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Growth, Dry Matter Production and Yield Performance of Transplanted *Aman* Rice Varieties Influenced by Seedling Densities per Hill

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Abstract: A field experiment was conducted at the experimental field of Sher-e-Bangla agricultural university during July to December 2010 to find out the effect of 1, 2, or 3 seedling(s) per hill on growth, dry matter production and yield performance of a modern inbred (BRRI dhan49) and four hybrid (BRRI hybrid dhan2, Heera, Tia and Aloron) transplant *aman* rice varieties. The experiment was laid out in randomized complete block design with three replications. Results showed that rice cultivars differed significantly in all growth characters, such as plant height, tillers number, chlorophyll content and dry matter weight of different plant parts, panicle length, filled grain, unfilled grain, filled grain percentage, 1000-grain weight, grain yield and straw yield. Numbers of seedling(s) per hill had remarkable influence on number of total tillers per hill and total dry matter production and single seedling per hill gave the highest grain yield (4.20 t ha^{-1}). The higher grain yield was attributed mainly to the number of effective tillers per hill, filled grains per panicle and 1000-grain weight.

Key words: Transplanted rice · Population density · Dry matter partitioning · Agronomic management

INTRODUCTION

Rice (*Oryza sativa* L.) is the second most widely grown cereal in the world and it is the staple food for more than half of the world's population. Asia is the leading producer of rice and most Asians get 60% of their calories from rice. Bangladesh ranks 4th in both area and production and 6th in the production of per hectare yield of rice in the world. It is the staple food of about 160 million people of Bangladesh. Rice cultivation is favored by the hot, humid climate and the large number of deltas across Asia's vast tropical and subtropical areas. 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 [1]. The population of Bangladesh is growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. During this time total rice area will also shrink to 10.28 million hectares. Rice yield therefore, needs to be increased by 53.3%. In Bangladesh, rice yield level is far below than that of many other countries like China, Japan, Korea and Egypt where yield is 7.5, 5.9, 7.3 and 7.5 t ha^{-1}, respectively [2]. Horizontal expansion of rice area is not possible in Bangladesh due to limited land resources and high population density. So, the only avenue left is to increase production of rice by vertical means, that is, management practices and introduction of hybrid varieties. The potential for increased rice production strongly depends on the ability to integrate a better crop management for the different varieties into the existing cultivation. Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. In the year 2010, among the *aman* rice varieties high yielding modern varieties covered 66.63% and yield was 2.49 t ha^{-1} and local varieties covered 24.97% and yield was 1.58 t ha^{-1} [3]. It is the farmers who have gradually replaced the local indigenous low yielding rice varieties by high yielding ones and modern varieties of rice developed by Bangladesh Rice Research Institute (BRRI) only because of getting 20 to 30% more yield unit land area [4].

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Planting density as a management practice in transplanted rice culture constitutes the number of seedling per hill or per unit area. Number of productive tillers and their greater growth both quantitative and qualitative growth are influenced by number of seedling per hill. Optimum seedling(s) per hill enables rice plants to grow properly both in their aerial and underground parts by proper utilization of radiant energy, nutrients, space and water. However, controversy is found regarding the number of seedlings planted per hill. Nakano and Mizushima [5] reported that grain yield is negatively correlated with increasing the number of seedling per hill. Wen and Yang [6] found that effective panicles, the number of grains per panicle and the 1000- grain weight were also higher with only one seedling per hill. Obulamma *et al.* [7] recorded the highest grain yield, crop growth rate and net assimilation rate from one seedling per hill. Panda *et al.* [8] found that grain yield was highest with 4 seedlings per hill. Biswas and Salokhe [9] revealed similar yield of rice by planting 2-4 vegetative tillers per hill. Excess number of seedling hill^{-1} may produce more tillers resulting in mutual shading, lodging and lead to production of more straw instead of grain. While the least number of seedlings per hill may produce insufficient tiller, keeping space and nutrients unutilized resulting in less number of panicles per unit area, resulting poor yield [10]. Hybrid rice offers to break the yield ceiling of conventional semi-dwarf rice varieties. Hybrid rice out yielded the existing conventional High Yielding Varieties (HYVs) by 15-20% in India, Bangladesh and Vietnam [11]. In *aman* season, however, available information regarding the yield and yield contributing characters, both morpho-physiological characteristics of hybrid rice varieties are meager in Bangladesh. That is why, it is a prime need to conduct more research work to find out and develop sustainable technologies regarding hybrid rice cultivation under the prevailing local conditions in the *aman* season. Considering the above proposition, the research was undertaken with the following objective to determine the effect of seedling densities on the growth, yield and yield contributing characters of *aman* rice.

