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Interactive effects of irrigation and flobond on growth and yield of BRRI dhan29

MZ Rahman[1], R Ahmed[2], A Shila[1], MM Hasan[1], MHK Howlader[1*]

[1]Department of Agricultural Botany, Patuakhali Scienceand Technology University, Dumki, Patuakhali 8602, Bangladesh; [2]Department of Agriculture, Noakhali Science and Technology University, Noakhali 3814, Bangladesh.

Abstract

The experiment was conducted at the Research Farm of Patuakhali Science and Technology University (PSTU), Patuakhali during the period from December-May of 2015 to evaluate the effect of irrigation and soil conditioner on growth and yield of BRRI dhan29. A modern HYV rice variety BRRI dhan29 was grown under four different frequency of irrigation viz., four times, six times, eight times and ten times with five rates of flobond(soil conditioner), viz., 0.0, 5.0, 10.0, 15.0 and 20.0 per plot. The experiment was laid out in a split plot design with four replications. Irrigation and rate of soil conditioner and their interaction significantly influenced the yield contributing and other crop characters. It was observed that the highest grain yield (7.08 t ha-1) was obtained from eight times irrigations, but the highest straw yield was obtained from ten times irrigations (6.706 t ha-1).The highest grain yield (7.21 t ha-1) was obtained with 10g Flobond per plot but the highest straw yield (6.29 t ha-1) was obtained with no Flobond. However, the highest grain yield (8.38 t ha-1) was obtained with eight times irrigation coupled with 10g of Flobond per plot as soil conditioner and the lowest one (5.5 t ha-1) was obtained in four times irrigation and no Flobond. So, eight times irrigation coupled with 10g of Flobond per plot as soil conditioner was the best combination for obtaining best yield.

Key words: BRRI dhan29, irrigation, flobond

***Corresponding Author:** howladercbt@yahoo.com

Introduction

Rice (*Oryza sativa*) is one of the most extensively cultivated cereals of the world. Rice is a nutritious food, providing about 90 percent of calories from carbohydrates and as much as 13 percent of calories from protein (Anon., 2005). It is the principal food crop of Bangladesh and constitutes 95% of grain production in the country. Among the rice producing countries, Bangladesh ranks fourth to China, India and Indonesia both in acreage and production (FAO, 2013). In Bangladesh Boro rice covers about 48.97% of total rice area and contributes to 38.14% of total rice production in the country (BBS, 2012). In Bangladesh about 4.065 m ha land is under Boro rice cultivation of which modern high yielding varieties (MV) cover about 96%, most of them are with irrigation. At present, about 80% of groundwater is used for irrigation, of which 73% is used exclusively by Boro farmers (Rahman and Ahmed, 2008).With the increase in irrigation facilities, Boro rice crop is now being taken in areas outside its traditional boundaries and a new cropping system is emerging (Singh, 2003). But irrigation is one of the costly inputs for Boro rice cultivation in Bangladesh. It is an established fact that for producing 1 kg of paddy rice, it requires even up to

2500 liters of water (De Silva, 2007).Thus irrigation is imparting alarming rise of cost of production along with other inputs. Recently management practice like AWD (Alternate wetting and drying) is suggested to reduce irrigation water requirement. By applying AWD, farmers or pump-owners are able to save 15 to 30% of their irrigation water (Rahman and Bulbul, 2014). Knowledge on the role of irrigation in growth and development of plant and the optimum time of application of water may help to economize the use of limited amount of water in obtaining the maximum yield of rice. But the supply of irrigation water and preparing irrigation channel are costly. So, by using chemical water retainer like flobond farmers can economize water, the scarce resource and also be able to reduce the cost of production.

