J. Agrofor. Environ. 4 (2): 177-180, 2010 ISSN 1995-6983

Effect of variety, number of seedling hill^{-1} and fertilizer application on the growth and yield of fine rice under late transplanted condition

A.A. Mamun, M.A.R. Sarkar and F.M. J. Uddin
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from 31 September to 21 December 2009 to examine the effect of variety, number of seedling hill^{-1}, fertilizer application and their interactions under late transplanted condition. The experiment included three rice varieties viz. BRRI Dhan34, Ukunmadhu and Kataribhog, three levels of seedlings hill^{-1} viz. 2, 4 and 6 and two recommended doses of urea fertilizer viz. Prilled Urea and Urea Super Granule. It was laid out in three factor randomized complete block design (RCBD) with three replications. Variety, number of seedlings hill^{-1}, recommended dose of urea fertilizer and their interactions exerted significant influence on almost all the crop characters. Yield increased with increasing number of seedlings hill^{-1} up to four seedlings hill^{-1} and application of recommended dose (1.8g) of USG fertilizer for all varieties with the improvement of yield contributing characters. Kataribhog was found significantly superior to Ukunmadhu and BRRI Dhan34 with respect to plant height, panicle length, fertile grains panicle^{-1}, grain yield, straw yield and biological yield. The highest number of total tillers hill^{-1}, number of effective tillers hill^{-1}, weight of 1000 grains, grain yield, biological yield and harvest index were found in the crop with 4 seedlings hill^{-1}. The highest plant height, number of total tillers hill^{-1}, leaf area, leaf dry weight, effective tillers hill^{-1}, panicle length, grains panicle^{-1}, unfilled spikelets panicle^{-1}, weight of 1000 grains, straw yield, biological yield and harvest index were produced when recommended dose (1.8g) of Urea Super Granules (USG) was applied. Among the three varieties Kataribhog produced higher grain yield (2.90 t ha^{-1}) compared to other two varieties. The number of seedlings hill^{-1} had significant effect on grain yield. The highest grain yield (3.30 t ha^{-1}) was obtained in four seedlings hill^{-1}. Between two urea fertilizer levels significantly higher grain yield (3.25 t ha^{-1}) was obtained from recommended dose (1.8g) of Urea Super Granule (USG) application. The highest grain yield (4.22 t ha^{-1}) was obtained from the interaction of Kataribhog with six seedlings hill^{-1} and recommended dose (1.8g) of USG fertilizer.
Key words: Variety, number of seedling hill-1, fertilizer, growth, yield.

Introduction

Globally, rice (*Oryza sativa L.*) ranks second, wheat being the first one, in terms of area but as food rice is important since it provides more calorie than any other cereal. Rice is one of the most extensively cultivated cereals of the world and it is feeding one-half of the world's total population. Among the cereals, it ranks first in Bangladesh. Bangladesh earns about 23.46% of her GDP from agriculture (Kiron, 2003). So the national economy and general welfare of the country are largely depending on sound development of agriculture. About 40% of the world's population consumes rice as a major source of calorie (Banik *et al*. 1997). Among the major rice growing countries of the world, Bangladesh ranks third in respect of growing area and fourth in production **(**Huke and Huke, 1990).

There are many rice varieties grown in Bangladesh. Some of these have some good quality like fineness, aroma, taste and protein content (Kaul *et al.* 1982). The size of the rice grain are categorized into coarse and fine. The productivity of fine rice is very low (Chander and Jitendra, 1996). But the fine quality rice has more demand in both internal and external trade markets. For example, Basmati (aromatic) rice has extremely high demand in the world and occupies a unique place in the world rice market (Sood, 1978). The major fine rice varieties are BRRI dhan34, Ukunmadhu, Kataribhog, Kalizira, Chinigura, BR5, Bashful, BRRI dhan37, BRRI dhan38, Khaskani, Badshabhog, Dudshagor, Tulsimala, Khirshabhog, Horibhog, Parbatjira, Khasha, Modhumadab, Tilkapur, Chinikanai, Khirkon, Shakhorkora etc., of which Kataribhog, Basmati, Kalizira and BRRI dhan34 have high demand in home and abroad. Fine rice is a high value crop because of having small grain, pleasant aroma, higher price and taste.