MATERIALS AND METHODS

The field experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University (SAU), under the agro-ecological zone of Modhupur Tract, AEZ-28, during *aman* season(July to December, 2010) with a view to finding out the influence of planting density on growth and yield of hybrid rice. Geographically the experimental area is located at 24◦75' N and 90◦50' E longitude at the elevation of above 18 m the sea level.The experiment was laid out in randomized complete block design with three replications of seedling(s) number per hill (3) *viz* 1 seedling, 2 seedlings, 3 seedlings and 5 inbreed and hybrid varieties *viz* BRRI dhan49, BRRI hybrid dhan2, Heera, Tia and Aloron. There were 15 treatments combinations. The total numbers of unit plots were 45. The size of unit plot was 5 m x 3 m = 15 m^2. At the time of first ploughing cowdung at the rate of 10 t ha^{-1} was applied. The experimental plots were fertilized a day before transplanting with 130, 120, 70, 10 kg ha^{-1}in the form of triple superphosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate respectively, according to the recommended dose of BRRI (2010). Urea was top-dressed @ 120 kg N ha^{-1} in three equal splits at 10, 30 and 50 days after transplanting (DAT). The entire amounts of TSP, MP, gypsum and zinc sulphate were applied at the final land preparation as basal doses. Pre-germinated seeds were sown in the wet seedbed and proper care was taken to raise the seedlings in seedbed. Thirty days old seedling was transplanted in each hill maintaining the spacing with 25cm×15 cm according to the planting density treatments. Intercultural operations such as gap filling, weeding and chemical pest management were done when necessary. About 2-3 cm water layer was maintained in the each plot until the crop attained maturity. Five hills in each plot were randomly selected and tagged for recording and data were collected in tillering, panicle initiation, booting, flowering and harvesting stages on the following growth parameters *viz* plant height (cm), number of tillers per m^2, dry matter weight of leaves (g), dry matter weight of stem (g), dry matter weight of panicle (g), chlorophyll content (mg/g) and panicle length (cm). Maturity of crop was determined when 90% of the grains become golden yellow in color. An area of 3 m^2 was harvested from centre of each plot avoiding the border effect. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. Threshing was done by pedal thresher. The grains were cleaned and sun dried to moisture content of 12 %. Straw was also sun dried properly. After harvesting, threshing, cleaning and drying the grain and straw yield as well as yield contributing characters *viz* number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, per cent filled and unfilled grains and 1000-grain weight, grain yield, straw

yield, biological yield and harvest index were recorded. Finally grain and straw yields plot^{-1} were recorded and converted to t ha^{-1}. The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT computer package program. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Plant Height: Number of seedling(s) per hill had no significant effect on plant height (Figure 1). Plant height was also unaffected by the different number of seedlings per hill at panicle initiation, booting and even at flowering stage. At panicle initiation stage, numerically the tallest plant (80.3 cm) was obtained from 2 seedlings per hill and the shortest plant (79.9 cm) was obtained from 3 seedlings per hill. At booting stage, numerically the tallest plant (92.3 cm) was obtained from 1 seedling per hill and the shortest plant (92.1cm) was obtained from 3 seedlings per hill. At flowering stage, numerically the tallest plant (102.3 cm) was obtained from 3 seedlings per hill and the shortest plant (101.9 cm) was obtained from 1 seedling per hill. The results are similar to the findings of Masum *et al.* [12], Hushine [13], Shrirame *et al.* [14] and Zhang and Huang [15], who reported that plant height was not significantly affected by seedlings per hill. The results are in conflict with that of Hasanuzzaman *et al.* [16], Miah *et al.* [10] and Shah *et al.* [17] who stated that plant height increased with decrease in seedling number per hill where as Faruque [18] and Singh [19] showed that plant height increased with increased the seedling number per hill.

