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INFLUENCE OF PLANTING MATERIALS AND PLANTING METHODS ON YIELD AND YIELD ATTRIBUTES OF INBRED AND HYBRID RICE

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ABSTRACT

A field experiment was carried out at Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka , 2005 to study the influence of planting materials and methods on yield and yield attributes of aman rice varieties. The experiment consisted of three planting materials: Sprouted seed (M_1), Nursery seedling (M_2) and Clonal tiller (M_3); two varieties: Inbreed variety (BR11, Mukta) and Hybrid variety (Sonar Bangla-1); and two planting methods: Broadcast (T_1) and Line (T_2) sowing. The experiment was laid out in a split- split-plot design with four replications. Experimental results showed that planting materials had significant effect on the studied parameters like total and filled grains panicle^{-1}, 1000-grain weight, grain yield and harvest index except effective tillers hill^{-1} and straw yield. The highest grain yield (4.96 t ha^{-1}) was obtained from clonal tillers and the lowest grain yield (4.24 t ha^{-1}) from the sprouted seeds. Variety significantly influenced panicle length, 1000-grain weight and grain yield. The highest grain yield (4.70 t ha^{-1}) was obtained from hybrid variety Sonar Bangla-1 and the inbred variety BR11 gave the lowest grain yield (4.43 t ha^{-1}). Methods of planting influenced only on grain yield and harvest index. Line arrangement showed better performance with highest grain yield (4.81 t ha^{-1}) than haphazard method (4.32 t ha^{-1}). The combined effect of planting materials, varieties and planting method resulted in the highest grain yield from clonal tillers of hybrid variety with line sowing method.

Keywords: Planting material, planting method, yield, aman rice

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important crop of tropical world and in Bangladesh. It is grown in 11.025 million hectares of land with a production of 26.796 million tons in three growing seasons. Of the seasons Aman rice covers the large area of 5.678 million hectares with a production of 11.520 million tons (BBS, 2004). In South and Southeast Asia, floodwater may remain for more than a month during the period of Aman rice grown with maximum submergence reaching to about 50 to 400 cm in depth (Mazaredo *et al.*, 1996). Complete submergence by flash floods has been reported as a major production constraint in about 25 million ha of lowland in this region. Although rice is adapted to lowland, complete submergence for more than 2-3 days killed most of the rice cultivars (Mishra *et al.*, 1996). This type of damage would be rather serious for dwarf and semidwarf varieties, which cause total crop losses. Horizontal expansion of aman rice area is not possible due to high human population pressure on land. Therefore, it is an urgent need of the time to increase rice production through increasing the yield. Proper planting and management practices are the most effective means for increasing yield of aman rice at farmers level using inbreed and hybrid varieties (Alauddin, 2004). There are different methods of planting such as direct seedings (haphazard and line sowing), transplanting of seedlings (haphazard and line sowing), transplanting of clonal tillers. The vegetative propagation using clonal tillers separated from the previously established transplanted crop was beneficial for restoration of a damaged crop of aman rice (Biswas, 2001). Haphazard planting produced the highest grain yield which was statistically similar to the row planting (Roknuzzaman, 1997). Varughese *et al.* (1993) observed higher grain yield in seedling transplanted haphazardly compared with transplanted seedlings in rows. Reddy and Ghosh (1987) found that grain yield, plant height and straw yield of aman rice did not differ significantly for different planting methods.