Bangladesh has bright prospect for export of these fine rice thereby earning foreign exchange. The yield of fine rice is lower than that of coarse and medium rice. The reason for low yield is mainly associated with lack of improved varieties and judicious fertilizer management especially inorganic fertilizer like Urea Super Granules (USG), Prilled Urea (PU) etc. Selection of potential of variety, planting of appropriate number of seedlings hill^{-1} and application of optimum amount of nutrient elements can play an important role to increase yield.

Seedlings hill^{-1} is an important practice for the growth and yield of fine rice. The number of tillers and their growth are greatly affected qualitatively and quantitatively by number of seedlings hill^{-1}. Optimum number of seedlings hill^{-1} may enable the rice plants to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, nutrient, space and water and could reduce seedling cost of the farmer. The excess number of seedlings hill^{-1} may produce higher number of tillers hill^{-1} resulting in shading, lodging and thus favour the increased production of straw instead of grain. While less number of seedlings hill^{-1} may cause insufficient tiller growth and thus keeping space and nutrient unutilized in soil. At the end total number of panicles m^{-2} will be reduced resulting in poor yield.

Nitrogen losses are a problem in cultivation of rice in Bangladesh during transplanted aman season. So, the practical method of more efficient use of urea is needed. Modified urea fertilizers are designed to control one or more types of N loss to which ordinary urea is commonly susceptible. To minimize the losses of nitrogen, the slow release of nitrogen fertilizers have been advocated with deep placement. Slow release nitrogenous fertilizers dissolve slowly in the soil providing a steady supply of available nitrogen throughout the growing period of the crop. It is known that the response of crops to nitrogen varies due to variety. So, extensive researches are necessary to find out appropriate variety and different forms of urea fertilizers and mode of its application under rainfed situation. The superiority of USG, a slow release nitrogenous fertilizer over conventional urea is not yet

well established especially under irrigated or rainfed conditions in Bangladesh. A suitable combination of variety and rate of nitrogen is necessary for better yield. Though there is a heavy demand of aromatic fine rice in the world, enough information on their varietal performance and nitrogen response are sporadic and scattered.

Cultivation of fine rice is becoming popular due to its remunerative prices and huge export potentialities (Gangaiak and Prasad, 1999). Fine rice varieties are preferred by some consumers despite of their higher price and lower yield (Ratho, 1984). For maximizing the yield, combination of proper varieties with appropriate seedling number hill-1 is important.

Therefore, the experiment was undertaken to find out suitable variety, number of seedlings hill-1 and appropriate dose of prilled urea or urea super granules under late transplanted condition for higher yield.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the period from September to December 2009. The experiment was laid out in three factor randomized complete block design (RCBD) with three replications. Total unit plots were 54. The unit plot size was 10 m^2 (4m x 2.5m). . The experiment included three rice varieties viz. BRRI Dhan34, Ukunmadhu and Kataribhog, three levels of seedlings $hill^{-1}$ viz. 2, 4 and 6 and two recommended doses of urea fertilizer viz. Prilled Urea and Urea Super Granule. The selected land was first opened with power tiller on 15 September 2009. After one week the land was further ploughed and cross ploughed with country plough and followed by laddering on 23 September 2009 to get a good puddled condition. The puddled field was laid out according to the experimental design adopted. The bunds around individual plot were made firm enough to control water movement between plots. Individual plots were prepared by cleaning off weeds and stubble with the help of spade. Puddling and leveling were also done thoroughly before their specified date of transplanting. Final Puddling was completed one day before the scheduled date of transplanting. Chemical fertilizers were applied at the rate of 60 kg P_2O_5, 40 kg K_2O, 60 kg gypsum and 10 kg zinc sulphate ha^{-1}. The whole amounts of TSP, MP, gypsum and zinc sulphate were applied at the time of final land preparation. Prilled Urea at 80 kg N ha^{-1} was top dressed in 3 equal installments at 15, 30 and 45 days after transplanted (DAT) and Urea Super Granule (1.8g) was applied in the middle of 4 hills of two adjacent rows at the time at 15 DAT (Days after Transplanting).The intercultural operations viz. gap filling, weeding, and p est management were done as and when necessary. The soil was kept moist throughout the growth stage. Flood irrigation was given to the field and on the following day (after over night stay) the excess standing water was expelled out from the crop field to kept the soil at moist condition. Data were collected two times before harvest and after harvest of rice.

