Effect of number of seedlings per hill and fertilizer dose on yield and yield   attributes of advanced line and variety of rice

Z. Akhter, M.S.U. Bhuiya and M.N.H. Miah

Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202

Abstract: A field experiment was conducted at the experimental field of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during July to December 2008 following a randomized complete block design with three replications, to evaluate the effect of number of seedlings $hill^{-1}$ and fertilizer dose on the yield and yield attributes of two released *aman* varieties and an advance rice line. The experiment consisted of three varieties viz., Binadhan-7 (V_1), advanced rice line YS-1281 (V_2) and BRRI dhan32 (V_3); three levels of seedlings $hill^{-1}$ viz., two (S_1), four (S_2) and six (S_3) with two fertilizer doses viz., BARC (F_1) and BRRI recommended fertilizer dose (F_2). It was evident from the results that significant variations were observed in all varieties in respect of all growth parameters, yield and yield attributes. BRRI dhan32 produced the maximum panicle length (23.8 cm), grains $panicle^{-1}$ (96.1), weight of 1000-grain (24.96 g), grain yield (6.06 t ha^{-1}) and straw yield (7.32 t ha^{-1}). Number of seedlings $hill^{-1}$ with fertilizer dose significantly influenced all the characters except weight of 1000-grain and harvest index at maturity. Both grain (6.46 t ha^{-1}) and straw yield (6.57 t ha^{-1}) was highest with the treatment of four seedlings $hill^{-1}$ and BRRI recommended fertilizer dose and the lowest grain (5.30 t ha^{-1}) and straw yield (5.71 t ha^{-1}) was obtained from two seedlings $hill^{-1}$ with BRRI recommended fertilizer dose and four seedlings $hill^{-1}$ with BARC recommended fertilizer dose, respectively. Results revealed that among line/varieties, the highest grain yield (7.40 t ha^{-1}) was obtained from BRRI dhan32 when transplanted with 4 seedlings $hill^{-1}$ along with BRRI recommended fertilizer dose and the lowest grain yield (5.03 t ha^{-1}) was obtained from Binadhan-7 when transplanted with 2 seedlings $hill^{-1}$ and BRRI recommended fertilizer dose.
Key words: Rice, Variety, Seedlings $hill^{-1}$, Fertilizer.

Introduction

Rice is the staple food for the people of Bangladesh. It is the most important crop in Asia and Asia pacific. Asia as a whole contributes to about 92% of the world rice harvest (IRRI, 1995). About 40 % of the world's people consume rice as the main source of calories (Banik, 1999). The soil and climate of Bangladesh are favorable for rice cultivation throughout the year. In Bangladesh rice is extensively grown here as *aus, aman* and *boro* crops whereas *aman* rice covers a largest area of 9.82 million hectares and produce 12.84 million tons (AIS, 2008). The average yield of rice in Bangladesh is around 2.3 t ha^{-1} which is much below the potential yield and even much lower than other leading rice growing countries of the world. The reasons are varietal, cultural, economical and management practices. In Bangladesh, food deficit is increasing day by day at an alarming rate. To meet this challenge, food production needs to be increased. Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) released a number of varieties suitable for cultivation in one or more rice growing seasons of Bangladesh.

Number of seedlings is an important factor among the management practices. Excess number of seedlings $hill^{-1}$ may produce higher number of tillers $hill^{-1}$ resulting in mutual shading and lodging and thus favoring the production of straw instead of grain, while less number may cause insufficient use of space, nutrient utilization and tiller growth and at the end, total number of panicles $unit^{-1}$ area may be reduced resulting in poor yield. Therefore, it may be necessary to determine optimum number of seedlings $hill^{-1}$ for a particular variety or varieties which may be considered as an important means to increase the yield of transplant *aman* rice. Among the production factors affecting crop yield, fertilizer is the most important one that plays a dominant role in yield increase of rice. The problem of nutrient deficiency as well as lower nutrient content in crop field is caused by intensive cropping with high yielding varieties of rice. Imbalance use of both macro and micro nutrients results in malnutrition disorders, growth retardation and reduced yield. It is necessary to maintain balanced use of fertilizer for satisfactory yield of rice. Nutrients imbalance can be minimized by judicious application of different fertilizers. There is need to develop appropriate management technique to evaluate the performance and to assess the nutrient requirement for cultivation. A satisfactory yield of rice can be obtained if rice varieties are cultivated with appropriate number of seedlings $hill^{-1}$ and proper dose of fertilizer. With the above view in mind, the present piece of research work was undertaken to assess the yield performances of two released varieties and an advanced rice line by combining two management practices viz., number of seedlings $hill^{-1}$ and fertilizer dose and to recommend the suitable combination as well as variety for maximizing yield.

