International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 5, No. 5, p. 124-134, 2014

RESEARCH PAPER OPEN ACCESS

Optimum water requirement of some boro rice mutant lines

F. Aftab[1], M.N. Islam[1], M.A.A. Sarkar[2], M.M. Rahman[3*], M.A. Rahman[2]

[1]*Department of Irrigation and Water Management, BAU, Mymensingh 2202, Bangladesh*

[2]*Bangladesh Institute of Nuclear Agriculture, BAU, Mymensingh 2202, Bangladesh*

[3]*Department of Food Engineering and Tea Technology, SUST, Sylhet 3114, Bangladesh*

Article published on November 23, 2014

Key words: Irrigation, Boro Rice, Mutant Lines, Grain Yield, and Irrigation Efficiency.

Abstract

The study was conducted to find out the effect of irrigation on yield and optimum water requirement of some Boro rice mutant lines developed by Bangladesh Institute of Nuclear Agriculture (BINA) and the check variety BRRIdhan 28. The rice mutant lines (RM-200©-1-17, RM-200©-1-1, RM-200©-1-13) and BRRIdhan 28 were grown maintaining five irrigation treatments. The treatments were arranged in a Randomized Complete Block Design (RCBD) with three replications. Irrigation showed significant effect on the yield and yield contributing characters of different rice mutant lines and the check variety. The highest grain yield of 6.9 t ha^{-1} was obtained in treatment T_4 where irrigation applied to make 7 days after disappearance of previous water was imposed to the crop. It was also found that the crop grown under continuous ponding and continuous saturation of T_0 and T_1 treatments respectively did not increase the yield, rather caused the wastage of irrigation water. Among the three rice mutant lines and the check variety, the yield of the mutant lines were 6.08 t ha^{-1} in RM-200©-1-17, 6.79 t ha^{-1} in RM-200©-1-1, 6.20 t ha^{-1} in RM-200©-1-13 and 6.02 t ha^{-1} in BRRIdhan 28. The highest yield was 6.79 t ha^{-1} in treatment RM-200©-1-1.The mutant line RM-200©-1-1 was found to be superior over the other two mutant lines, and The treatment T_4 was the optimum water stress condition for the check variety which produced the highest yield. The water use efficiency was 0.033 t $ha^{-1}cm^{-1}$ in T_0, 0.045 t $ha^{-1}cm^{-1}$ in T_1, 0.125 t $ha^{-1}cm^{-1}$ in T_2, 0.168 t $ha^{-1}cm^{-1}$ in T_3 and 0.216 t $ha^{-1}cm^{-1}$ in T_4. The water use efficiency (WUE) was the highest (0.216 t $ha^{-1}cm^{-1}$) in treatment T_4, obviously due to minimum water use. Therefore, from the experimental findings, it was revealed that irrigation treatment of T_4 gave the highest yield which would help to lessen extra cost.

* **Corresponding Author:** M. M. Rahman ✉ mmr.fet@gmail.com

Introduction

Bangladesh has 9.03 million hectares of cultivable land, out of which only 42% land is brought under irrigation (BBS, 2010). About 69.14% of the irrigated rice cultivation area is being covered by Boro rice during dry winter period (BBS, 2010). Though there have been considerable seasonal variations in rice area and production, the total rice area has fairly remained stagnant at around 10 million hectares. The domestic production of this crop cannot keep pace with the mounting population pressure. Due to shortage of land in Bangladesh, it is not possible to increase rice production by bringing more area under cultivation. Therefore, greater attention should be given to increase yield by high yielding varieties and management practices.

Irrigation water is a critical factor for crop production in Bangladesh. It is the most important factor which can make a crop either successful or unsuccessful. Although the monsoon climate, with its high humidity and temperature, is favorable for rice cultivation in Bangladesh but the rainfall is not evenly distributed throughout the year. It is often said that the major problems of agriculture in Bangladesh are excess water and drought. About 96% of the total rainfall occurs during the months of April to October, leaving the remaining five months of the year essentially dry. Drought conditions prevail over most of Bangladesh during the months from November to April, when potential evaporation far exceeds rainfall (Monalo, 1976). A rice crop can not be sustained during this period from rainfall alone. Due to very limited availability of rain water during dry season (November- April), the Boro rice is fully dependent on irrigation. Therefore, the expanding demand for food grains in the country will most likely be met from expansion of irrigated area with the available water resources.