Number of Total Tiller per m^2: Except at harvesting stage, total tiller numbers per m^2 per hill was significantly influenced by the different number of seedlings per hill at tillering, panicle initiation, booting and flowering stage (Figure 2). Maximum tiller per m^2 was obtained at panicle initiation stage for all the treatments of seedling numbers per hill and then with advancement to age it declined up to maturity. At tillering stage, maximum (264.25) number of tillers per m^2 per hill was counted with transplanting 3 seedlings per hill and minimum (161.35) number of tillers per m^2 hill was counted with transplanting 1 seedling per hill. At panicle initiation stage, maximum (393.38) number of tillers per m^2 per hill was counted with transplanting 3 seedlings per hill and it was followed by transplanting 2 seedlings per hill and minimum (329.60) number of

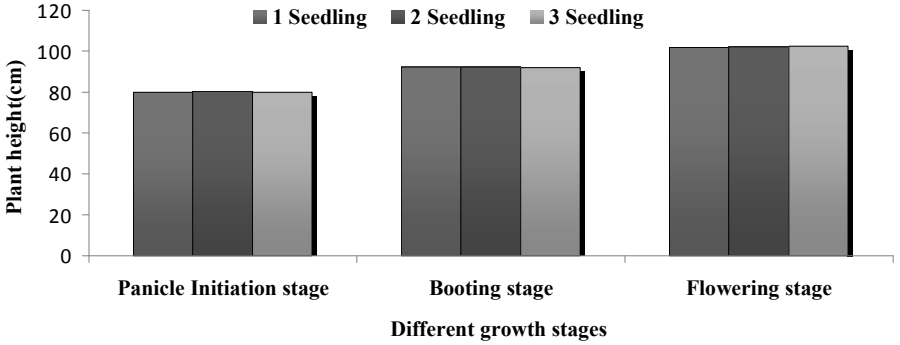

Fig. 1: Effect of seedling numbers per hill on plant height (cm) of transplanted *aman* rice at different growth stages

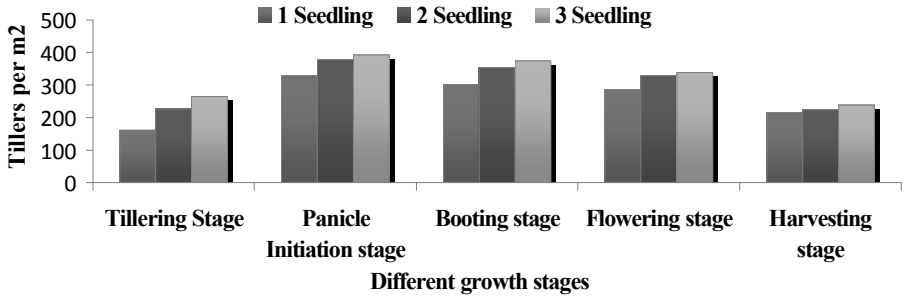

Fig. 2: Effect of seedling numbers per hill on total tillers per m^2 of transplanted *aman* rice at different growth stage

Table 1: Chlorophyll a content, Chlorophyll b content, cumulative chlorophyll a and b content and ratio of chlorophyll a and b of flag leaf of transplanted *aman* rice as influenced by seedling(s) number per hill on varieties

Treatment	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Chlorophyll (a+b) (mg/g)	Chlorophyll a/ Chlorophyll b
S_1	3.29	2.35	5.64	1.41
S_2	3.30	2.35	5.66	1.41
S_3	3.35	2.41	5.76	1.39
LSD (5%)	ns	ns	ns	ns

S_1= 1 seedling, S_2= 2seedlings, S_3= 3 seedlings (Values followed by same letter(s) in a column do not differ by MSTAT range test)