Five hills were randomly selected two weeks after transplanting and marked with bamboo sticks in each plot excluding border rows to record the data on plant height and number of tillers $hill^{-1}$ at 15 day intervals beginning on 30 DAT up to harvesting. For weight of dry matter, 2 hills $plot^{-1}$ were uprooted at 15-day intervals beginning on 30 DAT up to harvesting. finally data on crop characters, yield components and yield were collected at harvest. Data recorded for different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance (ANOVA) was done with the help of computer package MSTAT. The mean differences among the treatment were adjudged by Duncan's Multiple Range test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

There were significant effects of variety on all most all crop characters studied at harvest. The highest plant height (129.17cm), panicle length (26.88cm), fertile grains $panicle^{-1}$ (185.11), Grain yield (2.90t ha^{-1}) Straw yield (3.71 t ha^{-1}) and biological yield (6.61 t ha^{-1}) were produced by Kataribhog variety. The highest total number of tillers $hill^{-1}$ (14.59), effective tillers $hill^{-1}$ (11.86), weight of 1000-grain (14.41g) and harvest index (46.91%). The highest number of non effective tillers $hill^{-1}$ (3.34) and number of sterile spikelets $panicle^{-1}$. The probable reasons for variation in yield might be due to their genetic variation between the varieties. Alam (1988) and Ahmed (1987) reported that a variety could give high yield even with finer grain size if they have genetic potentiality (Table 1).

The result revealed that number of seedlings $hill^{-1}$ had significant effect at 1% level of probability on all crop character except weight of 1000-grain and straw yield. The highest total number of tillers $hill^{-1}$ (15.59), number of effective tillers $hill^{-1}$ (12.41), weight of 1000-grain (11.83g), grain yield (3.30 t ha^{-1}) and harvest index (51.79%) were produced at four seedlings $hill^{-1}$. The highest plant height (117.28cm), panicle length (25.43cm), number of fertile grains $panicle^{-1}$ (170.61) and straw yield (3.40 t ha^{-1}) were produced at two seedlings $hill^{-1}$. Incase of six seedlings $hill^{-1}$ the highest number of non effective tillers $hill^{-1}$ (3.44) and number of sterile spikelets $panicle^{-1}$ (38.62). Grain yield increased due to increase in the number of seedlings $hill^{-1}$ and thereafter declined. BINA (1993), Prasad *et al.* (1992) and Ahmed *et al.* (1972) reported similar results (Table 2).

Results showed that all the plant characters had significant effect at 1 % level of probability. The performance of recommended dose (1.8g) of Urea Super Granules (USG) on all crop characters was higher than Prilled Urea (PU) at all times. The highest plant height (118.41cm), total number of tillers $hill^{-1}$ (14.54), number of effective tillers $hill^{-1}$ (11.50), panicle length (25.17cm), number of fertile grains $panicle^{-1}$ (168.12), number of sterile spikelets $panicle^{-1}$ (35.65), weight of 1000-grain (11.90g), Grain yield (3.25 t ha^{-1}), Straw yield (3.63 t ha^{-1}), biological yield (6.88 t ha^{-1}) , and harvest index (47.92%) were produced when Urea Super Granule (USG) was applied. Only number of non effective tillers $hill^{-1}$ (3.15) was

highest incase of Prilled Urea applied. Probably the slow release property and deep placement of USG was responsible for this better performance. This view is also in agreement with the findings of Islam and Black (1998), Bhardwaj and Singh (1993), Bhuiyan (1991), Chauhan and Mishra (1989), Patra and Padhi (1989), Lal *et al*. (1988) and Kishnappa *et al*. (1986) (Table 3).

