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Effect of number of seedlings hill^{-1} on the yield and yield contributing characters of short duration *Aman* rice cultivars

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Abstract

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from July to October 2016 to study the effect of age of seedling on the yield and yield contributing characters of short duration *Aman* rice cultivars. The study consisted two factor A: Variety- three- i) BINA dhan7 (V_1), (ii) BRRI dhan56 (V_2) and (iii) BRRI dhan62 (V_3); and factor B: Number of seedlings hill^{-1}- (i) Single seedling hill^{-1} (S_1), (ii) Two seedlings hill^{-1} (S_2) and (iii) Three seedlings hill^{-1} (S_3). The experiment was laid out in a randomized complete block design with three replications. The highest grain yield was obtained from the cultivar BINA dhan7 which was statistically identical with BRRI dhan56 and this was the consequences of higher number of total and effective tillers hiil^{-1} and highest number of grains panicle^{-1}. Grain yield was not significantly affected by the number of seedlings hill^{-1} but numerically the highest grain yield was recorded from single seedling hill^{-1}. From the interaction it is observed that grain yield was not significantly affected by the interaction of cultivar and number of seedlings hill^{-1}. But numerically the highest grain yield was recorded from the interaction of BRRI dhan56 × single seedling hill^{-1}. From the economic analysis it is observed that the highest BCR (1.64) was recorded from single seedling hill^{-1} in BRRI dhan56 which was close to single seedling hill^{-1} in BINA dhan7 and the lowest BCR (103) was obtained from two seedlings hill^{-1} in BRRI dhan62. From the results of the study it may be concluded that BRRI dhan56 with single seedling hill^{-1} might be cultivated in AEZ-9 for obtaining higher yield and higher economic return in *Aman* season.

Key words: Weed control, *T. Aman*, BRRI *Dhan* 32

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Introduction

Rice (*Oryza sativa* L.) is the staple food of Bangladesh. The almost uneven topography and humid climate along with abundant monsoon offers a unique environment for the rice plant in Bangladesh. Rice is extensively grown in Bangladesh in three seasons namely, *Aus*, *Aman* and *Boro*, which covers 80% of the total cultivable area of the country (AIS, 2011). During the year 2014-2015 rice covered an area of 28209 thousand acres with a production of 34710 thousand m. tons (BBS, 2016). The yield of rice may be increased through improved agronomic management practices. Cultivar is the key component to produce higher yield of rice depending upon their differences in genotypic characters, input requirements and response, growth process and off course the prevailing environmental conditions during the growing season.

Cultivar is an important genetic factor which contributes a lot for producing higher yield and yield components of a particular crop. Yield components are

directly related to the cultivar and the neighboring environments on which it grows. Rice cultivar has tremendous impact on the growth and yield of rice. Yield components such as number of effective tillers hill^{-1}, number of grains panicle^{-1} and weight of individual grain contribute to increase or decrease the yield. Each cultivar has certain tiller producing capacity. Adequate number of effective tillers unit^{-1} area exerts a role in producing panicle number and the spikelet number. Panicle number unit^{-1} area and the fertile spikelet per panicle are the most important yield components in rice. Optimum number of tillers unit^{-1} area is a prerequisite for obtaining maximum yield from a rice variety and rice yield increases with increased number of panicles unit^{-1} area. Bangladesh Rice Research Institute (BRRI) has released some modern high yielding short duration *Aman* rice cultivars. BRRI dhan56 and BRRI dhan62 are two of them. BINA dhan7 is also a high yielding short duration *Aman* rice cultivar developed by Bangladesh Institute of Nuclear Agriculture (BINA).