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Hence an experiment was undertaken to study the effects of planting materials and planting methods on yield and yield attributes of inbred and hybrid rice in aman season.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field at Sher-e-Bangla Agricultural University, Dhaka during the period from June to November, 2005. The experimental area was under the sub-tropical climate that characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the rabi season (October-March). The weather data during the study period of the experimental site is shown in Table 1. The experimental soil was silty clay in nature with pH 5.6, organic carbon 0.45%, organic matter 0.78%, total N 0.03%, available P 20ppm, exchangeable K 0.10meq/100 g soil and available S 45ppm. The experimental area was fertilized with 120, 80, 80, 20 and 5 kg N, P_2O5, K_2O, S and Zn ha^{-1} applied in the form of urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate, respectively. The entire amounts of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation as a basal dose. Urea was applied in four equal installments. The first one-fourth urea was top dressed at 7 days after planting. Second split at 15 days after first top dressing, third at 15 days after second top dressing and fourth at 15 days after third top dressing. Three sets of treatments included in the experiment were A. Three planting materials viz. Sprouted seed (M_1), Nursery seedling (M_2) and Clonal tiller (M_3); B. Two varieties viz. Inbred variety, BR11 (V_1) and Hybrid variety, Sonar Bangla-1 (V_2) and C. Two planting methods viz. Broadcast (T_1) and Line sowing (T_2). The experiment was laid out in a split- split plot design with four replications having planting materials in the main plots and varieties in the sub-plots and planting methods in the sub-sub plots. The size of unit plot was 4 m x 3 m. Direct seeds were sown in the main field on June 22, 2005 and at the same time seed bed was used for raising seedlings. A 25-days old seedlings were transplanted as per experimental treatment in haphazard and line arrangements with the spacing of 20 cm x 15 cm on July 18, 2005. Clonal tillers were separated (30 days after transplanting) from the mother plant and replanted on the main field on August 18, 2005. The clonal tillers were collected from the plot which was also prepared on the same day of seedling transplanting on the main field. Two hand weedings were done for every planting technique, first weeding was at 20 days after seeding/planting followed by second weeding at 15 days after first weeding. Irrigation was given to each plot according to the needs. Plant protections were taken as and when necessary. Maturity of crop was determined when 90% of the grains become golden yellow in color. The harvesting was done on October 25, 2005, October 30, 2005 and November 7, 2005 for sprouted seeds, nursery seedlings and clonal tillers respectively. Ten hills in each plot were selected from which different agronomic data were collected and 6 m^2 areas from middle portion of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yields. Threshing was done using by pedal thresher. The grains were cleaned and sun dried to moisture content of 14 %. Straw was also sun dried properly. Finally grain and straw yields of 6 m^2 were recorded and converted to ton ha^{-1}. The collected data were analysed using IRRISTAT (Version 4.0, IRRI, Philippines) computer package program developed by IRRI. The mean differences among the treatments were compared by least significant difference test at 5 % level of significance.

RESULTS AND DISCUSSION

Effect of planting materials

Significant variations were observed among the planting materials for all the studied parameters except effective tillers hill^{-1} and straw yield (Table 2). The highest panicle length (26.64 cm) was observed in the sprouted seeds but nursery seedlings and clonal tillers gave similar panicle size. Yang *et al.* (1998) also found higher panicle length in sprouted seeds than transplanting. The highest number of total grains panicle^{-1} (202.72) was obtained from the clonal tillers followed by nursery seedling and lowest number of grain panicle^{-1} (186.73) was recorded from sprouted seeds. Biswas (2001) reported higher number of grains in clonl tillers than nursery seedlings but Xiang *et al.* (1999) and Yang *et al.* (1998) reported the higher number of grains in sprouted seeds compared to that of transplanting seedlings. The maximum number of filled grains panicle^{-1} (173.76) was counted in clonal tillers followed by nursery seedling (155.14) that was statisticaly

Table 1. Weather data of the experimental side during the study period from April to November, 2005

Months	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)	Relative Humidity (%)
June	33.4	26.8	260	78.60
July	31.1	26.1	542	80.78
August	32.0	26.7	361	83.22
September	31.7	26.0	514	81.71
October	30.6	23.3	413	88.42
November	29.0	19.8	03	73.90

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212

Table 2. Individual effect of planting materials, varieties and planting methods on different parameters of aman rice

Treatments	Effective tillers/hill	Panicle length (cm)	Total grains/ panicle (No.)	Filled grains/ panicle (No.)	Wt. of 1000 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
Planting materials:								
M_1	8.50	26.64	186.73	147.09	26.83	4.24	5.47	43.77
M_2	8.81	25.69	192.59	155.14	28.78	4.50	5.20	46.60
M_3	8.50	25.76	202.72	173.36	27.49	4.96	5.22	49.04
LSD $_{(0.05)}$	NS	0.72	13.13	12.81	1.30	0.15	NS	2.01
Varieties:								
V_1	8.57	25.66	191.08	156.84	27.08	4.43	5.19	46.04
V_2	8.64	26.40	196.94	160.22	28.32	4.70	5.40	46.89
LSD $_{(0.05)}$	NS	0.59	NS	NS	1.06	0.12	NS	NS
Planting methods:								
T_1	8.81	26.05	193.21	157.41	27.29	4.32	5.33	44.72
T_2	8.40	26.01	194.81	159.65	28.11	4.81	5.27	47.81
LSD $_{(0.05)}$	NS	NS	NS	NS	NS	0.12	NS	2.01
CV (%)	21.7	3.7	9.1	10.9	6.3	4.4	15.7	7.7

M_1- Sprouted seeds, M_2- Nursery seedlings, M_3- Clonal tillers; V_1- BR11, V_2- Sonar Bangla -1; T_1- Broadcast, T_2- Line

identical with recorded seeds. Dwivedi *et al.* (1996) found higher filled grains panicle^{-1} in nursery seedlings than sprouted seeds. The highest weight of 1000 grains (28.78 g) was obtained from the nursery seedlings followed by clonal tillers (27.43 g) and the lowest weight (26.83 g) was

obtained from sprouted seeds. But Xiang *et al.* (1999) found higher 1000 grains weight in sprouted seeds than transplanting seedling.