Flobond is a chemical water retainer which is used to retain the water in the soil, keep the soil moist and reduce the frequency of irrigation. Flobond increases the cohesion of poorly structured soils and reduces 95% soil erosion, improved germination rate about 35%, reduces leaching of nutrients e.g. 84% less for phosphates and nitrates and the porosity of the soil is also conserved about 35% on clay loam soils to 50% on clay soils. Flobond economizes the use of water, reduces cost of cultivation and maximize crop yield without affecting the health of ecosystem. So, flobond as a chemical water retainer can be used in rice cultivation for retaining irrigation water and other sources of soil water in soil for the period as mentioned above, thereby save the scarce resource and minimizes the extra cost for irrigation as well as improve the growth and yield.

Materials and Methods

A field experiment was conducted at the Research Farm of Patuakhali Science and Technology University (PSTU), Patuakhali during the period from January to May, 2015 in order to study the growth and yield of rice as affected by level of irrigation and rate of Flobond (Water retainer). The soil of the experimental field was silty clay loam having pH value of 7.00. The characteristics of experimental soil were examined by the Soil Resource Development Institute (SRDI), Regional Laboratory, Barisal. The experiment was laid out in a split plot design with four replications. Irrigation treatments were assigned to the main plot and flobond to the sub plot, respectively, at random. The size of a unit plot was (2.5 m×2.0 m). The rice variety BRRI dhan29 was used as planting material. It was released by Bangladesh Rice Research Institute. It is a high yielding variety and suitable for Boro season. Planting materials were collected from Breeding Division of BARI, Gazipur. The healthy seeds were selected by specific gravity method were immersed in water for 24 hours and then spread in thick layer within gunny bags. The seeds started sprouting after 48 hours and were sown in the wet nursery bed after 72 hours. The area of nursery bed was 10 m^2. Sprouted seeds (2 kg) were uniformly sown in the wet nursery bed on 25 December 2014. Well decomposed 10 kg cow dung was applied for nursery bed. The land of the experimental plot was opened on 10 January 2015 with power tiller. The layout of the experimental field was done on 20 January, 2015 according to the design adopted. Individual plots were leveled with wooden plank. A fertilizer dose of 120-80-60-10 kg per ha of TSP, MP, Gypsum and Zinc sulphate respectively was applied at the time of final land preparation. Urea was top dressed at 15, 45 and 55 days after transplanting (DAT) with three splits of the full dose of 220 kg urea per ha. Flobond was applied two times in the soil. First after the final land preparation mixed with ashes and second one month after transplanting. Thirty two days old seedlings were uprooted carefully from the nursery bed and were transplanted on 24 January 2015 at the rate of 2-3 seedlings per hill maintaining a spacing of 25 cm × 15 cm. Water application to the experimental plots was done through irrigation channels. For this purpose a canal (size 0.5 m × 0.3m) was made at a distance of 7 m from the experimental area. Deep tube well water was stored in the storage canal from which water was applied to the plots using aluminum bowl by hand. Maturity of crop was determined as the time when 90% of the grains became golden yellow in colour. The crop was harvested on 15 May 2015 with sickle at proper maturity. Harvesting was done plot-wise and tagged for proper identification for further processing. The grains were threshed, cleaned and sun dried and the grain yield per plot recorded at 14% moisture content. Afterwards, the yield was converted to ton/ha. Straw was sun dried to record the straw yield per plot and then converted to ton/ha. Observation was made on Plant height, Leaf area index(LAI),Total number of tillers per plant, Number of effective tillers per plant, Number of non-effective tillers per plant, Panicle length, Number of total spikelets per panicle, Grain yield, Straw yield and Harvest index. Leaf area index (LAI) of 5 plants was measured by dividing leaf area per plant with land area (cm^2) covered by the plant.

$$LAI = \frac{\text{Leaf area per plant}(cm^2)}{\text{Ground area covered by per plant}(cm^2)}$$

Harvest index is the ratio of economic yield to biological yield (Gardner *et al*., 1986).The collected data were statistically analyzed using analysis of variance technique with the help of computer package programme MSTAT and significance of mean difference was adjudged by Duncan's Multiple Range Test (DMRT) as laid out by Gomez and Gomez (1984).