On the other hand, number of seedlings hill^{-1} is an important factor for successful rice production because it influences tiller population unit^{-1} area, which ultimately influence the yield (Bhowmoik *et al.,* 2012). Optimum number of seedlings hill^{-1} ensures proper crop establishment. Generally if single seedling is used than there is a chance for missing hills. On the other hand, if more than optimum seedlings hill^{-1} is used then there will be misuse of seedlings resulting excess use of seeds. Seedling vigor contributes to successive tillering, yield and quality of transplanted rice. Growth and production of rice depend on timely cultivation and growth duration of cultivar which is affected by the number of seedlings hill^{-1} (Mishra and Salokhe, 2008). So, keeping the above facts in views the present research work was, therefore, undertaken to see the effect of number of seedlings hill^{-1} on the yield and yield contributing characters of short duration *Aman* rice cultivars.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from July to October 2016 to study the effect of number of seedlings hill^{-1} on the yield and yield contributing characters of short duration *Aman* rice cultivars. The experimental site belongs to the Sonatola soil series under the Old Brahmaputra Floodplain Agro-ecological zone (AEZ-9) having non-calcareous dark grey floodplain soil. (UNDP and FAO, 1988). The study consisted of two factor A: Variety- three- i) BINA dhan7 (V_1), (ii) BRRI dhan56 (V_2), and (iii) BRRI dhan62 (V_3) and factor B: Number of seedlings hii^{-1}- (i) Single seedling hill^{-1} (S_1), (ii) Two seedlings hill^{-1} (S_2) and (iii) Three seedlings hill^{-1} (S_3). The experiment was laid out in a randomized complete block design with three replications. Each of the replication represented a block in the experiment. Each block was divided into 9 unit plots where 9 treatment combinations were allocated at random. There were 27 plots in the experiment. The size of unit plot was 4.0 m × 2.5 m. The distance maintained between two unit plots was 0.75 m and between blocks was 1 m. Treatments were randomly allocated in the experiment. Seeds were immersed in water in bucket for 24 hours. Then seeds were taken out of water and kept thickly in gunny bags. The seeds sprouted after 48 hours. Then the sprouted seeds were sown in the nursery bed on 24 June 2016. The field layout was made on 22 July 2016. In the experiment, full doses of fertilizers viz., triple super phosphate (120 kg ha^{-1}), muriate of potash (70 kg ha^{-1}), gypsum (60 kg ha^{-1}) and zinc sulphate (10 kg ha^{-1}) were applied at the time of final land preparation. Urea (165 kg ha^{-1}) was top dressed in three equal installments at 7, 21 and 36 DATs. Thirty-day-old seedlings were uprooted carefully from the nursery bed and transplanted on 24 July 2016 at the rate of single , two and three seedlings hill^{-1} (as per treatment) maintaining a spacing of 25 cm × 15 cm. Three weedings were done in order to keep the crop weed free at 15, 30 and 45 DAT. Irrigation was applied as

and when necessary. Days of 90% maturity was counted when 90% spikelets of all the rice varieties become matured enough to harvest from randomly selected five hills. The crops were harvested on 13 October 2016 (BINA dhan7 and BRRI dhan62) (80 DAT) and 23 October 2016 (BRRI dhan56) (90 DAT). In each plot central 1 m × 1 m area was harvested to record the yields of grain and straw. Five hills were randomly selected for measuring the data on yield contributing characters. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The harvested crops were threshed by pedal thresher and the fresh weights of grain and straw were recorded plot-wise. Grains were cleaned and dried to a moisture content of 14%. Straws were sun dried properly. Final grain and straw yields plot^{-1} were recorded and converted to t ha^{-1}. Data were collected on plant height, total tillers hill^{-1}, effective tillers hill^{-1}, length of panicle, grains panicle^{-1}, 1000-grain weight, grain yield, straw yield and harvest index. Collected data were analyzed using "Analysis of Variance Technique" with the help of a computer package programmes MSTAT and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