The highest grain yield (4.96 t ha^{-1}) was obtained with the clonal tillers followed by nursery seedlings (4.50 t ha^{-1}) and the lowest grain yield (4.24 t ha^{-1}) was obtained from sprouted seeds. The vegetative tillers were healthier and vigorous than their nursery or sprouted seeds that would have contributed to better growth followed by greater grain yield. Biswas and Salokhe (2001), Sharma (1992), Sharma (1994), Reddy and Ghosh (1987) and Sharma and Ghosh (1998) reported the higher grain yields of clonal tillers than nursery seedlings. The highest harvest index (49.04%) was found from the clonal tillers that was statistically similar with nursery seedlings and the lowest harvest index (43.77%) was with sprouted seeds. Such lower harvest index of nursery seedlings and sprouted seeds compared to clonal tillers might be due to their lower grain yield. Biswas (2001) observed higher harvest index in clonal tillers than nursery seedlings. Dwivedi *et al.* (1996) observed higher harvest index in transplanting than sprouted seeds but Sarkar *et al.* (2003) reported higher harvest index in sprouted seeds than nursery seedling.

Effect of varieties

There were no significant variation of effective tillers $hill^{-1}$, total grains $panicle^{-1}$, filled grains $panicle^{-1}$, straw yield and harvest index observed between the two varieties but hybrid variety showed higher panicle length, grain weight and grain yield compared to inbred variety (Table 2). The variety Sonar Bangla-1 gave the longer panicle (26.40 cm) compared to that of BR11 (25.66 cm). The highest weight of 1000 grains (28.32 g) was obtained from the hybrid variety and the lowest (27.08 g) was obtained from the inbred variety. The highest grain yield (4.70 t ha^{-1}) was obtained from the hybrid variety Sonar Bangla-1 and that was 4.43 t ha^{-1} from inbred variety BR11 (Mukta).

Effect of planting methods

There were no significant variations observed between the two planting methods for all the studied parameters except grain yield and harvest index (Table 2). Line arrangement resulted the higher grain yield (4.81 t ha^{-1}) than haphazard arrangement (4.32 t ha^{-1}). Rajkhowa and Gogoi (2004), BRRI (1981) and Rao *et al.* (1981) reported that row planting gave higher yield than haphazard transplanting. Venkatachalapathy and Veerabadran (2002) reported that row planting with drum seeder gave the higher yield but Rajkhowa. and Gogoi (2004), Anbumani *et al.* (2000), Roknuzzaman (1997), Ye and Ye (1997) and Varughese *et al.* (1993) found higher yield of rice in haphazard or broadcast method. Bordoloi *et al.* (1996) reported that there was no significant yield variation between the direct or line sowing method. The higher harvest index (47.81%) was found from the line sowing and the lower harvest index (44.72%) was at broadcast method.

Interaction of planting materials and varieties

Interaction effect of planting materials and varieties showed significant variations for all the studied parameters except effective tillers/hill and straw yield (Table 3). The highest panicle length (26.76 cm) was obtained from the sprouted seeds of hybrid variety and the lowest panicle length (25.18 cm) was obtained from the nursery seedlings of inbreed variety. The highest number of grains $panicle^{-1}$ (217.00), filled grains $panicle^{-1}$ (186.00) and grain yield (5.13 t ha^{-1}) were recorded in clonal tillers of hybrid variety. The lowest grain yield (3.99 t ha^{-1}) was observed in the sprouted seeds of inbred variety. The highest weight of 1000 grains (30.34 g) was obtained from the nursery seedling of hybrid variety and all other interactions showed almost similar grain weight. The highest straw yield (5.50 t ha^{-1}) was recorded in sprouted seeds of inbred variety and the lowest (5.00 t ha^{-1}) in nursery seedling of inbred variety. Irrespective of variety clonal tillers showed the highest range of harvest index (48.52 to 49.55%) that was statistically similar with nursery seedlings of inbred variety. The lowest harvest index (42.71%) was recorded in sprouted seeds of inbred variety.