Results and Discussion

***Effect of frequency of irrigation on plant height*:** The effect of frequency of irrigation on plant height was found significant in 75 days after sowing (DAS) whereas it was non-significant in 45 DAS and 60 DAS. At 75 DAS the tallest plant (75.65 cm) was found in ten times irrigation treatment and that was statistically identical with eight times irrigation and six times irrigation treatments. The shortest one (70.45 cm) was found with four times irrigation (Table 1). Nayak and Sengupta (1981) reported that in case of plant height, mature plant did not response too much to irrigation frequencies.

Table 1. Effect of frequency of irrigation on plant height at different D**AS.**

Level of irrigation	Plant height (cm)		
	45 DAS	60 DAS	75 DAS
I4	52.69	64.80	70.45^{d}
I6	50.30	63.53	72.55^{c}
I8	51.68	63.86	73.53^{b}
I10	50.51	64.91	75.65^{a}
LSD	0.453	0.745	0.324
Level of significance	NS	NS	**
CV (%)	6.32	4.43	3.79

DAS= Days after sowing; I4=Four-irrigation; I6=Six-irrigation; I8=Eight; I10=Ten-irrigation, NS=Non significant; * and ** 5% and 1% level of significant, respectively. Same letter (s) in a column did not differ significantly.

***Effect of rateof flobond on plant height*:** Plant height was significantly influenced by rate of flobond at 75 DAS, whereas it showed non-significant effect in case of 45 DAS and 60 DAS (Table 2). In 45 DAS, plant varies from 49.95 cm to 52.60 cm; and for 60 DAS it ranged from 63.40cm to 65.91cm. The maximum plant height (74.45 cm) at 75 DAS was found with 15g flobond/5m^2 which was statistically identical with 10g flobond/5m^2 and 20g flobond/5m^2. The shortest plant height (50.91cm) was found in control plot where no flobond was applied (Table 2). At maturity the tallest plant (82.80cm) was found with 5g flobond/5m^2 plots and the shortest one (80.16cm) was found in control plots.

***Effect of interaction of irrigation and flobond on plant height*:** The interaction effect between irrigation level and the rate of flobond application on plant height was statistically at 45 DAS, 60 DAS and 75 DAS (Table 3). In case of 45 DAS, the maximum plant height (53.75cm) was attained in combination of 20g flobond/5m^2 with four-irrigation and the shortest plant height (48.33 cm) was found in 20g flobond/5m^2 with eight-irrigation. At 60 DAS, the tallest plant height (66.58cm) was found in combination of 15g flobond/5m^2 with ten-irrigation and that of shortest (61.92 cm) was observed in control plots where no flobond was used in four-irrigation. Similar effects were observed in 75 DAS where the tallest (73.26cm) and shortest plant heights (79.08cm) were found in combinations of 15g flobond/5m^2 with ten-irrigation and no flobond with four-irrigation, respectively (Table 3).

Table 2. Effect of rate of flobond on plant height at different DAS.

Rate of flobond	Plant height (cm)		
	45 DAS	60 DAS	75 DAS
F0	50.91	63.40	70.55 d
F1	50.30	63.63	71.55 c
F2	49.95	64.86	73.53 b
F3	52.60	65.91	74.45 a
F4	50.80	64.54	73.53 b
LSD	0.533	0.785	0.434
Level of significance	NS	NS	**
CV (%)	5.76	7.34	4.67

DAS=Days after sowing; F0=No flobond (Control); F1=5 g flobond/5m2; F2=10 g flobond/5m^2; F3=15 g flobond/5m2; F4=20 g flobond/5m2; NS=Non significant; * and ** 5% and 1% level of significant, respectively. Same letter (s) in a column did not differ significantly.

Effect of interaction of irrigation and flobond on total number of tillerper plant: The number of total tillers per plant was significantly influenced by the interaction of irrigation with the rate of flobond application (Table 4). The highest number of total tillers per plant(19.60) was obtained with 15g flobond/5m^2 plot under four irrigation followed by 5g flobond/5m^2 plot in eight-irrigation. The lowest number of tillers per plant (12.95) was obtained from no flobond under four-irrigation plots and 10g flobond/5m^2 under ten-irrigation plots.