***Effect of variety on the yield and yield contributing characters of transplant Aman rice*:** From the Table 1, it is observed that the plant height was significantly affected by the short duration *Aman* rice cultivars. Among the three short duration *Aman* rice cultivars, the tallest plant (110.20 cm) was recorded in BRRI dhan56 and the shortest one (98.99 cm) was recorded in BINA dhan7. This result indicates that the plant height of the rice cultivars varied significantly due to the differentiation in their genetic characters and also the variation in adaptability with field condition of the locality. Such variation in plant height of many rice cultivars were also reported by Hossain *et al*. (2005), Zubaer *et al*. (2007), Ashrafuzzaman *et al*. (2009) and Uddin *et al*. (2010). The production of total tillers hill^{-1} in rice due to varieties has been presented in Table 1. Number of total tillers hill^{-1} was significantly affected by the cultivars. The cultivar BINA dhan7 produced the highest number (16.54) of total tillers hill^{-1}. The lowest number (12.59) of total tillers hill^{-1} was observed from the cultivar BRRI dhan62 which was statistically identical (12.69) with BRRI dhan56. The results shows that BINA dhan7 produced the maximum number of total tillers hill^{-1} than BRRI dhan6 and BRRI dhan62 which might be due to the genetic makeup of the cultivars and also the variation in adaptability with the studied area. The highest number (14.04) of effective tillers hill^{-1} was obtained from the cultivar BINA dhan7 which was statistically similar with the cultivar BRRI dhan56. The lowest number (11. 38) of effective tillers hill^{-1} was obtained from the cultivar BRRI dhan62. Tiller(s) number hill^{-1} is an important yield contributing character in rice. Mondal *et al*. (2005) found significant differences in number of tillers hill^{-1} in 17 rice varieties. Differences in the production of total tillers and effective tillers hill^{-1} might be due to genetic variation, physiological functions and growth characters of the cultivars under study. Similar trend was also reported by Sohel *et al*. (2009) who reported that all the yield and yield contributing characters differed significantly due to varietal differences. Panicle length was not significantly affected by the studied cultivars. Numerically the longest panicle (24.39 cm) was recorded in BINA dhan7 and the shortest one (23.37 cm) was obtained in BRRI dhan62. Number of grains panicle^{-1} was significantly influenced by the cultivars studied (Table 1). Among three cultivars, BINA dhan7 produced the highest number (123.17) of grains panicle^{-1} and BRRI dhan62 produced the lowest number (79.86) of grains panicle^{-1}. The variation in number of grains panicle^{-1} might be due to the variation in total and effective tiller production. Similar result was also found by Hossain *et al*. (2014) who reported that the both hybrid rice cultivars Heera2 (119.8) and Aloron (111.8) produced the highest spikelets panicle^{-1} than that of BRRI dhan48 (105.5). Uddin *et al*. (2011)

also found that the modern cultivar BRRI dhan44 performed better than local cultivars due to genetic makeup of the cultivars and these findings were identical to the study of Hossain *et al*. (2005). Cultivar had no significant effect on 1000-grain weight. The results indicate that individual grain weight of the three short duration rice cultivars were more or less similar. Although individual grain weight is a genetic characters but this parameter did not vary significantly for the studied three short duration *aman* rice cultivars. Significant variations in grain yield among the cultivars were observed (Table 1).

Table 1. Effect of variety on the yield and yield contributing characters of T. *Aman* rice

Variety	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	BCR
BINA dhan7	98.99b	16.54a*	14.04a	24.39	123.12a	21.73	4.97a	5.93	45.16a	1.12
BRRI dhan56	110.2a	13.09b	12.03ab	23.88	107.73b	21.77	4.85a	6.46	43.02ab	1.12
BRRI dhan62	100.2b	12.69b	11.38b	23.37	79.86c	21.92	3.58b	5.39	40.89b	0.85
CV (%)	3.25	15.45	16.52	4.39	3.00	3.97	14..71	14.24	5.93	
Level of sig.	0.01	0.01	0.05	NS	0.01	NS	0.01	NS	0.01	

*In a column figures having common letter(s) do not differ significantly as per DMRT, NS = Statistically not significant

Among the three cultivars, BINA dhan7 produced the highest grain yield (4.97 t ha^{-1}) which was statistically identical (4.85 t ha^{-1}) with BRRI dhan56. The lowest grain yield (3.58 t ha^{-1}) was recorded from BRRI dhan62. Highest grain yield was recorded from BINA dhan7 might be due to the highest number of total and effective tillers hill^{-1} and the highest number of grains panicle^{-1}. Uddin *et al*. (2010) and Pruneddu and Spanu (2001) also reported that the cultivars which produced higher number of effective tillers hill^{-1} and higher number of grains panicle^{-1} also produced higher grain yield ha^{-1}. Similar research finding was also reported by Mondal *et al.* (2005) in rice. Sohel *et al*. (2009) reported that these variations in grain yield among the cultivars might be due to genetic makeup of the varieties. Though straw yield was not significantly affected by the cultivars, but numerically the highest straw yield (6.46 t ha^{-1}) was obtained from the cultivar BRRI dhan56 due the tallest plant of this cultivar. The results are in accordance with the findings of Hossain (2002). Pheloung and Siddique (1991) reported that straw yield could be assigned to plant height. Harvest index (HI) represents comparative yield performance between grain and straw yields. The data on harvest index was significantly influenced by the cultivars (Table 1). The cultivar BINA dhan7 produced the highest harvest index (45.16%) which was statistically similar with that of cultivar BRRI Dhan56. The lowest harvest index (40.89%) was observed in BRRI dhan62. These results reveal that harvest index differed significantly due to the genetic differences of the studied cultivars, their differential adaptability and also the variation of grain and straw yields. This finding was also similar to that of the study of Uddin *et al*. (2011) who reported that the harvest index differed significantly among the studied cultivars due to their genetic variability.