Materials and Methods

The experiment was conducted at the experimental field of BINA, Mymensingh during the period from July to December 2008 to study the effect of number of seedlings $hill^{-1}$ and fertilizer dose on the yield and yield attributes of two released *aman* variety and an advanced rice line. The land was medium high with silty loam in texture and more or less neutral in reaction. The organic matter and potassium contents of the soil are low. Two factors were included in the experiment, the first one was variety viz., Binadhan-7 (V_1), Advanced rice line YS-1281 (V_2), BRRI dhan32 (V_3) and the other one was the number of seedlings $hill^{-1}$ combined with fertilizer dose viz., 2 (S_1), 4 (S_2) and 6 (S_3) seedlings $hill^{-1}$ with BARC (F_1: 195, 75, 100, 70 and 8.4 Kg N, P, K, S and Zn ha^{-1}, respectively) and BRRI recommended fertilizer dose (F_2: 166, 62.5, 83, 56 and 7 Kg N, P, K, S and Zn ha^{-1}, respectively). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments were allocated randomly. The unit plot was 3.6 m² (2m x 1.8m). The seeds of the varieties were collected from BINA, Mymensingh. The seeds were sown in the wet seed bed on 2 August 2008. The unit plot were fertilized according to above mentioned fertilizer doses in the form of urea, triple super phosphate, muriate of potash, gypsum

and zinc sulphate, respectively. Thirty-day old seedlings according to seedling treatments were transplanted on 1 September 2008 following the planting spacing of 20 cm x 15 cm.

The data were recorded on two broad parameters viz., growth characters and yield components. Three hills from each plot from central 1m^2 area were randomly selected and tagged for taking data on growth parameters. The data were taken on plant height, number of total and effective tillers hill^{-1}, leaf weight, stem weight, panicle weight and leaf area at 60, 75 and 90 DAT to investigate the growth performance of the varieties. An area of 1 m x 1 m was selected at maturity in the middle of the plot and five hills were uprooted from that area at harvest for recording data on different crop and yield characters. The crop was harvested on 1 December 2008. Data on yield attributing characters including plant height, number of total and effective tillers hill^{-1} were recorded from five hills in each plot. Twenty panicles were randomly selected from the above five hills for taking data on panicle length, grains panicle^{-1}, sterile spikelets panicle^{-1}. Grain and straw yields and 1000-grain weight were taken from the harvest of twenty hills at maturity from the middle 1 m^2 area also. The grains were cleaned and its dry weights as well as dried straw weight were taken by weighting in a balance. The grain weight was adjusted at 14% moisture content. From these data of grain and straw per plot yield were calculated and finally converted as t ha^{-1}.

Finally the data were tabulated in proper form and were analyzed statistically with the help of computer package MSTAT-C program. The mean differences among the treatments were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Variety had significant effect on all yield and yield contributing characters at maturity. The highest plant height (107.7 cm) was produced by BRRI dhan32 and the lowest (84.4 cm) was produced by the advanced rice line YS-1281. Higher number of total (11.2) and effective (10.8) tillers hill^{-1} were obtained from BRRI dhan32 which were statistically similar to Binadhan-7 (10.8 and 10.4, respectively) and lower number of total (9.6) and effective (9.5) tillers hill^{-1} was obtained from advanced rice line YS-1281. Hossain et al. (1990) and Chowdhury et al. (1993) noticed that number of total and effective tillers hill^{-1} differed among the varieties. The variation in number of total and effective tillers hill^{-1} might be due to genetic differences and inherent capacity of the varieties along with environmental conditions of the experimental sites. Maximum number of grains panicle^{-1} (96.1) was obtained from BRRI dhan32 and the minimum (76.5) was obtained from advanced rice line YS-1281. Maximum number of sterile spikelets panicle^{-1} (34.4) was recorded from advanced rice line YS-1281 and the minimum (18.0) was obtained from Binadhan-7. Chowdhury et al. (1993) observed that number of sterile spikelets panicle^{-1} differed due to varietal differences. This might be due to genetic make up of the varieties.