Table 1. Effect of variety on the growth and yield of fine rice

Variety	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Fertile grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1	111.43b	14.22	10.93b	3.34a	24.86b	161.75b	41.30a	10.23b	2.25b	2.69b	4.94b	46.50ab
V_2	107.90c	14.59	11.86a	2.84b	22.61c	137.82c	34.65b	14.41a	2.75ab	3.11ab	5.86ab	46.91a
V_3	129.17a	14.51	11.47ab	3.14ab	26.88a	185.11a	30.55c	10.79b	2.90a	3.71a	6.61a	45.44b
S(x)	0.30	0.20	0.19	0.07	0.06	0.88	0.67	0.04	0.08	0.13	0.15	0.92
Level of sig.	**	NS	**	**	**	**	**	**	**	**	**	**

In a column, figurers with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT; * = Significant at 5% level of probability. ** = Significant at 1% level of probability,NS = Not significant, V_1 = BRRI dhan34, V_2 = Ukunimadhu,V_3 = Kataribhog

Table 2. Effect of number of seedlings hill^{-1} on the growth and yield of fine rice

No. of seedling	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Fertile grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
S_1	117.28a	13.57c	10.93b	2.74b	25.43a	170.61a	36.15b	11.78	2.22b	3.40	5.62b	41.52c
S_2	116.33ab	15.39a	12.41a	3.14ab	23.99b	149.31c	31.72c	11.83	3.30a	3.04	6.35a	51.79z
S_3	114.89b	14.37b	10.91b	3.44a	24.93ab	164.77b	38.62a	11.82	2.38b	3.07	5.45b	45.54b
S(x)	0.30	0.20	0.19	0.07	0.06	0.88	0.67	0.04	0.08	0.13	0.15	0.92
Level of sig.	**	**	**	**	**	**	**	NS	**	NS	**	**

In a column, figurers with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, * = 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}

Table 3. Effect of urea fertilizer on the growth and yield of fine rice

Urea fertilizer	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Fertile grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
U_0	113.92	14.34	11.33	3.15	24.39	155.01	35.35	11.72	2.02	2.71	4.73	44.64
U_1	118.41	14.54	11.50	3.07	25.17	168.12	35.65	11.90	3.25	3.63	6.88	47.92
S(x)	0.24	0.16	0.15	0.05	0.05	0.71	0.54	0.03	0.06	0.10	0.12	0.75
Level of sig.	**	**	**	**	**	**	**	**	**	**	**	**

In a column, figurers with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant, U_0 = Recommended dose of Prilled Urea, U_1 = Recommended dose of Urea Super Granules (1.8g)

Table 4. Interaction effect of varieties and number of seedlings hill^{-1}on and urea fertilizer the growth and yield of fine rice