For rice 1 kg of paddy, it is estimated that farmers use 3 to 4 thousand liters of water whereas it actually needs 1.0 to 1.5 thousand liters only. Thus, for irrigation farmers pay about 30-40% of the extra cost. This might be due to their ignorance about the need of water for rice cultivation as well as consequence of misuse of water. So, they hold abundance of water in the rice field to avoid risk of uncertainty in next water supply. The almost even topography and humid tropical climate of the country with abundant monsoon rain offers a unique environment for the rice plant in Bangladesh. Once this present cultivable land was capable of meeting the food demand of the country but with the passage of time the cultivated land started diminishing with the rapid growth of population. Feeding of these new mouths with rice became a heavy burden with the present level of food production and therefore it has created a great attention to increase yield. So, in this situation of higher demand of rice and low yield per unit area, a high yielding variety with improved irrigation water management becomes necessary to be developed to achieve higher yield of rice as good water management practice is one of the most important factors in rice production. Very recently Bangladesh Institute of Nuclear Agriculture (BINA) has developed some high yielding (5.9 t ha^{-1} to 6.0 t ha^{-1}) and relatively short duration (120 days; Seed to Seed when transplanted in February) rice mutant lines which deserve studies for their water requirement for cultivation during the Boro season. With the above views, the present study was made to conduct a pot experiment with the rice mutant lines at BINA farm, Mymensingh, Bangladesh to determine the optimum water requirement for higher yield and water use efficiency of the newly developed Boro rice mutant lines.

Materials and methods

Site Selection and Experimental materials

Pots of 20.5 cm diameter used for the experiment were conducted in controlled condition at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh, Bangladesh during the period from January to June 2011. Three Boro rice mutant lines namely RM-200©-1-17, RM-200©-1-1, RM-200©-1-13 developed by BINA (thereby referred to as V_1, V_2 and V_3, respectively) and the check variety BRRIdhan 28 represented by V_4 were used for the experiment.

Design and layout of the experiment

The experiment was conducted following the Randomized Complete Block Design (RCBD). The treatments (T_0= continuous ponding (3-5 cm), T_1= continuous saturation, T_2= Alternate flooding and wetting at 3 days after disappearance of 5 cm, T_3= Alternate flooding and wetting at 5 days after disappearance of 5 cm, T_4= Alternate flooding and wetting at 7 days after disappearance of 5 cm) used in the experiment were replicated thrice. Thus, total 60 pots were required to establish the experiment. In each replication 20 pots were placed side by side maintaining 10 to 25 cm distances in between. On the other hand, the replicates were placed at 1 m distance between them. The treatments in mutant lines (V_1= RM-200-1-17, V_2= RM-200-1-17, V_3= RM-200-1-17 and V_4= BRRIdhan 28) were randomly arranged to avoid any biasness for placement. The layout of the experiment is shown in table 1.

Pot preparation and Fertilizer application

Each pot filled with 7 kg of soil was placed at the north yard (in Lysimeter house) of the BINA farm. The pots were pre-labeled for each mutant line and irrigation treatment. Extra amount of water was applied to bring the soil moisture suitable for seedling due to pots filled with dry soil. For this, 2 liters of water was added to saturate the soil. Fertilizer doses (Annonymous, 1997) for pot experiment were applied as 0.33 g, 0.42 g, 0.233 g per pot in the form of urea, triple super phosphate (TSP), muriate of potash (MP), respectively. Whole amounts of urea, TSP, MP were applied during the final land preparation. Another 0.33 g urea per pot was applied at 30 and 55 days after transplanting (DAT), respectively.

Raising seedling and Water stress

One No. of forty four days old seedlings (previously grown in seed bed) of the mutant lines and the check variety were collected from BINA farm. Seedlings were uprooted carefully from the bed and bundled with proper care and brought for transplanting in the pots. After the establishment of the crop (about 3 weeks after transplantation), irrigation was given to make 4 cm standing water and then water stress was imposed in treatments T_0, T_1, T_2, T_3 and T_4. The individual pot was weighed whenever required. The irrigation was continued up to 15 days before the harvest of the crop.

Intercultural operations

During the growth period, especially in the early stages, sometimes weeds were observed and uprooted by hand. No major insects were noticed except grass hopper and stem borers during the growth period. The infestation was controlled by applying insecticides (15 to 20 diazenol granules) in each pot at the active tillering stage. Other operation like mulching was done as and when necessary.

Harvesting, data recording and processing

Appearance of flowering was recorded when 50% panicles were emerged. The flower was uniform over the pots and all pots were ready to harvest at 152 DAT uniformly. Similarly, maturity date was identified when 90% grains were matured. At maturity, the whole plant was cut at ground level with sickle. The harvested crop of each pot was bundled separately and tagged properly. After recording data on plant height and panicle length of each plant, the plant materials were then sun dried for grain collection. Finally, grain and straw yield and yield contributing parameters were recorded separately.