Table 2: Leaf blade dry matter weight of transplanted *aman* rice as influenced by seedling(s) number per hill on varieties

Treatment	Leaf dry matter weight/m^2 at tillering stage(g)	Leaf dry matter weight/m^2 at panicle initiation stage	Leaf dry matter weigh/m^2 t at booting stage	Leaf dry matter weight/m^2 at flowering stage
S_1	25.76 c	137.3 b	175.3 b	187.9 b
S_2	33.62 b	152.4 a	179.1 b	203.7 a
S_3	37.41 a	157.3 a	196.1 a	213.0 a
LSD (5%)	2.37	12.71	16.72	13.08

S_1= 1 seedling, S_2= 2seedlings, S_3= 3 seedlings (Values followed by same letter(s) in a column do not differ by MSTAT range test)

tillers per m^2 per hill was counted with transplanting 1 seedling per hill. At booting stage, maximum (373.16) number of tillers per m^2 per hill was obtained with transplanting 3 seedlings per hill and it was followed by transplanting 2 seedlings per hill and the minimum (301.60) number of tillers per m^2 per hill was obtained at 1 seedling per hill. The similar trend of tiller production was also observed at flowering stage. At harvesting stage, numerically maximum tiller per m^2 per hill was obtained at 3 seedlings per hill and minimum at 1 seedling per hill.These results are in agreement with the findings of Hasanuzzaman *et al.* [16], Masum *et al*. [12], Miah *et al.* [10].

Chlorophyll Content: The chlorophyll a content in flag leaf varied insignificantly due to seedling number per hill shown in Table 1. It was observed that 3 seedlings per hill (S_3) content numerically higher (3.35 mg/g) in flag leaf and the lowest chlorophyll a content (3.29 mg/g) was measured from 1 seedling (S_1). Similar trend was found from chlorophyll b and cumulative value of chl a and chl b. But in case of the ratio of chl a and chl b the highest ratio (1.408 mg/g) was measured from 2 seedlings per hill and lowest ratio was found from 1 seedling per hill.

Leaf Blade Dry Matter Weight (g): Seedling number per hill had significant effect on leaf dry matter weight per m^2 at different stages (Table 2). Statistically the highest (37.41 g) leaf dry matter weight was found with 3 seedlings (S_3). The second highest (33.62 g) leaf dry matter was measured from 2 seedlings per hill (S_2). The lowest leaf dry matter weight (25.76 g) was obtained from 1 seedling per hill (S_1). At panicle initiation stage, the highest (157.3 g) leaf dry matter weight was found with 3 seedlings (S_3) which was statistically identical with 2 seedlings (S2) (152.4 g). The lowest leaf dry matter weight (137.3 g) was obtained from 1 seedling per hill (S_1). At booting stage, the highest (196.1 g) leaf dry matter weight was found with 3 seedlings (S_3). The lowest leaf dry matter weight (179.1 g) was obtained from 2 seedlings per hill (S_2) which was statistically identical with 1 seedling (S_1). At flowering stage, the highest (213.0 g) leaf dry matter weight was found with 3 seedlings (S_3) which was statistically similar with 2 seedlings (S_2) (203.7 g).The lowest leaf dry matter weight (187.9 g) was obtained from 1 seedling per hill (S_1).

Cumulative Dry Matter Weight of Stem and Leaf Sheath: Except at tillering stage, cumulative dry matter weight of stem and leaf sheath per m^2 was not significantly influenced by the different number of seedlings per hill at panicle initiation, booting and flowering stage (Table 3). At tillering stage, the highest cumulative dry matter weight of stem and leaf sheath per m^2 (51.83 gg) area was obtained from 3 seedlings per hill. The second highest cumulative dry matter weight of stem and leaf sheath per m^2 (49.08 gg) was obtained from 2 seedlings per hill. The lowest cumulative dry matter weight of stem and leaf sheath per m^2 (31.04 gg) was obtained from 1 seedling per hill. At panicle initiation stage, numerically highest cumulative dry matter weight of stem and leaf sheath per m^2 (212.85 gg) area was obtained from 3 seedlings per hill and lowest cumulative dry matter weight of stem and leaf sheath per m^2 (192.75 gg) was obtained from