***Effect of number of seedlings hill^{-1} on the yield and yield contributing characters of transplant Aman rice*:** Most of the yield and yield contributing characters did not vary significantly except total tillers hill^{-1}. These results indicate that number of seedlings per hill had no significant effect on yield and yield attributes of rice. Plant height was not significantly influence by the number of seedlings hill^{-1}. Muhammad *et al.* (1987) reported that plant height remained unaffected due to variation in planting density. Total

tillers hill^{-1} was significantly influenced by number of seedlings hill^{-1}. The highest number (15.10) of total tillers hill^{-1} was recorded from single seedling hill^{-1} which was statistically similar with that of two seedlings hill^{-1}. The lowest number of total tillers hill^{-1} was obtained from three seedlings hill^{-1}. It is revealed that planting excess seedlings (more than one or two) in a single hill does not affect the tiller production of rice. Nakano and Mizushima (1994) also observed similar findings. Effective tillers hill^{-1}, length of panicle, grains panicle^{-1} and 1000-grain weight were not significantly affected by the number of seedlings hill^{-1}. Similar research finding was also reported by Khatun *et al.* (2015) who reported that there were no significant differences among one seedling hill^{-1}, two seedlings hill^{-1} and three seedlings hill^{-1} for the above mentioned characters. Grain yield was not significantly affected by the number of seedlings hill^{-1}. Numerically the highest grain yield (4.62 t ha^{-1}) was recorded from single seedling hill^{-1} and no significant differences in grain yield were observed among single, two and three seedlings hill^{-1}. Therefore, the optimum seedlings per hill ensure the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation, water and nutrients (Miah *et al.,* 2004). Straw yield and harvest index were also not significantly affected by the number of seedlings hill^{-1} (Table 2).

Table 2. Effect of number of seedlings hill^{-1} on the yield and yield contributing characters of transplanted *Aman* rice

Number of seedlings hill^{-1}	Plant height (cm)	Total tillers hill^{-1} (cm)	Effective tillers hill^{-1} (cm)	Panicle length	Grains panicle (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	BCR
One	103.40	15.10a*	13.00	24.091	105.10	21.88	4.62	6.02	43.27	1.08
Two	102.91	14.63ab	12.93	23.690	103.42	21.91	4.43	5.84	42.46	1.03
Three	103.05	12.59b	11.52	23.854	102.15	21.63	4.36	5.93	43.35	1.01
CV (%)	3.25	15.45	16.52	4.39	3.00	3.97	14.71	14.24	5.93	
Level of sig.	NS	0.05	NS	NS	NS	NS	NS	NS	NS	

*In a column figures having common letter(s) do not differ significantly as per DMRT, NS = Statistically not significant

***Interaction effect of variety and number of seedlings hill–1 on the yield and yield contributing characters of transplant Aman rice*:** Interaction of variety and number of seedlings hill^{-1} exerted significant effect on plant height (Table 3). The tallest plant (111.5 cm) was recorded from the interaction of BRRI dhan56 × single seedlings hill^{-1} which was statistically identical with BRRI dhan56 × three seedlings hill^{-1}, BRRI dhan62 × single seedling hill^{-1} and BRRI dhan62 × two seedlings hill^{-1}. The shortest plant (97.64 cm) was obtained from the interaction of cultivar BINA dhan7 × one seedling hill^{-1} which was statistically similar with variety BINA dhan7 × two seedlings hill^{-1} and variety BINA dhan7 × three seedlings hill^{-1}. Number of total tillers hill^{-1} was significantly affected by the interaction of cultivar and number of seedlings hill^{-1}. The highest number of total tillers hill^{-1} (19.41) was obtained from the interaction of cultiva BINA dhan7 × two seedlings hill^{-1} which was statistically similar with that of BINA dhan7 × single seedlings hill^{-1}. Effective tillers hill^{-1} and length of panicle were not significantly affected by the interaction of cultivar and number seedlings hill^{-1}. Grains panicle^{-1} was significantly affected by the interaction of cultivar and number of seedlings hill^{-1}. The highest number (125.71) of grains panicle^{-1} was recorded from the interaction of BINA dhan7 × one seedling hill^{-1} which was statistically identical with BINA dhan7 × three seedlings hill^{-1} and BINA dhan7 × two seedlings hill^{-1}. The lowest number (79. 96) of grains panicle^{-1} was observed from the interaction