Table 3. Interaction effect of planting materials and varieties on different parameters of aman rice

Treatments	Effective tillers/hill	Panicle length (cm)	Total grains/ panicle (No.)	Filled grains/ panicle (No.)	Wt. of 1000 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
M_1V_1	8.30	26.53	190.00	153.00	26.35	3.99	5.50	42.71
M_1V_2	8.70	26.76	167.00	144.00	27.32	4.29	5.45	44.83
M_2V_1	8.63	25.18	185.00	158.00	27.23	4.04	5.00	46.90
M_2V_2	9.00	26.20	188.00	153.00	30.34	4.32	5.40	46.29
M_3V_1	8.76	25.29	184.00	159.00	27.68	4.53	5.08	48.52
M_3V_2	8.23	26.24	217.00	186.00	27.31	5.13	5.35	49.55
LSD $_{(0.05)}$	NS	1.02	24.51	21.35	1.84	0.56	NS	5.72

M_1- Sprouted seeds, M_2- Nursery seedlings, M_3- Clonal tillers; V_1- BR11, V_2- Sonar Bangla -1

Interaction of planting materials and planting methods

Significant variations observed for the interaction of planting material and planting method in all the studied parameters except effective tillers hill^{-1} (Table 4). Highest panicle length (26.79 cm) was obtained from the sprouted seeds in broadcast method and the lowest panicle length (25.18 cm) was in clonal tillers with haphazard planting which was statistically similar with clonal tillers transplanted in line. The highest number of total grains panicle^{-1} (208.21), filled grains panicle^{-1} (178.59), grain yield (5.21 t ha^{-1}) and harvest index (50.53%) were recorded in clonal tillers with line planting but the highest weight of 1000 grains (29.83 g) was obtained from the nursery seedlings with line planting. The highest grain yield was followed by clonal tillers with haphazard planting that was identical with nursery seedlings with line planting and the lowest yield (3.77 t ha^{-1}) was found in sprouted seeds following broadcast sowing. The highest straw yield was recorded in sprouted seeds with broadcast method (4.59 t ha^{-1}) that was similar with all other interaction treatments except sprouted seeds sown in line (4.21 t ha^{-1}).

Table 4. Interaction effect of planting materials and planting methods on different parameters of aman rice

Treatments	Effective tillers/hill	Panicle length (cm)	Total grains/ panicle (No.)	Filled grains/ panicle (No.)	Wt. of 1000 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
M_1T_1	7.93	26.79	182.75	140.71	26.47	3.77	5.49	40.49
M_1T_2	9.08	26.50	191.90	142.63	27.19	4.19	4.21	46.35
M_2T_1	9.30	25.84	198.75	159.31	27.74	3.96	5.04	45.13
M_2T_2	8.33	25.54	182.98	142.44	29.83	4.59	5.11	46.56
M_3T_1	9.20	25.18	196.34	160.25	27.66	4.54	4.94	48.54
M_3T_2	7.80	26.00	208.21	178.59	27.32	5.21	5.15	50.53
LSD $_{(0.05)}$	NS	1.02	24.51	21.35	1.84	0.56	1.30	5.71

M_1- Sprouted seeds, M_2- Nursery seedlings, M_3- Clonal tillers; T_1- Broadcast, T_2- Line

Interaction effect of varieties and planting methods

Significant variations in filled grains panicle^{-1}, weight of 1000-grains, grain yield and harvest index was observed for the interaction of varieties and planting methods (Table 5). The highest number of filled grains panicle^{-1} (163.73) was recorded in hybrid variety planted in line and no significant variations of filled grains panicle^{-1} observed among the other three interactions.

Table 5. Interaction effect of varieties and planting methods on different parameters ofaman rice

Treatments	Effective tillers/hill	Panicle length (cm)	Total grains/ panicle (No.)	Filled grains/ panicle (No.)	Wt. of 1000 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
V_1T_1	8.78	25.73	193.90	158.11	26.32	4.26	5.14	45.38
V_1T_2	8.35	25.60	188.28	155.58	27.85	4.55	5.25	46.94
V_2T_1	8.83	26.38	192.53	156.71	28.26	4.37	5.52	43.89
V_2T_2	8.45	26.43	201.36	163.73	28.38	5.03	5.28	49.14
LSD $(_{0.05})$	NS	NS	NS	14.79	1.50	0.45	NS	4.66

V_1- BR 11, V_2- Sonar Bangla 1; T_1- Broadcast, T_2- Line

The highest weight of 1000-grains (28.38 g) was obtained from the hybrid variety with line sowing and it was statistically similar with the other interactions except of inbred variety under broadcast method that showed the lowest weight of 1000-grains (26.32 g). The highest grain yield (5.03 t ha^{-1}) and harvest index (49.14%) was observed in hybrid variety with line sowing method and the lowest grain yield (4.26 t ha^{-1}) followed BR 11 as broadcasted. The minimum harvest index (43.89%) was found in hybrid variety with broadcast method.