Recording data during the crop growth period and other analysis at harvest

Plant height at maturity (cm): Plant height was measured from the ground level to the tip of the longest spike.

Tillers plant^{-1} (no): Tillers that had at least one leaf visible were counted. It included both effective and non-effective tillers.

Panicle length (cm): Panicle length was recorded from the basal code of the rachis to the apex of each panicle.

Grains plant^{-1} (no): Presence of any food material in the grain was considered as grain and total numbers of grains presented on each panicle were counted. It included both filled grain and unfilled grain.

Grain yield (t ha^{-1}): Grains obtained from each plant were sun dried. At first the seeds of best five panicles were weighed and then the seeds of rest of the panicles were weighed carefully by electrical balance. Thereafter the total seed yield was calculated by adding seed yield of best five panicles and the rest of panicles. The grain weight was expressed in gram (gm) and finally converted to t ha^{-1}.

Straw yield (t ha^{-1}): Straw obtained from each plant was sun dried. Straw yield was recorded following the similar procedure of grain yield. The straw weight were also expressed in gram (gm) and finally converted to t ha^{-1}.

1000- Grain weight (gm): One thousand clean dried grains were counted from the seed stock obtained from three sample plants of treatment combinations and weighed by using an electrical balance.

Harvest index (%): The ratio of grain yield to the grain plus straw yield together was regarded as harvest index, which was calculated by the following formula (Gardner *et al*., 1985).

Harvest index = Grain yield / (Straw yield+ Grain yield)*100

Estimation of irrigation water and water use efficiency

Amount of applied irrigated water was recorded from days after transplanting (DAT) and continued up to 15 days before harvest. Water use efficiency (WUE) of rice was calculated by dividing the total yield with the total amount of water required during entire crop growth period by following formula (Michael, 1978):

Water use efficiency = Y/WR (t ha^{-1} cm^{-1})

Where,

Y = grain yield (t ha^{-1})

WR = total amount of water used (cm)

Statistical Analysis

All the data recorded for different parameters were tabulated in proper form for the statistical analysis. Analysis of variance was done following the Randomized Complete Block Design (RCBD) with the help of computer package MSTAT program and the mean differences were adjudged by the Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez (1984).

Results and discussion

The mean effects of irrigation treatments, rice varieties, and their interactions on the yield and yield contributing characters are presented in Table 2 and 3, respectively. The results of each of the yield characters are described below separately.

Table 1. Layout of the pot experiment at BINA farm, Mymensingh.

	R_1				R_2				R_3			
T_0	V_1	V_2	V_3	V_4	V_2	V_3	V_4	V_1	V_3	V_4	V_1	V_2
T_1	V_2	V_3	V_4	V_1	V_3	V_4	V_1	V_2	V_4	V_1	V_2	V_3
T_2	V_3	V_4	V_1	V_2	V_4	V_1	V_2	V_3	V_1	V_2	V_3	V_4
T_3	V_4	V_1	V_2	V_3	V_1	V_2	V_3	V_4	V_2	V_3	V_4	V_1
T_4	V_1	V_2	V_3	V_4	V_2	V_3	V_4	V_1	V_3	V_4	V_1	V_2

Effect of Irrigation and Rice Variety on Plant Height

The plant heights were significantly affected due to application of irrigation water. The plant height was found to be statistically significant at 5% level of probability (Table 2). The plant heights of different treatments ranged from 70.92 to 83.32 cm. The highest plant height (83.32 cm) was observed with the irrigation treatment T_4 and the lowest (70.92 cm) in treatment T_1. This is dissimilar to the results of Naphade and Ghildyal (1974) and Cruj *et al.* (1975) who reported that continuous flooding increased plant height significantly than that of other treatments.

The effect of rice variety on the plant height was statistically insignificant. The highest plant height (79.64 cm) was obtained from V_1 while the lowest (78.35 cm) was obtained from V_4 (Table 2). The interaction effect of irrigation and varieties were significant (Table 2) considering the plant height. However, the highest plant height (85.90 cm) was observed for the interaction T_4V_1 and the lowest plant height (69.80 cm) was for T_0V_3.

Table 2. Mean effects of Irrigation Treatments and Varieties on Yield and Yield Contributing Characters of Boro Rice.