Table 1. Mean effect of variety on different yield and yield attributing characters at maturity

Variety	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	Total spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	HI (%)
V$_1$	87.6b	10.8a	10.4a	21.7c	82.7b	18.0c	100.7c	23.49b	5.98ab	5.34b	52.88a
V$_2$	84.4c	9.6b	9.5b	22.4b	76.5c	34.4a	110.9b	21.83c	5.18b	5.41b	49.03b
V$_3$	107.7a	11.2a	10.8a	23.8a	96.1a	20.0b	116.0a	24.96a	6.06a	7.32a	45.13c
CV (%)	5.49	10.77	2.86	13.51	2.63	3.74	4.82	5.62	3.54	6.89	3.91
Level of sig.	**	**	**	**	**	**	**	**	**	**	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), CV = Co-efficient of variation, ** = Significant at 1% level of probability, V$_1$= Binadhan-7; V$_2$= Advanced rice line YS-1281; V$_3$= BRRI dhan32

The highest number of total spikelets panicle^{-1} (116.0) was obtained from BRRI dhan32 and the lowest number (100.7) was obtained from Binadhan-7. The maximum 1000-grain weight (24.96 g) was produced by BRRI dhan32 and the minimum (21.83 g) was produced by advanced rice line YS-1281. The highest grain yield (6.06 t ha^{-1}) was obtained from BRRI dhan32 which was statistically similar to Binadhan-7 (5.98 t ha^{-1}). BRRI dhan32 also gave maximum straw yield (7.32 t ha^{-1}). The lowest grain (5.18 t ha^{-1}) and straw yield (5.34 t ha^{-1}) were obtained from advanced rice line YS-1281 and Binadhan-7, respectively. Higher harvest index (52.88 %) was obtained from Binadhan-7 and lower (52.88 %) was obtained from BRRI dhan32 (Table 1).

Seedlings hill^{-1} with fertilizer dose had significant influence on all yield characters except 1000-grain weight and harvest index. The maximum plant height (96.2 cm) was obtained from 4 seedlings hill^{-1} with BARC recommended fertilizer dose and the minimum (90.2 cm) was obtained from 6 seedlings hill^{-1} with BRRI recommended fertilizer dose. The maximum number of total (11.6) and effective (11.3) tillers hill^{-1} was obtained from 6 seedlings hill^{-1} with BRRI recommended fertilizer dose which was statistically similar to 6 seedlings hill^{-1} with BARC recommended fertilizer dose (11.2 and 10.9, respectively) and the minimum number of total (9.3) and effective (9.0) tillers hill^{-1} was obtained from 2 seedlings hill^{-1} with BARC recommended fertilizer dose. This result agreed with the findings of Inaba et al. (2005) and Obulamma et al. (2002), who found that the number of total and effective tillers hill^{-1} increased with the increase of plant population density. The maximum number of grains panicle^{-1} (95.1) was recorded with 4 seedlings hill^{-1} when BRRI recommended fertilizer dose was applied and the minimum number of grains panicle^{-1} (80.3) was recorded with 6 seedlings hill^{-1} when BRRI recommended fertilizer dose was applied which was similar to 6 seedlings hill^{-1} when BARC recommended fertilizer dose

(80.0) was applied. The highest number of sterile spikelets panicle[-1] (28.4) was recorded with 2 seedlings hill[-1] when BRRI recommended fertilizer dose was applied and the lowest number of sterile spikelets panicle[-1] (21.0) was recorded with 4 seedlings hill[-1] when BRRI recommended fertilizer dose was applied. The highest number of total spikelets panicle[-1] (116.1) was recorded with 4 seedlings hill[-1] when BRRI recommended fertilizer dose was applied and the lowest number of total spikelets panicle[-1] (104.0) was recorded with 6 seedlings hill[-1] when BARC recommended fertilizer dose was applied which was similar to 6 seedlings hill[-1] when BRRI recommended fertilizer dose (104.2) was applied. The maximum 1000-grain weight (23.60 g) was recorded from 4 seedlings hill[-1] with BRRI recommended fertilizer dose and the minimum 1000-grain weight (23.28 g) was recorded with 6 seedlings