Table 3: Cumulative dry matter weight of stem and leaf seath of transplanted *aman* rice as influenced by seedling(s) number per hill on varieties

Treatment	Dry matter weight/m^2 at tillering stage(gg)	Dry matter weight/m^2 at panicle initiation stage	Dry matter weight/m^2 at booting stage	Dry matter weight/m^2 at flowering stage
S_1	31.04 c	192.75	301.41	441.2
S_2	49.08 b	209.61	304.23	464.7
S_3	51.83 a	212.85	323.10	482.8
LSD (5%)	2.22	ns	ns	ns

S_1= 1 seedling, S_2= 2seedlings, S_3= 3 seedlings (Values followed by same letter(s) in a column do not differ by MSTAT range test)

Table 4: Total dry matter weight of transplanted *aman* rice as influenced and seedling(s) number per hill on varieties

Treatment	Dry matter weight/m^2 at tillering stage(g)	Dry matter weight /m^2 at panicle initiation stage(g)	Dry matter weight /m^2 at booting stage(g)	Dry matter weight /m^2 at flowering stage(g)
S_1	56.8 c	330.0 b	478.3	641.2 b
S_2	82.71 b	362.0 a	485.1	679.8 ab
S_3	89.24 a	370.1 a	521.2	707.4 a
LSD (5%)	3.47	25.44	ns	44.73

S_1= 1 seedling, S_2= 2seedlings, S_3= 3 seedlings (Values followed by same letter(s) in a column do not differ by MSTAT range test)

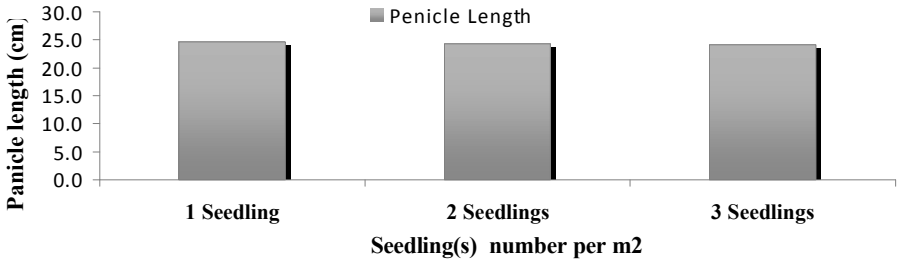

Fig. 3: Effect of seedling number (s) per hill on panicle length of transplanted *aman* rice varieties

1 seedling per hill. At booting stage, numerically highest cumulative dry matter weight of stem and leaf sheath per m^2 (323.1 gg) area was obtained from 3 seedlings per hill and lowest cumulative dry matter weight of stem and leaf sheath per m^2 (301.41 gg) was obtained from 1 seedling per hill. At flowering stage, similar trend was found.

Total Dry Matter Production: Dry matter production was significantly influenced by different seedling number per hill at all stage except booting stage (Table 4). At tillering stage, the highest total dry matter weight per m^2 (89.24 g) was measured from 3 seedlings per hill. The second highest total dry matter weight per m^2 (82.71 g) was obtained from 2 seedlings per hill. The lowest total dry matter weight per m^2 (56.8 g) was obtained from 1 seedling per hill. At panicle initiation stage, the highest total dry matter weight per m^2 (370.1 g) was measured from 3 seedlings per hill which was statistically similar with 2 seedlings per hill. The lowest total dry matter weight per m^2 (330.0 g) was obtained from 1 seedling per hill. At booting stage, numerically maximum total dry matter weight per m^2 (521.2 g) was measured from 3 seedlings per hill and minimum (478.3 g) from 1 seedling. At flowering stage, the highest total dry matter weight per m^2 (707.4 g) was measured from 3 seedlings per hill which was statistically identical with 2 seedlings per hill. The lowest total dry matter weight per m^2 (641.2 g) was obtained from 1 seedling per hill. The result was conformity with Miah *et al*. [10], Obulamma *et al*. [7] who observed significant increased in dry matter production with the increased seedlings number per hill.