Table 3. Effect of interaction of irrigation and flobond on plant height at different DAS.

Interaction (Irrigation x Rate of flobond)	Plant height (cm)		
	45 DAS	60 DAS	75 DAS
I4F0	51.99 ad	61.92 de	69.08 f
I4F1	52.66 ac	65.58 ac	71.33 ae
I4F2	48.83 de	65.08 ac	71.24 ae
I4F3	53.33 ab	63.42 bd	69.99 ef
I4F4	51.16 ae	62.99 cd	70.08 df
I6F0	49.24 de	63.58 bd	70.49 df
I6F1	51.66 ad	63.08 cd	70.16 df
I6F2	49.74 ce	63.58 bd	70.91 cf
I6F3	52.08 ad	66.08 ab	73.16 ab
I6F4	53.75 a	66.33 ab	72.99 ac
I8F0	51.50 ae	63.33 ad	70.91 cf
I8F1	49.66 ce	65.08 ac	71.58 ae
I8F2	50.41 be	65.41 ac	72.17 ad
I8F3	52.99 ac	64.08 ad	71.33 ae
I8F4	48.33 e	65.42 ac	71.67 ae
I10F0	50.91 ae	64.33 ad	70.91 cf
I10F1	49.99 ce	63.66 ad	70.83 df
I10F2	50.75 ae	65.41 ac	72.16 ad
I10F3	49.83 ce	66.58 a	73.25 a
I10F4	50.58 ae	64.58 ad	71.08 bf
LSD	0.843	0.535	0.732
Level of significance	**	*	*
CV (%)	7.86	5.64	4.39

DAS= Days after sowing; I4=Four-irrigation; I6=Six-irrigation; I8=Eight-irrigation; I10=Ten-irrigation; F0=No flobond (Control); F1=5 g flobond/5m2; F2=10 g flobond/5m2; F3=15 g flobond/5m2; F4=20 g flobond/5m2; NS=Non significant; * and ** 5% and 1% level of significant, respectively. Same letter (s) in a column did not differ significantly.

Table 4. Effect of interactionof irrigation and flobond on plant contributing characters**.**

Interaction (Irrigation X Rate of Flobond)	Number of total tillers plant-1	Number of effective tillers plant-1	Number of non effective tillers plant-1	Panicle length (cm)	Number of grains panicle-1	Number of sterile grains panicle-1
I4F0	12.65h	9.450i	3.20de	22.07ce	104.7ij	25.73a
I4F1	15.00df	10.80gh	4.10ab	22.65 ac	116.3df	17.15bd
I4F2	16.33bc	13.10ce	3.15de	22.66 ac	120.2cd	14.52be
I4F3	19.60a	15.60a	3.95ac	22.36bd	126.5b	13.55ce
I4F4	16.23bd	12.50e	4.35a	22.16ce	123.6bc	12.09e
I6F0	14.32fg	10.65gh	3.65bd	22.13ce	101.6j	14.67be
I6F1	13.40gh	9.775hi	3.65bd	22.38bd	117.4df	13.48de
I6F2	13.60gh	10.15hi	3.45d	21.79de	115.8dg	12.32e
I6F3	15.60ce	11.35fg	3.50cd	21.88 de	124.2bc	11.96e
I6F4	14.80ef	11.35fg	3.45d	22.19ce	132.7a	11.85e
I8F0	12.95h	9.950hi	3.25de	22.14ce	109.4hi	13.28de
I8F1	17.00b	14.25b	2.75ef	21.49e	110.8gh	11.66e
I8F2	13.45gh	10.10hi	3.35d	22.01ce	119.3ce	14.39be
I8F3	15.25cf	12.70de	2.80ef	22.27bd	119.4ce	13.94be
I8F4	14.90ef	12.35ef	2.55fg	22.99ab	120.3cd	17.72b
I10F0	15.65ce	12.95ce	2.75ef	22.06ce	109.1hi	17.37bc
I10F1	16.40bc	13.90bc	2.50fg	22.00ce	113.0fh	17.02bd
I10F2	12.95h	10.10hi	2.85ef	22.67ac	114.1eh	13.63de
I10F3	15.50cf	12.05ef	3.45d	22.29bd	118.1df	14.63be
I10F4	15.95be	13.75bd	2.20g	23.21a	124.3bc	13.38de
Level of sig.	**	**	**	**	**	**
CV (%)	5.23	4.56	6.45	4.42	5.34	4.38