hill[-1] with BARC recommended fertilizer dose. The highest grain yield (6.46 t ha^{-1}) was obtained from 4 seedlings hill[-1] with BRRI recommended fertilizer dose and the lowest (5.30 t ha^{-1}) was obtained from 2 seedlings hill[-1] with BRRI recommended fertilizer dose which were statistically similar to 2, 4 and 6 seedlings hill[-1] when BARC recommended fertilizer dose (5.83 t ha^{-1}, 5.64 t ha^{-1} and 5.61 t ha^{-1}, respectively) and also 6 seedlings hill[-1] when BRRI recommended fertilizer dose (5.87 t ha^{-1}) were applied. This result agreed with that of Hasan *et al*. (2005). The highest straw yield (6.57 t ha^{-1}) was obtained from 4 seedlings hill[-1] with BRRI recommended fertilizer dose and the lowest straw yield (5.71 t ha^{-1}) was obtained from 4 seedlings hill[-1] with BARC recommended fertilizer dose which were statistically similar to 6 seedlings (Table 2).

Table 2. Effect of seedlings hill[-1] with fertilizer dose on different yield and yield attributing characters at maturity

Treatment (Fertilizer dose × seedlings hill[-1])	Plant height (cm)	Total tillers hill[-1]	Effective tillers hill[-1]	Panicle length (cm)	Grains panicle[-1]	Sterile spikelets Panicle[-1]	Total spikelets panicle[-1]	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	HI (%)
S_1F_1	93.5bc	9.3d	9.0d	22.1c	83.1c	23.3c	106.4d	23.43	5.83b	6.23ab	48.67
S_2F_1	96.2a	10.3bcd	10.0bcd	23.3a	88.9b	24.0b	112.9b	23.53	5.64b	5.71b	50.05
S_3F_1	92.2c	11.2ab	10.9ab	22.3bc	80.0d	24.0b	104.0e	23.28	5.61b	5.84b	49.15
S_1F_2	93.1bc	9.9cd	9.6cd	22.2bc	83.1c	28.4a	111.6c	23.41	5.30b	5.99b	47.47
S_2F_2	94.2b	10.8abc	10.5abc	23.4a	95.1a	21.0d	116.1a	23.60	6.46a	6.57a	49.55
S_3F_2	90.2d	11.6a	11.3a	22.5b	80.3d	23.9b	104.2e	23.30	5.60b	5.82b	49.23
CV (%)	5.49	10.77	2.86	13.51	2.63	3.74	4.82	5.62	3.54	6.89	3.91
Level of sig.	**	**	**	**	**	**	**	NS	**	*	NS

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), CV = Co-efficient of variation, * = Significant at 5% level of probability; ** = Significant at 1% level of probability; NS = Not significant, S_1= 2 seedlings hill[-1]; S_2= 4 seedlings hill[-1]; S_3= 6 seedlings hill[-1], F_1= BARC recommended fertilizer dose; F_2= BRRI recommended fertilizer dose

The results of the experiment showed that the interaction between variety and combination of seedlings hill[-1] with fertilizer dose had no significant influence on plant height, total tillers, 1000- grain weight, straw weight hill[-1] and straw yield ha^{-1}. However, the maximum plant height (109.0) was obtained from BRRI dhan32 with 4 seedlings hill[-1] and BARC recommended fertilizer dose and the minimum plant height (81.0) was obtained from advanced rice line YS-1281 with 6 seedlings hill[-1] and BRRI recommended fertilizer dose. BRRI dhan32 transplanted with 6 seedlings hill[-1] and BRRI recommended fertilizer dose resulted in maximum number of total tillers hill[-1] (12.2) and the minimum number (8.2) was obtained from advanced rice line YS-1281 transplanted with 2 seedlings hill[-1] and BARC recommended fertilizer dose. BRRI dhan32 and advanced rice line YS-1281 transplanted with 6 seedlings hill[-1] and BRRI recommended fertilizer dose resulted in maximum number of effective tillers hill[-1] (11.3) and the minimum number of effective tillers hill[-1] (8.1) was obtained from advanced rice line YS-1281 transplanted with 2 seedlings hill[-1] and BARC recommended fertilizer dose. The highest panicle length (25.0 cm) was obtained from BRRI dhan32 when treated with 4 seedlings hill[-1] with BRRI recommended fertilizer dose and the lowest panicle length (21.1 cm) was obtained from Binadhan-7 when treated with 6 seedlings hill[-1] and BARC recommended fertilizer dose. The result indicated that, among three varieties the highest number of grains panicle[-1] (107.3) was obtained from BRRI dhan32 when