Treatments /varieties	Plant height (cm)	Effective tillers/hill (No.)	Length panicle (cm)	of Filled Grains/ Panicle (No.)	Unfilled grains/ panicle (No.)	1000-grain wt (g)	Grain yield (t/ha)	Grain yield (gm/pot)	Straw yield (t/ha)	Straw yield (gm/pot)	Harvest index (%)
T_0	70.92d	10d	20.81e	93d	10c	27.80	5.60c	13.40b	6.60bc	15.24a	45.82b
T_1	78.28c	12c	21.46d	107c	12c	28.33	5.60c	22.06ab	6.42cd	13.21b	46.58b
T_2	81.01b	14b	21.96c	119b	14b	29.29	6.50b	23.30a	6.40d	11.01b	50.28a
T_3	81.01b	15a	22.42b	128a	11c	29.09	6.72ab	25.14a	6.65b	17.23a	50.25a
T_4	83.32a	14b	22.90a	109c	20a	29.08	6.94a	27.25a	6.85a	18.42a	50.28a
LSD 0.05%	1.13	0.43	0.22	2.99	0.94	NS	0.27	5.40	0.16	4.18	1.12
V1	79.64	12c	21.86ab	108c	12c	28.90	6.08b	21.26bc	6.42b	13.37b	48.49b
V2	78.85	14a	21.76b	117a	11d	28.85	6.79a	25.17a	6.67a	18.17a	50.40a
V3	78.77	13b	22.09a	111b	13b	28.63	6.20b	22.60b	6.62a	14.44b	48.21b
V4	78.35	13b	21.92ab	110bc	17a	28.50	6.02b	19.88c	6.63a	14.09b	47.47b
LSD 0.05%	NS	0.38	0.20	2.67	0.84	NS	0.24	4.83	0.14	3.74	1.00

In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
NS= Non-significant.

Effect of Irrigation and Rice Variety on the Number of Effective Tillers per Hill

The results obtained from the field experiment for the numbers of effective tillers per hill of Boro rice varied significantly at 5 % level of probability (Table 2). The highest number of effective tillers per hill 15 was found in treatment T_3 and lowest number of effective tillers per hill 10 was found in treatment T_0. The number of effective tillers per hill varied significantly at 5 % level of probability due to three mutant and the check varieties (Table 2). The highest numbers of effective tillers per hill 14 was obtained from V_2 while the lowest 13 was obtained from V_4. The interaction effect of irrigations and varieties were significant (Table 2) considering the numbers of effective tillers per hill. However, the highest number of effective tillers per hill 17 was observed for the interaction T_3V_2 and the lowest number of effective tillers per hill 10 was T_0V_2.

Effect of Irrigation and Rice Variety on Length of panicle

The panicle length of Boro rice was significantly affected by water stress (Table 2) the longest panicle length (22.90 cm) was found in treatment T_4 and the shortest (21.46 cm) in treatment T_1. The panicle lengths from the treatments T_0, T_2 and T_3 were found to be 20.81, 21.96, 22.42 cm, respectively. The effect of rice variety on panicle length was statistically significant at 5 % level of probability (Table 2). The highest panicle length (22.09 cm) was obtained from variety V_3 and the lowest (21.76 cm) from variety V_2. The interaction of irrigation treatments and three rice mutant lines and the check variety showed significant variation for with the panicle length (Table 3). It can also be seen that the combination T_4V_3 produced the highest panicle length (23.42 cm) and the combination T_0V_3 produced the lowest panicle length (20.50 cm).

Effect of Irrigation and Rice Variety on Number of Filled Grains per Panicle

Water stress in rice field had significant effect on number of filled grains per panicle at 5% level of probability (Table 2). It was found that the highest number of filled grains per panicle was 128 obtained in treatment T_3. The lowest number of filled grains per panicle was 93 found in treatment T_0. Thus, the result is also in agreement with Mandal and Chatterjee (1984) and IRRI (1970) who reported that number of filled grains per panicle was reduced as water stress increased. The effect of rice variety on number of filled grains per panicle was statistically significant at 5 % level of probability (Table 2). The highest number of filled grains per panicle was 117 from variety V_2 and the lowest number was 108 from variety V_1, respectively. The interaction effect of irrigation treatments and three mutant lines and the check variety showed that significant variation was found on the number of filled grains per panicle (Table 3). The result also indicated that combination T_3V_2 produced the highest number of filled grains per panicle was 133 and the combination T_0V_3 produced the lowest number of filled grains per panicle was 85, respectively.

Table 3. Interaction effects of Irrigation Treatments and Varieties on Yield and Yield Contributing Characters.