Panicle Length: The longest (24.62 cm) and shortest (24.08 cm) panicle length was observed in 1 and 3 seedlings per hill respectively though the value did not differ significantly (Figure 3).The results are conformity with Hasanuzzaman *et al.* [16], Islam *et al.* [20], Hushine [13], BRRI [21], Zhang and Huang [15] who stated that panicle length was unaffected by the number of seedlings per hill. But this result is contradictory with Bozorgi *et al.* [22] and Roshan *et al.* [23] who stated that panicle length significantly differed due to seedling number variation per hill.

Table 5: Filled grain, unfilled grain, filling % and 1000 grain weight of transplanted *aman* rice as influenced by seedling (s) number per hill on varieties

Treatment	Filled grain/m^2	Unfilled grain/m^2	Filling %	1000 grain weight
S_1	21818.11	5917.98 a	79.77 b	24.43
S_2	23327.18	5352.27 a	81.77 b	24.36
S_3	24812.26	4122.52 b	85.78 a	24.31
LSD (5%)	ns	715.1	2.53	ns

S_1= 1 seedling, S_2= 2seedlings, S_3= 3 seedlings (Values followed by same letter(s) in a column do not differ by MSTAT range test)

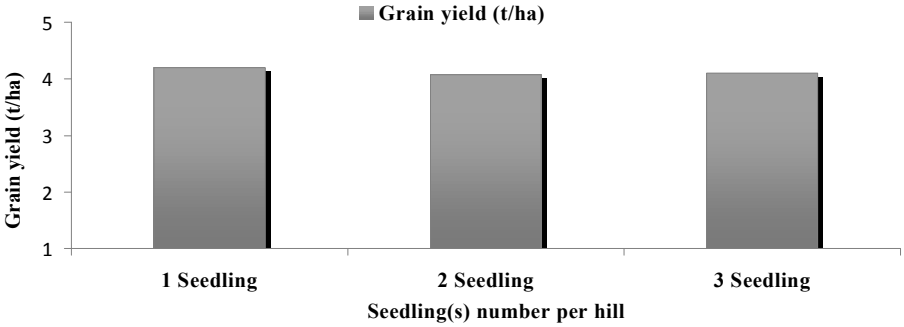

Fig. 4: Effect of different seedling number per hill on grain yield of transplanted *aman* rice at different growth stages

Yield Contributing Characters

Filled Grain per m^2: Number of filled grains per m^2 was not significantly influenced by the number of seedlings per hill (Table 5). The highest (24812.26) and lowest (21818.11) of filled grains per m^2 was obtained with 3 and 1 seedling per hill respectively. The result is in agreement with Shah *et al.* [17] and Singh *et al.* [24] who stated that filled grains per m^2 was unaffected by the number of seedling(s) per hill.

Number of Unfilled Grains per m^2: Number of unfilled grains per m^2 was statistically influenced by the number of seedlings per hill (Table 5). The minimum number (4122.52) of unfilled grains per m^2 was counted at 3 seedlings per hill and the maximum number (5917.98) was found at 1 seedling per hill which was statistically at par with 2 seedlings per hill. Bozorgi *et al.* [22], Roshan *et al.* [23].

Filled Grain %: Grain filling % was found statistically significant on the seedling numbers per hill (Table 5). The minimum number (79.77%) of grain filling% was counted at 1seedling per hill which was statistically similar with 2 seedlings per hill. The maximum number (85.78%) was found at 3 seedlings per hill. This contradictory with the report of Miah *et al.* [10], who reported that percentage of filled grain did not show statistically significant variation due to seedlings transplanted per hill.