treated with 4 seedlings hill[-1] and BRRI recommended fertilizer dose and the lowest number of grains panicle[-1] (72.3) was obtained from advanced rice line YS-1281 when treated with 6 seedlings hill[-1] and BARC recommended fertilizer dose. The highest number of sterile spikelets panicle[-1] (37.0) was obtained from advanced rice line YS-1281 when treated with 6 seedlings hill[-1] along with both BARC and BRRI recommended fertilizer dose and the lowest sterile spikelets panicle[-1] (10.0) was obtained from Binadhan-7 when treated with 2 seedlings hill[-1] and BARC recommended fertilizer dose. The highest number of total spikelets panicle[-1] (121.3) was obtained from BRRI dhan32 when treated with 4 seedlings hill[-1] and BRRI recommended fertilizer dose and the lowest number of total spikelets panicle[-1] (91.0) was obtained from Binadhan-7 when treated with 6 seedlings hill[-1] and BRRI recommended fertilizer dose and also with 2 seedlings hill[-1] and BARC recommended fertilizer dose. Among the three varieties BRRI dhan32 produced maximum 1000-grain weight (25.20 g) when treated with 4 seedlings hill[-1] and BRRI recommended fertilizer dose and advanced rice line YS-1281 produced the minimum (21.60 g) when treated with 6 seedlings hill[-1] and BARC recommended fertilizer dose. The highest grain yield (7.40 t ha^{-1}) was obtained from BRRI dhan32 when treated with 4 seedlings hill[-1] and BRRI recommended fertilizer dose and the lowest (5.03 t ha^{-1}) was obtained from Binadhan-7 when treated with 2 seedlings hill[-1] and BRRI recommended fertilizer dose . The reasons for variation in

grain yield was due to variation in production of total tillers, effective tillers, grains panicle[-1] and 1000-grain weight which were again influenced by heredity and management practice like number of seedlings hill[-1] and fertilizer doses. Similar results were also obtained by Hossain *et al.* (1991). The highest straw yield (7.80 t ha^{-1}) was obtained from BRRI dhan32 when treated with 2 seedlings hill[-1] and BARC recommended fertilizer dose and the lowest straw yield (4.74 t ha^{-1}) was obtained from Binadhan-7 when treated with 4 seedlings hill[-1] and BARC recommended fertilizer dose (Table 3).

From the above results, it can be stated that BRRI dhan32 showed better performance over Binadhan-7 and advanced rice line YS-1281 and use of 4 seedlings hill[-1] with BRRI recommended fertilizer dose appeared to the best for higher number of effective tillers hill[-1], grains panicle[-1], 1000-grain weight and these factors ultimately produced the highest grain yield. Therefore, it can be inferred from the results of this study that the variety BRRI dhan32 could be cultivated for the highest grain yield from a combination of 4 seedlings hill[-1] with BRRI recommended fertilizer dose (7.40 t ha^{-1}). Further trials are necessary to confirm the present findings.

Table 3. Effect of interaction of variety and combination of seedlings hill[-1] with fertilizer dose on yield and yield contributing characters at maturity