Interactions	Plant height (cm)	Effective tillers/hill (No.)	Length of panicle (cm)	Filled Grains/ Panicle (No.)	Unfilled grains/ panicle (No.)	1000-grain wt (g)	Grain yield (t/ha)	Grain yield (gm/pot)	Straw yield (t/ha)	Straw yield (gm/pot)	Harvest index (%)
T_0V_1	72.67e	10j	21.07ij	100ij	7h	27.81	5.58ef	17.53i	6.42def	13.17i	46.53hij
T_0V_2	70.50ef	10j	21.13hij	102hi	7h	28.27	6.33cd	15.23j	6.75a-d	13.51hi	48.39d-h
T_0V_3	69.80f	12ghi	20.50k	85k	7h	27.88	5.17f	15.52j	6.58c-f	9.13jk	43.95k
T_0V_4	70.70ef	10j	20.53k	86k	20b	27.25	5.33f	13.62k	6.67b-e	13.00i	44.43jk
T_1V_1	72.77e	12fgh	20.76jk	95j	12def	28.91	5.08f	7.23L	6.25f	8.40k	44.86jk
T_1V_2	81.23cd	13de	21.28hi	107ghi	12de	28.75	5.92de	28.13d	6.42def	16.30d	47.97e-i
T_1V_3	79.20d	11hi	21.56gh	108fgh	11efg	27.75	5.50ef	24.80f	6.42def	14.11gh	46.16ij
T_1V_4	79.90d	13efg	22.25ef	119cde	12d-g	27.90	5.92de	19.77h	6.58c-f	9.27j	47.34f-i
T_2V_1	83.90ab	13def	22.16ef	122cd	11d-g	29.60	6.58bc	19.25h	6.58c-f	14.89ef	49.98b-e
T_2V_2	81.07cd	15b	21.91fg	128ab	12def	29.05	7.33a	32.85a	6.42def	20.90b	53.33a
T_2V_3	79.10d	14d	22.19ef	120cd	13d	29.28	6.50bc	25.41f	6.33ef	9.07jk	50.64bcd
T_2V_4	79.97d	13def	21.57gh	105hi	18c	29.21	5.58ef	21.98g	6.25f	14.44efg	47.16ghi
T_3V_1	82.97bc	12ghi	22.31def	120cd	10g	29.33	6.33cd	25.01f	6.42def	13.71hi	49.67b-f
T_3V_2	80.93cd	17a	22.17ef	133a	10fg	29.02	5.22a	30.91b	6.67b-e	21.05b	52.01ab
T_3V_3	80.50d	16a	22.77bcd	133a	11efg	29.01	6.92ab	22.72g	6.83abc	19.01c	50.31b-e
T_3V_4	79.63d	16a	22.44cde	125bc	12de	29.02	6.42bcd	21.91g	6.67b-e	15.14e	49.02c-g
T_4V_1	85.90a	11ij	23.03ab	101ij	20b	28.84	6.83abc	22.11g	6.42def	16.71de	51.43abc
T_4V_2	80.53d	16a	22.33c-f	112efg	12de	29.17	7.17a	25.04f	7.08a	22.56a	50.29b-e
T_4V_3	85.27a	14cd	23.42a	109fgh	24a	29.22	6.92ab	26.54e	6.92abc	17.43d	50.00b-e
T_4V_4	81.57cd	15bc	22.82abc	115def	22a	29.11	6.83abc	29.00c	7.00ab	18.62c	49.39b-f
LSD 0.05%	2.27	0.86	0.45	5.97	1.89	NS	0.54	10.79	0.32	8.37	2.24

In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.

NS= Non-significant.

Effect of Irrigation and Rice Variety on number of Unfilled Grains per Panicle

The treatments significantly affected the number of unfilled grains per panicle at 5 % level of probability (Table 2). It was found that the highest number of unfilled grains per panicle was observed in treatment T_4 was 20 and the lowest in treatment T_0 was 10, respectively. The effect of rice variety on number of unfilled grains per panicle was statistically significant (Table 2). The highest number of unfilled grains per panicle was 17 was obtained from variety V_4 and the lowest was 11 from variety V_1, respectively. The interaction effect of irrigation treatments and three rice mutant lines and the check variety showed that significant variation was found on the number of unfilled grains per panicle (Table 3). It was also evidenced that combination T_4V_3 produced the highest number of unfilled grains per panicle was 24 and the combination T_0V_3 produced the lowest number of unfilled grains per panicle was 7, respectively.

Table 4. Water use and water productivity under different irrigation treatments.