1000-Grain Weight: Weight of 1000-grain was not significantly influenced by the number of seedlings per hill (Table 5). Numerically the heaviest (24.43 g) 1000-grain weight was found under the transplanting 1 seedling per hill and the lowest (24.31 g) 1000-grain weight was found at 3 seedlings hill^{-1}. The results showed that 1000 grain weight was declined with increasing seedling numbers per hill (Table 5). Islam *et al.* [25] found that 1000-grain weight was not significantly influenced by the number of seedlings per hill. Karim *et al.* [26] reported that 1000-grain weight slightly decreased with increasing plant density. This findings also accord with those of Wen and Yang [6] who reported higher 1000-grain weight by using 1 seedling per hill than with 4 seedlings per hill. Hassanuzzaman *et al.* [16] and Roshan *et al.* [23] also stated that 1000 grain weight was significantly influenced by the number of seedlings per hill.

Grain Yield: Grain yield was not significantly influenced by the number of seedlings per hill (Figure 4). Numerically the highest (4.20 t per ha) grain yield was found with 1 seedlings per hill and the lowest grain yield was measured with 3 seedlings per hill. The result was contradictory with the findings of Masum *et al.* [27], Hasanuzzaman [16], Masum *et al.* [12], Islam *et al.* [25], Kabir [28], Rajarathinam and Balasubramanuyan [29], Asif *et al.* [30] and Hossain and Haque [31] who observed highest grain yield with 2 seedlings per hill. Likewise, Srinivasulu *et al.* [32] noted that planting 1 seedling per hill of rice gave highest grain yield comparable to that of 2 seedlings per hill. Whereas, Shrirame *et al.* [14] found similar grain yield under 1, 2 and 3 seedlings per hill. The result disagreed with Islam *et al.* [20], Shahi and Gill [33] who observed

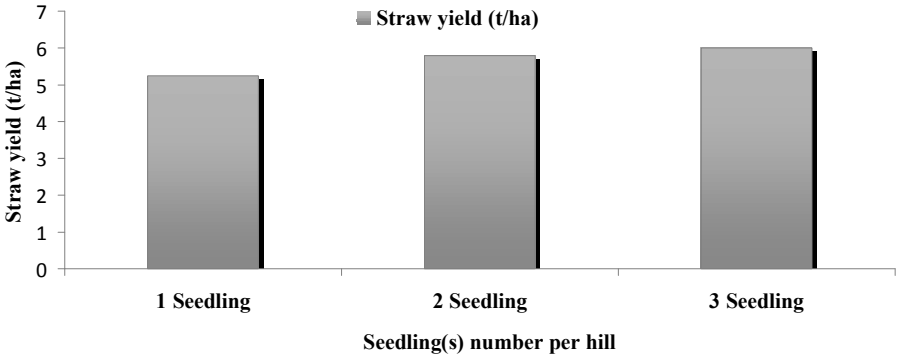

Fig. 5: Effect of different seedling number per hill on straw yield per ha of transplanted *aman* rice at different growth stages

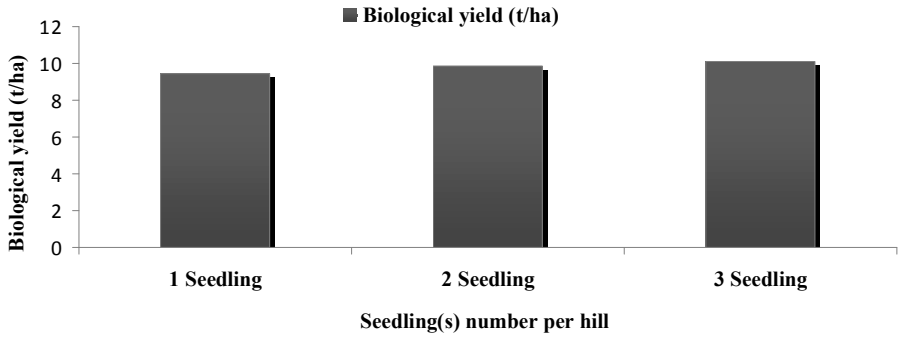

Fig. 6: Effect of seedling numbers per hill on Biological yield of transplanted *aman* rice