I4=Four-irrigation; I6=Six-irrigation; I8=Eight-irrigation; I10=Ten-irrigation. F0= No flobond (Control); F1=5 g flobond/5m2; F2=10 g flobond/5m2; F3=15g flobond/5m2; F4=20 g flobond/5m2.NS=Non significant; * and ** 5% and 1% level of significant, respectively. Same letter (s) in a column did not differ significantly.

Effect of interaction of irrigation and flobondon number of effective tillersper plant: The interaction effects between the level of irrigation and rate of flobond on number of effective tiller was significant. The highest number of effective tillers (15.60) was found in combination of 15g flobond/5m^2 plot under four-irrigation followed by 5g flobond/5m^2 under eight-irrigation plot (Table 4). On the other hand, the lower number of effective tillers (9.45) was found in four-irrigation where no flobond was used. This indicated that flobond influences in increasing the number of effective tillers in BRRI dhan29.

Effect of interaction of irrigation and flobond on number of non-effective tillersper plant: Number of non-effective tillers per plant was significantly affected by the interaction of rate of flobond and irrigation treatment at 1% level of probability (Table 4). The highest number of non-effective tillers per plant (4.35) was obtained in 20g flobond/5m^2 under four-irrigation followed by 5g flobond/5m^{2}under four irrigation. On the other hand, the lowest one (2.20) was found with 20g flobond/5m^2 under ten- irrigation.

Effect of interaction of irrigation and flobond on panicle length: It is seen from Table 4, that panicle length was significantly influenced by irrigation treatment and rate of flobond. However, numerically the longest panicle (23.21 cm) was produced with of 20g flobond plot-1 under ten irrigations and the shortest panicle (21.49 cm) was found with no flonond plot-1 under eight irrigations.

Effect of interaction of irrigation and flobond on number of grains per panicle: From the Table 4, it is found that the number of grains panicle-1 was significantly influenced by the combination of rate of flonond and the level of irrigation. The highest number of grains panicle-1 (132.7) was found in plots of 15g flobond/5m^2 under six-irrigation followed by plots of 10g flobond/5m^2 under four-irrigation. The lowest number of grains panicle-1 (104.6) was found in plots of no flobond with six- irrigation which was statistically identical with no flobond under four-irrigation.

Effect of interaction of irrigation and flobond on number of sterile grains per panicle: Interaction of the flobond rate and the level of irrigation had significant effect on grain sterility. Maximum grain sterility (25.73) was observed in combination of no flobond with four-irrigation. Least number of sterile grains was found in combinations of 10g flobond, 15g flobond and 20g flobond with six-irrigations, eight irrigations and ten irrigations (Table 4).

Effect of interaction of irrigation and flobond on grain yield: From the Table 5, it is found that the grain yield was significantly affected by the interaction of rate of flobond and the level of irrigation. The highest grain yield (8.38 t ha-1) was found with the combination of 10g flobond/5m^2 under eight-irrigation followed by 15g flobond/5m^2 under eight-irrigation and 20g flobond/5m^2 with eight-irrigation. The lowest grain yield (5.50 t ha-1) was obtained in no flobond with four-irrigation, which was statistically identical with 5g flobond/ 5m^2 under four-irrigation.

Table 5. Effect of interaction of irrigation and flobond on yield and yield characters.