Treatment	No. of irrigations	Frequency of water application (DAT)	Water used for crop establishment (cm)	Irrigation Water Applied (cm)	Total Water Use (cm)	Grain yield (t ha^{-1})	Water Productivity (t ha^{-1} cm^{-1})
T_0	Continuous ponding	Every day	4	162	166	5.6	0.033
T_1	Continuous saturation	Every alternate day	4	118	122	5.6	0.045
T_2	12	30,35,40,45,50,54,59, 65,69, 75, 79,83	4	48	52	6.5	0.125
T_3	9	30,37,44,51, 57,65,71,78,84	4	36	40	6.72	0.168
T_4	7	30,39,47,55, 64,73,83	4	28	32	6.94	0.216

Effect of Irrigation and Rice Variety on 1000- Grain Weight

Thousand grain weights were insignificant in treatments (Table 2). The highest 1000- grain weight (29.29 g) was found in treatment T_2 and the lowest (27.80 g) in treatment T_0. Thus, it is clear that the maximum 1000- grain weight was found in alternate flooding and wetting but not in continuous flooding. Thousand grain weights were insignificant influenced by variety level (Table 2) due to three rice mutant lines and the check variety. The highest 1000-grain weight (28.90 g) was obtained from V_1 while the lowest (28.50 g) was obtained from V_4. The interaction effect of irrigations and varieties were insignificant. The highest 1000-Grain weight (29.60 g) was observed for the interaction $T_2V_1$and the lowest (27.25 g) for T_0V_4 (Table 3).

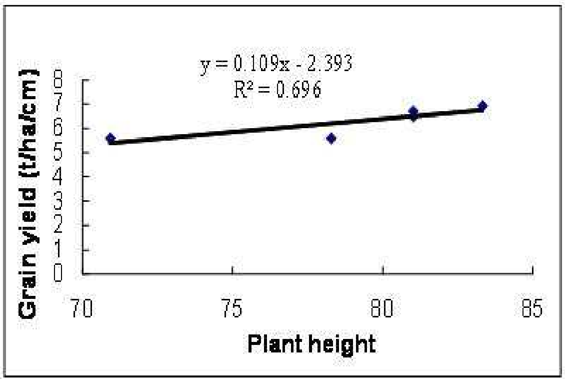

Fig. 1. Relationship between Plant height and Grain yield in treatment.

Effect of Irrigation and Rice Variety on Grain Yield

The influence of irrigation treatments on grain yield was statistically significant at 5% level of probability (Table 2). The highest grain yield (6.94 t ha^{-1} or 27.25 gm/pot) was obtained with the irrigation treatment T_4 and the lowest yield (5.60 t ha^{-1} 13.40 gm/pot) in treatment T_0. This helped to conclude that the lowest yield in treatment continuous flooding or saturation is not always necessary to produce the maximum yield. This result partially agrees with Alam and Mondal (2003) who reported that maintaining continuous standing water in hybrid rice field is not necessary for optimum yield. They found that application of irrigation water 7 days after disappearing of standing water from the rice field could be practiced for obtaining optimum yield of hybrid rice with minimum water application. The effect of rice variety on grain yield was also statistically significant at 5% level of probability (Table 2). The highest grain yield (6.79 t ha^{-1} or 25.17 gm/pot) was obtained from variety V_2 and the lowest (6.02 t ha^{-1} or 19.88 gm/pot) from variety V_4. Therefore, the variety V_2 was the best in respect of producing the highest grain yield. The interaction effect of irrigation treatments and three rice mutant lines and one check variety showed that significant variation was found on the grain yield (Table 3). It can be seen that combination of T_2V_2 produced the highest yield (7.33 t ha^{-1} or 7.23 gm/pot) and the combination of T_1V_1 produced the lowest grain yield (5.08 t ha^{-1}or 32.85 gm/pot). The effects of treatment and variety on grain yield are depicted in Fig. 4.13 and in Fig. 4.14, respectively.

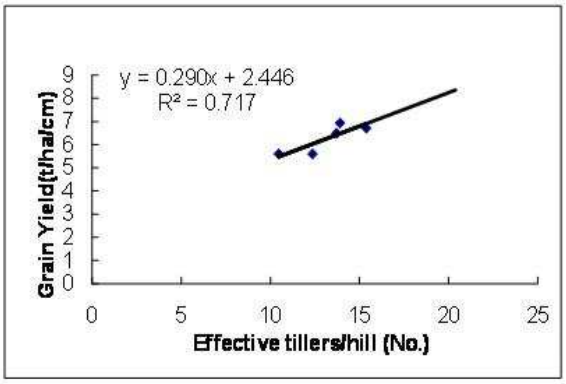

Fig. 2. Relationship between Effective tillers/hill and Grain yield in treatment.

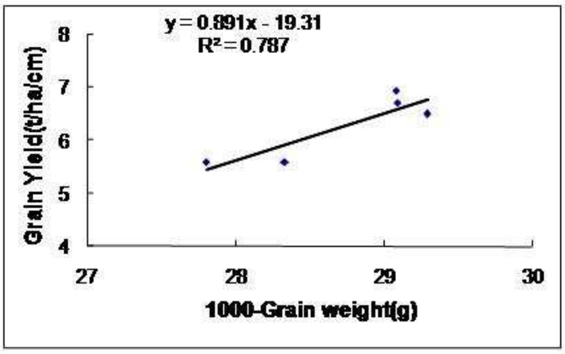

Fig. 3. Relationship between 1000-grain weight and Grain yield in treatment.