Interaction		Plant height (cm)	Total tillers hill[-1]	Effective tillers hill[-1]	Panicle length (cm)	Grains panicle[-1]	Sterile spikelets panicle[-1]	Total spikelets panicle[-1]	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	HI (%)
V_1	S_1F_1	87.5	9.7	9.3	21.3gh	81.0g	10.0n	91.0k	23.50	6.40b	5.62	53.23abc
	S_2F_1	90.5	10.8	10.2	22.3def	81.7g	27.0e	108.7i	23.60	6.37b	4.74	57.57a
	S_3F_1	86.9	11.2	11.0	21.1h	78.0h	14.0l	92.0k	23.37	5.50cde	5.18	51.37bcd
	S_1F_2	87.5	10.4	10.1	21.9efg	80.7g	26.0f	106.7j	23.50	5.03ef	5.23	49.53b-f
	S_2F_2	88.5	11.1	10.4	22.0ef	97.0c	18.0k	115.0d	23.60	6.50b	5.99	51.97bcd
	S_3F_2	84.6	11.3	11.1	21.3gh	78.0h	13.0m	91.0k	23.40	6.07bc	5.26	53.60c-g
V_2	S_1F_1	84.4	8.2	8.1	21.8fg	76.0i	35.0c	111.0ef	21.90	5.50cde	5.30	50.97b-f
	S_2F_1	89.2	8.9	8.9	23.0bc	79.0h	31.0d	110.0fgh	22.00	4.70f	5.21	47.60b-e
	S_3F_1	82.6	10.4	10.4	22.4de	72.3j	37.0a	109.3hi	21.60	4.90ef	5.11	48.87d-h
	S_1F_2	84.1	8.7	8.3	21.4gh	75.7i	35.3b	111.0ef	21.80	5.37c-f	5.26	50.60b-f
	S_2F_2	85.4	9.9	9.9	23.2bc	81.0g	31.0d	112.0e	22.00	5.47cde	6.28	46.77d-h
	S_3F_2	81.0	11.3	11.3	22.7cd	75.0i	37.0a	112.0e	21.67	5.17def	5.30	49.37b-f
V_3	S_1F_1	108.5	9.9	9.7	23.1bc	92.3d	25.0g	117.3c	24.90	5.60cde	7.80	41.77h
	S_2F_1	109.0	11.1	10.8	24.7a	106.0b	14.0l	120.0b	25.00	5.87bc	7.14	45.03e-h
	S_3F_1	107.1	12.0	11.2	23.2bc	89.7e	21.0j	110.7fg	24.87	6.43b	7.19	47.17d-h
	S_1F_2	107.6	10.6	10.4	23.5b	93.0d	24.0h	117.0c	24.93	5.50cde	7.51	42.27gh
	S_2F_2	108.8	11.4	11.1	25.0a	107.3a	14.0l	121.3a	25.20	7.40a	7.42	49.90b-f
	S_3F_2	105.1	12.2	11.3	23.3bc	88.0f	21.7i	109.7ghi	24.83	5.57cde	6.89	44.67fgh
CV (%)		5.49	10.77	2.86	13.51	2.63	3.74	4.82	5.62	3.54	6.89	3.91
Level of sig.		NS	NS	**	**	**	**	**	NS	**	NS	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), CV = Co-efficient of variation; ** = Significant at 1% level of probability; NS = Not significant, V_1= Binadhan-7; V_2= Advanced rice line YS-1281; V_3= BRRI dhan32, S_1= 2 seedlings hill[-1]; S_2= 4 seedlings hill[-1]; S_3= 6 seedlings hill[-1]

References

AIS (Agriculture Information Service). 2008. Krishi Diary. Agric. Info. Service. Khamarbari, Farmgate, Dhaka. pp. 10-15.

Banik, P. 1999. Cool injury problem in *boro* rice. In Proc. of the Workshop on Modern Rice Cultivation in Bangladesh. Bangladesh Rice Res. Inst. Joydebpur, Gazipur, Bangladesh. 14-16.

Chowdhury, M. J. U., Sarker, A. U., Sarkar, M. A. R. and Kashem, M. A. 1993. Effect of variety and number of seedlings hill[-1] on the yield and its components on late transplant *aman* rice. Bangladesh J. Agric. Sci. 20(2): 311-316.

Gomez., K. A. and Gomez. A. A. 1984. Duncan's Multiple Range Test. Statistical Procedures for Agricultural Research. 2nd Edn. A Wiley inter-Science Publication, John Wiley and Sons, New York. pp. 212-215.

Hasan, A, K., Anwar, M. P. and Rashid, M. H. 2005. Response of late transplant cv. BR23 to planting geometry and number of seedlings hill[-1]. Bangladesh J. Crop. Sci. 16 (1): 123-127.

Hossain, M. M. and Haque, M. Z. 1990. Seedling age and density effect on basal tiller survival and yield of transplant deep water rice. Bangladesh J Agril. Sci. 12 (2): 67-72.

Hossain, S. M. A., Alam, A. B. M. and Kashem, M. A. 1991. Performance of different varieties of *boro* rice. In: Fact Searching and Intervention in Two FSRDP Sites. Activities 1989-90. Farming Syst. Res. And Dev. Prog., Bangladesh Agril. Univ., Mymensingh. pp. 19-20.

Inaba, K., Kitano, M. 2005. Effect of number of seedlings hill[-1] on rice tillering. Japanese Journal of Crop Science. 2005. 74 (2): 141-148.

IRRI (International Rice Research Institute). 1995. Annual Report for 1994. Intl. Rice Res. Inst. Los Banos, Laguna, Philippines. pp. 179-181.

Obulamma, U., Reddeppa, R. and Reddy, R. 2002. Effect of spacing and seedling number on growth and yield of hybrid rice. Indian J. Res. ANGRAU. 30 (1): 76-78.