BRRI dhan62 × three seedlings hill^{-1} which was statistically identical with BRRI dhan62 × two seedlings hill^{-1}. 1000-grain weight, grain yield and straw yield were not significantly affected by the interaction of cultivar and number of seedlings hill^{-1}. The highest harvest index (47.03) was recorded from the interaction of variety BINA dhan7 × one seedling hill^{-1} which was statistically similar with other interactions except BRRI dhan62 × two seedling hill^{-1} and BRRI dhan62 × three seedlings hill^{-1} (Table 3).

Table 3. Interaction effect of variety and number of seedlings hill^{-1} on the yield and yield contributing characters of transplanted *Aman* rice.

Interaction (variety and number of seedlings hill^{-1})	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yields (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1 S_1	97.64b	16.56ab	13.33	24.17	125.71a	21.70	5.18	5.92	47.03a*
V_1 S_2	99.05b	19.41a	16.33	24.57	120.60a	21.80	4.99	5.50	45.77a
V_1 S_3	100.3b	13.67bc	12.47	24.43	122.82a	21.70	4.74	6.37	42.68ab
V_2 S_1	111.5a	15.11bc	14.00	25.00	109.63b	21.87	5.40	6.97	43.65ab
V_2 S_2	109.1a	12.48bc	11.33	23.17	108.70b	21.50	4.80	6.62	42.49ab
V_2 S_3	109.9a	11.67c	10.77	23.47	104.82b	21.93	4.35	5.78	42.92ab
V_3 S_1	109.9a	11.67c	10.77	23.47	104.82b	21.93	4.35	5.78	42.92ab
V_3 S_2	101.1b	13.63bc	11.66	23.11	79.96c	22.07	3.28	5.15	39.13b
V_3 S_3	100.7b	12.00c	11.13	23.33	80.81c	22.43	3.49	5.38	39.11b
CV (%)	0.05	15.45	16.52	4.39	3.00	3.97	14..71	14.24	5.93
Level of sig.	3.25	0.05	NS	NS	0.05	NS	NS	NS	0.05

*In a column figures having common letter(s) do not differ significantly as per DMRT, NS = Statistically not significant, V_1 = BINA dhan7, V_2 = BRRI dhan56, V_3 = BRRI dhan62, S_1 = One seedling hill^{-1}, S_2 = Two seedlings hill^{-1}, S_3 = Three seedlings hill^{-1}

The economic analysis shows (Table 4) that the highest BCR (1.64) was recorded from single seedling hill^{-1} in BRRI dhan56 which was close to (1.53) single seedling hill^{-1} in BINA dhan7. The lowest BCR (1.03) was obtained from two seedlings hill^{-1} in BRRI dhan62.

Table 4. BCR of different rice cultivars as influenced by number of seedlings hill^{-1}

Number of seedlings hill^{-1}	Bina *Dhan* 7	BRRI *Dhan* 62	BRRI *Dhan* 73
One seedling hill^{-1}	1. 53	1.64	1..31
Two seedlings hill^{-1}	1.46	1.47	1.03
Three seedlings hill^{-1}	1.43	1. 31	1.09

Conclusion

From the results of the study it may be concluded that BRRI dhan56 with single seedlings hill^{-1} might be cultivated in AEZ-9 for obtaining higher yield and higher economic return in *aman* season.

References

AIS (Agricultural Information Service) (2011). Krishi Dairy, Agril. Inform. Ser. Kamarbari, Farmgate. Dhaka, Bangladesh. p. 23.

Ali MS, Hasan MA, Sikder S, Islam MR and Hafiz, MHR (2013). Effect of seedling age and water management on the performance of *boro* rice (*Oryza sativa* L.) variety BRRI dhan28. *Agriculturists*. 11: 28-37.