Interaction effect of planting materials, varieties and planting methods

All the studied parameters were significantly influenced by the interaction of planting materials, varieties and planting methods except effective tillers $hill^{-1}$ and straw yield (Table 6). Highest panicle length (27.05 cm) was obtained from the sprouted seeds of inbred variety as broadcasted and the lowest panicle length (25.20 cm) was obtained from the clonal tillers of inbred variety under haphazard planting. The highest number of total grains $panicle^{-1}$ (229.63) and filled grains $panicle^{-1}$ (200.50) were recorded in clonal tillers of hybrid variety in line sowing method followed by clonal tillers of hybrid variety under broadcast method. The lowest number of filled grains $panicle^{-1}$ (139.05) was obtained in sprouted seeds of hybrid variety as broadcasted. The highest weight of 1000-grains (30.73 g) was obtained from the nursery seedlings of hybrid variety transplanted in line and the lowest weight of 1000-grains (25.53 g) was obtained from the nursery seedling of inbred variety under haphazard planting.

Table 6. Interaction effect of planting materials, varieties and planting methods on different parameters of aman rice

Treatments	Effective tillers/ hill	Panicle length (cm)	Total grains/ panicle (No.)	Filled grains/ panicle (No.)	Wt. of 1000 grains (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
$M_1V_1T_1$	8.15	27.05	188.30	139.05	26.10	3.87	5.61	41.20
$M_1V_1T_2$	8.48	26.00	202.60	157.65	26.60	4.21	5.38	46.21
$M_1V_2T_1$	7.70	26.53	172.20	146.00	26.85	4.13	5.84	41.78
$M_1V_2T_2$	9.70	27.00	175.20	147.60	27.79	4.88	5.05	48.47
$M_2V_1T_1$	8.95	24.93	204.90	158.40	25.53	4.28	4.66	48.89
$M_2V_1T_2$	8.30	25.43	174.70	150.82	28.93	4.38	5.34	46.92
$M_2V_2T_1$	9.65	26.75	199.60	152.23	29.95	4.24	5.64	44.38
$M_2V_2T_2$	8.35	25.65	195.25	149.05	30.73	4.91	5.16	48.20
$M_3V_1T_1$	9.25	25.20	194.80	159.70	27.32	4.80	5.14	45.75
$M_3V_1T_2$	8.30	25.38	192.75	152.55	28.03	5.07	5.03	50.29
$M_3V_2T_1$	9.15	25.85	209.88	160.80	28.00	4.89	5.07	48.32
$M_3V_2T_2$	7.30	26.63	229.63	200.50	26.61	5.42	5.64	49.77
LSD $(_{0.05})$	NS	1.44	34.66	30.19	2.60	0.79	NS	8.09

M_1- Sprouted seeds, M_2- Nursery seedlings, M_3- Clonal tillers; V_1- BR 11, V_2- Sonar Bangla 1
T_1- Broadcast, T_2- Line

The clonal tillers of hybrid variety as line sown gave the highest grain yield (5.42 t ha^{-1}) followed by clonal tillers of inbred variety with line sowing method and it was statistically similar with sprouted seeds of hybrid variety under line sowing method. The lowest grain yield (4.13 t ha^{-1}) was observed in sprouted seeds of hybrid variety under broadcast method. Clonal tillers of inbred

variety as line sown produced the highest harvest index (50.29%) and the lowest harvest index (41.20%) was in sprouted seeds of inbred variety under broadcast method. The maximum grains panicle^{-1}, filled grains panicle^{-1}, grain yield and harvest index was found in clonal tillers compared to other planting materials. Nursery seedlings gave bigger seeds. The hybrid variety Sonar Bangla 1 showed longer panicles, higher grain weight and grain yield than inbred variety BR 11. Line planting method gave higher harvest index and grain yield than haphazard planting. Intraction effect of planting materials, varieties and planting methods showed the highest grain yield in clonal tillers of hybrid variety transplanted in line that followed by clonal tillers of inbred variety transplanted in line and the lowest yield was recorded in sprouted seeds of inbred variety transplanted haphazardly. Harvest index was highest in clonal tillers of inbred variety transplanted in line and the lowest harvest index in sprouted seeds of inbred variety sown in broadcast method.

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