Interaction (Irrigation x Rate of flobond)	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index (%)
I4F0	5.50j	6.23 ef	46.85 hi
I4F1	6.25i	6.50 bf	48.84 fh
I4F2	7.10 bc	6.35 df	52.29 ce
I4F3	6.96 bf	6.68 ad	53.60 cd
I4F4	7.05 be	6.75 ad	51.08 df
I6F0	5.55 j	6.58 ae	45.76 i
I6F1	6.50 g	6.23 ef	51.08 df
I6F2	7.85 bg	6.15 f	52.69 ce
I6F3	6.65 ei	6.15 f	51.99 cf
I6F4	6.67 dh	6.38 cf	51.22 df
I8F0	6.38 hi	5.58 g	53.31 ce
I8F1	3.30 hi	5.30 g	54.66 bc
I8F2	8.38 a	5.06 h	62.27 a
I8F3	7.25 b	5.40 gh	57.32 b
I8F4	7.08 bd	5.30 gh	57.17 b
I10F0	5.70 j	6.79 ac	45.63 i
I10F1	6.30 hi	6.93 a	47.60 gi
I10F2	6.83 cg	6.43 bf	51.49 df
I10F3	6.55 gh	6.81 ab	49.01 fh
I10F4	6.63 f	6.58 ae	50.19 eg
Level of sig.	**	*	*
CV (%)	6.42	4.67	3.42

I4=Four-irrigation; I6=Six-irrigation; I8=Eight-irrigation; I10=Ten-irrigation. F0=No flobond (Control); F1=5 g flobond/5m2; F2=10 g flobond/5m2; F3=15g flobond/5m2; F4=20 g flobond/5m2. NS=Non significant; * and ** 5% and 1% level of significant, respectively. Same letter (s) in a column did not differ significantly.

Effect of interaction of irrigation and flobond on straw yield: Straw yield was significantly affected by the combination of rate of flobond and irrigation treatment (Table 5). Shows that the highest straw yield (6.93 t ha-1) was found with of 5g flobond/5m^2 under ten-irrigation followed by 15 g flobond/5m^2 under ten-irrigation. The lowest of that was obtained with 5g flobond/5m^2 under eight-irrigation (5.30 t ha-1) which was statistically identical with no flobond under eight-irrigation.

Effect of interaction of irrigation and flobond on harvest index: Harvest index was significantly affected by the interaction of irrigation treatment and rate of Flobond. It is observed that the highest Harvest Index (62.27) was found with 10g flobond/5m^2 under eight-irrigation and the lowest one (45.63) with the combination of no flobond with ten-irrigation, which was statistically identical with no flobond under six-irrigation plot(Table 5).

Table 6. Effect of different irrigation level on leaf area index (LAI) at different DAT**.**

Level of Irrigation	Leaf area index (LAI)			
	30 DAT	60 DAT	90 DAT	120 DAT
I4	0.85 c	1.91 d	2.83 b	2.33 d
I6	0.93 b	2.00 b	2.71 c	2.44 b
I8	1.00 a	2.12 a	2.89 a	2.49 a
I10	0.90 b	1.93 c	2.23 d	2.35 c
LSD	0.667	0.553	0.578	0.465
Level of significance	NS	**	NS	**
CV (%)	5.07	5.24	4.46	1.36

Effect of frequency of irrigation on leaf area index (LAI): Different level of irrigation showed significant difference in respect of LAI at 30 and 60 DAT but irrigation levels did not vary significant at 90 and 120 DAT (Table 6). Among the irrigation levels, eight-irrigation level recorded the highest (1.00 and 2.12) and the lowest (0.85 and 1.91) LAI at 30 and 60 DAT, respectively.

Conclusion

Interaction of level of irrigation and rate of flobond was significant for all the growth, yield and yield contributing characters except plant height and 1000-grain weight. The highest grain yield (8.37 t ha-1) was obtained under eight irrigations combined with 10 g Flobond. The lowest grain yield (5.500 t ha-1) was obtained under four times irrigations and no Flobond.

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