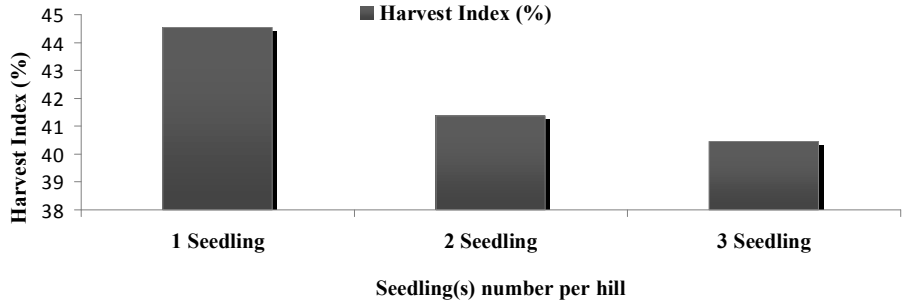

Fig. 7: Effect of seedling numbers per hill on Harvest Index (HI) of transplanted *aman* rice

the highest grain yield with 4 seedlings per hill and lowest at 1 seedling per hill. The result also disagreed with Rahman *et al.* [34] who observed the highest grain yield with 3 seedlings per hill and lowest at 1 seedling per hill.

Straw Yield: Straw yield was significantly influenced by the different level of seedling numbers per hill (Figure 5). The maximum (6.01 t per ha) straw yield was found with 3 seedlings per hill which was statistically at par with 2 seedlings per hill. The minimum (5.25 t ha^{-1}) straw yield was observed from 1 seedling per hill (Figure 14). The higher straw yield with 3 seedlings per hill was mainly due to higher number of total tillers per hill. The other possible reasons were that they could produce more biomass but mutual shading hampered translocation of enough food materials from body to growing panicles and thus favor the production of more straw instead of grain. On the contrary, 1 seedling per hill though produced lower number of total tillers per hill compared to 3 seedlings per hill but produced more effective tillers which bear panicles and growing panicles received more stored matter from stems and as a result straw yield was lower. These results are in agreement with the findings of Masum *et al* [12], Rahman *et al.* [34] and Karim *et al.* [35] also reported that 4 seedlings per hill produced higher straw than 1 seedling $hill^{-1}$. But, Rajarathinam and Balasubramanuyan [29] revealed no significant difference of straw yield due to different levels of seedlings per hill.

Biological Yield: Biological yield was not influenced by seedling numbers per hill (Figure 6). Maximum (10.12 t ha^{-1}) biological yield was observed with 3 seedlings per hill whereas, minimum (9.45 t ha^{-1}) biological yield was found with planting 1seedling per hill. But this result is contradictory with Bozorgi *et al.* [22] who stated that biological yield significantly differed due to seedling number variation per hill.

Harvest Index: Seedling numbers variation had significant effect on harvest index (Figure 7). However, 1 seedling per hill produced the maximum (44.55%) harvest index. On the other hand, the minimum (40.46%) harvest index was obtained from 3 seedlings per hill which was statistically similar to 2 seedlings per hill. One seedling produced higher grain yield compared to straw. The increase of harvest index was more prominent in less seedling number per hill and it was decreased with increasing planting density. Bozorgi *et al.* [22], Hasanuzzaman *et al*. [16] reported that harvest index significantly decreased with increasing seedling numbers per hill. The result is in agreement with the findings of Shrirame *et al.* [14] who reported that harvest index significantly affected by seedlings number per hill. Shah *et al.* [17] and Zhang and Huang [15] reported that harvest index was unaffected by the number of seedlings per hill.

CONCLUSION

Number of seedlings per hill had no significant effect on plant height, chlorophyll content but significant on tillering pattern, total dry matter production. Maximum tiller per m^2 was obtained at panicle initiation stage for all the treatments of seedling numbers per hill and then with advancement to age it declined up to maturity. 3 seedlings produced maximum tillers per m^2 per hill and total dry matter at all growth stages. Grain yield was not significantly influenced by the number of seedlings per hill. Numerically the highest (4.20 t ha^{-1}) grain yield was found with 1 seedling per hill and the lowest grain yield was measured with 2 seedlings per hill. In conclusion it could be suggested that transplanting 1 seedling per hill was found to be a promising practice for good yield

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