Ashrafuzzaman M, Islam MR, Ismail MR, Shahidullah SM, Hanafi MM (2009). Evaluation of six aromatic rice varieties for yield and yield contributing characters. *Int. J. Agric. Biol.* 11: 616-620.

BBS (Bangladesh Bureau of Statistics) (2016). Statistical Year Book of Bangladesh. Bangladesh Bur. Stat., Stat. Div., Min. Plan., Govt. People's Repub. Bangladesh, Dhaka. pp. 32-50.

Brar SK, Mahal SS, Brar AS, Vashist KK, Sharma N, Buttar GS (2012). Transplanting Time and Seeding Age Affect Water Productivity, Rice Yield and Quality in North-West India. *Agril. Water Manag*. 115: 217-222

Faruk MO, Rahman MA, Hasan MA (2009). Effect of Seedling Age and Number of Seedling per Hill on the Yield and Yield Contributing Characters of BRRI dhan33. *Intl. J. Sustain. Crop Prod*. 4: 58-61.

Faghani R, Mobasser HR, Dehpor AA, Kochaksarai ST (2011). The effect of planting date and seedling age on yield and yield components of rice (*Oryza sativa* L.) varieties in north of Iran. *African J. Agril.Res*. 6: 2571-2575.

Ginigaddara GAS, Ranamukhaarachchi SL (2011). Study of age of seedlings at transplanting on growth dynamics and yield of rice under alternating flooding and suspension of irrigation of water management. *Recent Res. Sci. Technol*. 3: 76-88.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research. John Willey and Sons. New York, Chichester, Brisbane, Toronto. pp. 97-129, 207-215.

Hossain MF, Bhuiya MSU, Ahmed M (2005). Morphological and agronomic attributes of some local and modern aromatic rice varieties of Bangladesh. *Asian J. Plant Sci.* 4: 664–666.

Hossaina MM, Sultana F, Rahman AHMA (2014). A comparative screening of hybrid, modern varieties and local rice cultivar for brown leaf spot disease susceptibility and yield performance. *Archives Phytopathol. Plant Protect*. 47:795–802

Mishra A, Salokhe VM (2008). Seedling characteristics and the early growth of transplanted rice under different water regimes. *Exptl. Agric*. 44**:** 365-383.

Nakano H, and Mizushima T (1994). Effect of competition in a hill to seedling number per hill on yield components and yield in paddy rice. *Japanese J. Crop Sci*. 63(3): 452-459.

Mondal MMA, Islam AFM, Siddique MA (2005). Performance of 17 modern transplant *aman* rice cultivars in the northern region of Bangladesh. *Bangladesh J. Crop Sci*. 16: 23-29.

Patra PS, Haque S (2011). Effect of Seedling Age on Tillering Pattern and Yield of Rice (Oryza sativa L.) under System of Rice Intensification. *ARPN J. Agril. Biol. Sci*. 6: 33-35.

Sarkar MAR, Paul SK, Hossain MA (2011). Effect of row arrangement, age of tiller seedling and number of tiller seedlings per hill on performance of transplant *aman* rice. *J. Agril. Sci.* 6: 61-63.

Sohel MAT, Siddique MAB, Asaduzzaman M, Alam MN, Karim MM (2009). Varietal performance of transplant aman rice under differnt hill densities. *Bangladesh J. Agril. Res*. 34: 33–39.

Uddin MJ, Hasan MM, Ahmed S. Hasan MM (2010). Effect of spacing on morpho-physiological response of different T. *aman* rice cultivars under coastal high land ecosystem. *Indian J. Agric. Res*. 44: 251–258.

Uddin MJ, Ahmed S, Harun–or–Rashid M, Hasan MA, Asaduzzaman M (2011). Effect of spacing on the yield and yield attributes of transplanted *aman* rice cultivars in medium lowland ecosystem of Bangladesh. *J. Agric. Res*. 49: 465–476.

UNDP and FAO (1988). Land Resources Appraisal of Bangladesh for Agricultural Development Report No. 2. Agro-ecological Regions of

Bangladesh. United Nations Development Programme and Food and Agricultural Organization, Rome, Italy. pp. 212-221.

Zubaer MA, Chowdhury AKMMB, Islam MZ, Ahmed T, Hasan MA (2007). Effects of water stress on growth and yield attributes of *aman* rice genotypes. *Int. J. Sustain. Crop Prod.* 2: 25-30.