Effect of Irrigation and Rice Variety on Straw Yield

The influence of irrigation treatments on straw yield was statistically significant at 5% level of probability (Table 2). The highest straw yield (6.85 t ha^{-1} or 18.42 gm/pot) was obtained with the irrigation treatment T_4 and the lowest (6.40 t ha^{-1} or 15.24 gm/pot) with treatment T_2. Since the straw yield is the function of plant height and number of effective tillers, thus, the treatments which had the highest number of tillers and greatest plant height would produce higher straw yield. It was found from the study that treatments T_4 significantly gave greatest plant height and good number of tillers as compared to treatments T_0, T_1, T_2, and T_3. So, it is obvious that the straw yield should be higher in case of that treatment. The effect of rice variety on straw yield was statistically significant at 5% level of probability (Table 2). The highest straw yield (6.67 t ha^{-1} or 18.17 gm/pot) was obtained from variety V_2 and the lowest (6.42 t ha^{-1} or 13.37 gm/pot) from variety V_1. Therefore, the variety V_2 was the best in respect of producing straw yield. The interaction effect of irrigation treatments and three rice mutant lines and the check variety showed that significant variation was found on the straw yield (Table 3). It was also evidenced that combination of T_4V_2 produced the highest yield (7.08 t ha^{-1} or 22.56 gm/pot) and the combination of T_2V_4 and T_1V_1 produced the lowest straw yield (6.25 t ha^{-1} or 8.40 gm/pot).

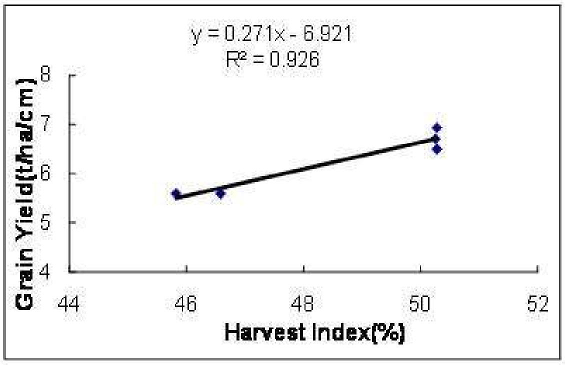

Fig. 4. Relationship between Harvest Index and Grain yield in treatment.

Effect of Irrigation and Rice Variety on Harvest Index (H.I)

The effect of irrigation treatments on harvest index (Table 2) was statistically significant at 5% level of probability. The harvest index was the highest in treatment T_2 (50.28%) and T_4 (50.28%) and the minimum in treatment T_0 (45.82%). This result shows that alternate flooding and wetting after disappearance water helps to obtain higher harvest index. This result is similar with the findings of Raju (1980) who reported that treatment having continuous flooding could not improve harvest index. The effect of rice variety on harvest index was statistically significant (Table 2). The highest harvest index (50.40%) was obtained from variety V_2 and the lowest (47.47%) from variety V_4, respectively. Therefore, the variety V_2 was the best in respect of producing highest harvest index. The interaction effect of irrigation treatments and three rice mutant lines and the check variety showed that significant variation was found on the harvest index (Table 2). It was also observed that combination T_2V_2 produced the highest harvest index (53.33%) and the combination T_0V_3 produced the lowest harvest index (43.95%).

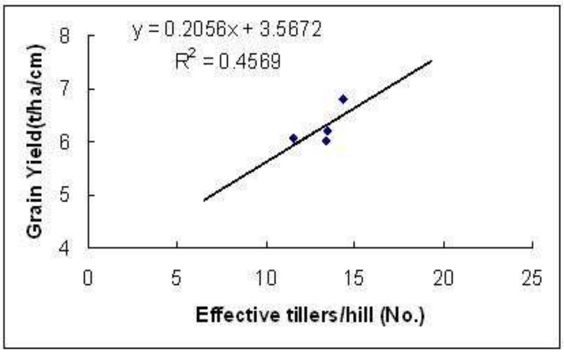

Fig. 5. Relationship between Effective tillers/hill and Grain yield in variety.

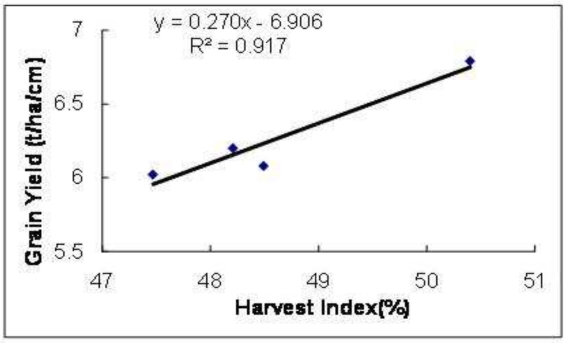

Fig. 6. Relationship between Harvest Index and Grain yield in variety.

