT) was found when 35-day old tiller seedlings in control treatment and the lowest total dry matter production hill^{-1} (8.04g, 45 DAT) was found when 25-day old tiller seedlings fertilized with USG 2.7 g (Table 6).

Number of tillers hill^{-1} was significantly influenced by the interaction among variety, age of tiller seedlings and nitrogen management at 30 DAT and 45 DAT. The highest number of tillers hill^{-1} (12.93, 30 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 fertilized with prilled urea in two splits and the lowest number of tillers hill^{-1} (4.66, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 USG1.8g. While the highest number of tillers hill^{-1} (12.33, 45 DAT) was found when 25-day old tiller seedlings of BRRI dhan49 in control treatment and the lowest number of tillers hill^{-1} (6.40, 45 DAT) was found when 35-day old tiller seedlings of BRRI dhan51 fertilized with prilled urea in two splits (Table 7). LAI was significantly influenced by the interaction among variety, age of tiller seedlings and nitrogen management at 15, 30 and 45 DAT. The highest LAI (0.54, 15 DAT) was found when 35-day old tiller seedlings of BRRI dhan51 fertilized with USG 2.7 g and the lowest LAI (0.14, 15 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 fertilized with prilled urea in two splits. LAI (1.39, 30 DAT) was recorded when 35-day old tiller seedlings of BRRI dhan49 fertilized with prilled urea in three splits and the lowest LAI (0.45, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 fertilized with USG 1.8g per four hill in every alternate row. The highest LAI (2.94, 45 DAT) was found when 35-day old tiller seedlings of BRRI dhan51 in control treatment and the lowest LAI (1.29, 45 DAT) was found when 25-day old tiller seedlings of BRRI dhan49 fertilized with USG 2.8 g per four hill in every alternate row (Table 7). Total dry matter production hill^{-1} was significantly influenced by the interaction among variety, age of tiller seedlings and nitrogen management at 15, 30 and 45 DAT. The highest TDM production hill^{-1} (2.69g, 15 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 fertilized with USG 2.7g and the lowest total dry matter production hill^{-1} (0.62g, 15 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 fertilized with prilled urea in two splits. The highest TDM production hill^{-1} (9.94g, 30 DAT) was found when 35-day old tiller seedlings of BRRI dhan49 fertilized with prilled urea in three splits and the lowest total dry matter production hill^{-1} (2.66g, 30 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 were planted applying USG 2.7g per four hill in every alternate row. TDM production hill^{-1} (16.14g, 45 DAT) was found when 35-day old tiller seedlings of BRRI dhan51 under control treatment and the lowest TDM production hill^{-1} (7.24g, 45 DAT) was found when 25-day old tiller seedlings of BRRI dhan51 fertilized with prilled urea in two splits (Table 7). From this study it can be concluded that cultivar, age of tiller seedlings and nitrogen management remarkably influenced on morpho-physiological attributes of transplant *Aman* rice.

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