Interaction (V×S×U)	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Fertile grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
$V_1 \times S_1 \times U_0$	105.67i	12.33e	9.20h	3.13	24.70e	155.80gh	34.68b-e	10.13	1.04f	3.00	4.04	33.94e
$V_1 \times S_1 \times U_1$	114.9e	13.33cde	11.00def	2.33	26.13c	173.93d	46.21a	10.11	2de	3.58	5.58	39.48cde
$V_1 S_2 \times U_0$	110.79f	16.00ab	12.33a-d	3.67	25.07e	166.13e	47.85a	10.21	2.15d	2.25	4.4	49.15ab
$V_1 \times S_2 \times U_1$	115.57e	13.20cde	9.40gh	3.80	25.47d	173.37d	46.67a	10.25	2.58d	2.58	5.16	49.96ab
$V_1 \times S_3 \times U_0$	113.37e	16.00ab	12.53abc	3.80	24.83e	159.01fg	46.53a	10.28	2.11d	1.83	3.95	52.36a
$V_1 \times S_3 \times U_1$	108.30gh	14.47bcd	11.13c-f	3.33	22.93g	142.27j	25.85fg	10.38	3.61bc	2.92	6.53	54.09a
$V_2 \times S_1 \times U_0$	104.87i	12.93de	10.20fgh	2.73	23.07g	148.45i	38.59b	14.31	1.46ef	3.33	4.79	36.39de
$V_2 \times S_1 \times U_1$	113.30e	14.27cd	12.27a-d	2.67	23.53f	151.63hi	37.14bc	14.48	3.67abc	3.25	6.92	52.48a
$V_2 \times S_2 \times U_0$	105.37i	13.47cde	10.53e-h	2.93	22.37h	133.60k	35.68bcd	14.37	1.33f	2.92	4.24	37.26cde
$V_2 \times S_2 \times U_1$	110.23fg	14.67abc	11.27c-f	3.40	23.67f	149.93hi	35.60bcd	14.57	3.49bc	3.42	6.91	50.47ab
$V_2 \times S_3 \times U_0$	106.63hi	16.27a	13.73a	2.53	21.33i	114.63l	26.48fg	14.29	2.58d	2.42	5.00	51.37a
$V_2 \times S_3 \times U_1$	107.00hi	15.93ab	13.13ab	2.80	21.70i	128.70k	34.39b-e	14.44	3.98ab	3.33	7.32	53.49a
$V_3 \times S_1 \times U_0$	129.70b	13.67cde	11.00def	2.67	27.10b	185.33c	29.88efg	10.56	2de	2.92	4.92	43.08bcd
$V_3 \times S_1 \times U_1$	135.23a	14.87abc	11.93b-e	2.93	28.03a	208.49a	30.40def	11.09	3.13c	4.33	7.47	43.75bc
$V_3 \times S_2 \times U_0$	120.63d	14.13cd	11.20c-f	2.93	25.07e	168.20de	33.57b-e	10.61	2.17d	2.42	4.59	48.23ab
$V_3 \times S_2 \times U_1$	126.77c	14.73abc	10.73efg	3.93	27.93a	197.37b	32.36cde	10.9	2.59d	4.83	7.43	38.16cde
$V_3 \times S_3 \times U_0$	128.27bc	16.07ab	12.80ab	3.27	26.00c	163.92ef	24.88g	10.72	3.31c	3.33	6.64	50.01ab
$V_3 \times S_3 \times U_1$	134.4a	13.6cde	11.13c-f	3.13	27.17b	187.35c	32.21cde	10.87	4.22a	4.42	8.64	49.4ab
Sx	0.73	0.49	0.46	0.16	0.14	2.14	1.63	0.09	0.18	0.31	0.37	2.24
Level of sig.	**	**	**	NS	**	**	**	NS	**	NS	NS	**

In a column, figurers with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, * = Significant at 5% level of probability, ** = Significant at 1% level of probability. NS = Not significant. V_1 = BRRI dhan34, V_2 = Ukunimadhu, V_3 = Kataribhog, S_1 = 2 seedlings hill^{-1}, S_2 = 4 seedlings hill^{-1}, S_3 = 6 seedlings hill$^{-1}U_0$ = Recommended dose of Prilled Urea, U_1 = Recommended dose of Urea Super Granules (1.8g).

The interaction effect of variety, number of seedlings hill^{-1} and urea fertilizer had significant effect on all crop character except number of non effective tillers hill^{-1}, weight of 1000-grain, Straw yield, and biological yield. The highest grain yield (4.22 t ha^{-1}) and biological yield (8.64 t ha^{-1}) were produced when kataribhoh at six

seedlings hill-^{1} under Urea Super Granule (USG) fertilization application. Kataribhog at two seedlings hill^{-1} and Urea Super Granule (USG) combination produced higher plant height (135.23cm), panicle length (28.03cm) and number of fertile grains panicle^{-1}(208.49). Number of total tillers hill^{-1} (16.27) and number of effective tillers hill^{-1} (13.73) produced highest incase of Ukunmadhu at six seedlings hill^{-1} when Prilled Urea was applied. The highest number of non effective tillers hill^{-1} (3.93) and straw yield (4.83 t ha^{-1}) were produced by kataribhog at four seedlings when Urea Super Granule applied. Higher harvest index (54.09%) by BRRI dhan34 at six seedlings hill^{-1} incase of Urea Super Granule (USG) was applied. Number of sterile spickelet panicle^{-1} (47.85) was highest on BRRI dhan34 at four seedlings hill^{-1} when Prilled Urea was applied (Table 4).

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