Water Use and Water Productivity

Water use and water productivity under different irrigation treatments are shown in Table 4. The number of irrigations applied in treatments T_2. T_3, T_4 were 12, 9, and 7 respectively and T_0 was continuous ponding and $T_1$was continuous saturation. It can be seen that irrigation water applied was maximum for treatment T_0 (162 cm) and minimum for treatment T_4 (28 cm), respectively. Among the treatments in which irrigation water applied, water productivity was the highest (0.216 t ha^{-1} cm^{-1}) in treatment T_4 and was found to be minimum (0.033 t ha^{-1} cm^{-1}) in treatment T_0. From these results, it can be seen that the water productivity decreased with the increase of irrigation water. Similar results are also reported by Islam and Mondal (1992).

Correlation and Regression

Yield is a complex phenomenon, which results from the interaction of various yield contributing characters, such as plant height, number of effective tillers per hill, number of filled grains per panicle, 1000-grain weight and straw yield. Simple correlation coefficient relating to the relationship of various characters versus grain yield were found by the method outlined for the experiment carried out during Boro season and is presented in Figs. 2 to 7.

Conclusions

Based on the experimental findings, the yield and yield contributing characters of the three rice mutant lines and the check variety were significantly affected by the application of irrigation water at different growth stages. The highest and lowest grain yields were as 6.94 t ha^{-1} in treatment T_4 (irrigation applied to make 5 cm standing water 7 days disappearance of previous water) and 5.60 t ha^{-1} in treatment T_0 (Continuous ponding (3-5 cm of water)). The individual yield performance of the three rice mutant lines and the check variety revealed that the mutant line (V_2) RM-200©-1-1 produced the highest yield of 6.79 t ha^{-1} in treatment T_2 and the mutant line (V_1) RM-200©-1-17 produced the lowest yield in treatment T_1. Thus, among the three mutant lines, the mutant line (V_2) RM-200©-1-1 showed superiority over the other two mutant lines. In Boro season, the highest and lowest water use efficiencies were obtained as 0.216 t ha^{-1} cm^{-1} and 0.033 t ha^{-1} cm^{-1} in treatments T_4 and T_0, respectively. Continuous standing water in the rice field, which is an usual practice in Bangladesh, was not found to give optimum yield. Rather it is better to apply irrigation water 7 days after disappearance of previous water.

References

Alam MM. Mondal MK. 2003. Comparative water requirements and management practices for hybrid and inbred rice cultivation in Bangladesh. Bangladesh J. Agril. Sci. **30(2),** 345-351.

Annonymous. 1997. Fertilizer Recommendation Guide, Bangladesh. Agricultural Research Council, Farmgate, New Air Road, Dhaka-1215, 67.

BBS. 2010. Statistical Yearbook of Bangladesh,

Bangladesh Bureau of Statistics. Statistic Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

Cruj JC, Brandao SS, Guidice RM, Ferreirs PA, Loureiro BT. 1975. Effect of different soil moisture tension at two stages of plant development in relation to growth and yield of rice (*Oryza Sativa*). Expt. Stat., Andra Pradesh, India **19,** 187-209.

Gomez KA, Gomez AA. 1984. Statistical Procedure for Agricultural Research. Second Edn., International Rice Research Institute, Los Banos, Manila, The Phillipines, 204-207.

IRRI. 1970. International Rice Research Institute. Los Banos, Philipines, 170-179.

Islam MJ, Mondal MK. 1992. Water management strategy for increasing monsoon rice production in Bangladesh. Agril. Water Mgt. **22,** 335-343.

Mandal BK, Chatterjee BN. 1984. Growth and yield performance of selected rice varieties during cooler months under two water regimes. Indian J. Agron. **29(1),** 94-100.

Monalo EB. 1976. Agro-climatic survey of Bangladesh. IRRI, Los Banos, Philippines.

Raju RA. 1980. Effect of irrigation regimes on agronomic characters of rice. Intl. Rice Res. Inst., Joydevpur, Gazipur, Dhaka, 243-244.

International Journal of Agronomy and Agricultural Research

[IJAAR]

ISSN 2223-7054 [Print]

2225-3610 [Online]

IJAAR ©

[**Off Print**]

Volume 5, Number 5, November 2014

INNSPUB

International Network For Natural Sciences

Website: www.innspub.net