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Effect of variety and water management on the growth and yield of *Boro* rice

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2014 to May 2015 to examine the effect of variety and water management system on the growth and yield performance of *boro* rice. The experiment consisted of three varieties (cv. BRRI dhan28, BRRI dhan29 and Binadhan-14) and four water management systems (viz. Traditional flooding, non-flooded rice straw mulching, non-flooded water hyacinth mulching and non-flooded no mulching). The experiment was laid out in a split plot design with three replications. Different growth characters, yield and yield contributing characters of *boro* rice were found to the significantly influenced by variety, water management system and their interactions. At 100 DAT, the highest plant height, maximum number of tillers hill^{-1}, dry matter of shoot hill^{-1} and dry matter of root hill^{-1}were obtained from BRRI dhan29 and the lowest values were found in Binadhan-14. At 100 DAT, the highest plant height, maximum number of tillers hill^{-1}, dry matter of shoot hill^{-1} and dry matter of root hill^{-1} were obtained in non-flooded rice straw mulching treatment and the lowest ones were obtained from non-flooded no mulching treatment. Variety had significant effect on all the crop characters under study except 1000-grain weight. The highest grain yield was obtained from BRRI dhan29 and the lowest value was recorded from Binadhan-14. Water management system was also significantly influenced all crop characters. The highest grain yield was recorded from non-flooded rice straw mulching treatment and the lowest grain yield was found from non-flooded no mulching treatment. The interaction of variety and water management system showed that BRRI dhan29 with non-flooded rice straw mulching resulted in the highest grain yield whereas the lowest yield was observed from the interaction of Binadhan-14 with non-flooded no mulching treatment. The result of the experiment suggests that BRRI dhan29 can be grown economically with non-flooded rice straw mulching treatment.

Key words: Rice, water management, traditional flooding, mulching

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Introduction

The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 57.26 million tons of rice for the year 2020 (BRRI, 2011). To reach the goal, it is necessary either to increase the crop area or to increase yield per unit area. But due to high population pressure, horizontal expansion of land is not possible. Therefore, increasing yield per unit area is the only means. In Bangladesh, there are three diverse growing seasons of rice namely, *aus*, *aman* and *boro*. Among different rice groups of Bangladesh *boro* is the most important that covers an area of 4.72 million hectares with a production of 13.73 million tons of grains (BBS,

2011).Variety is one of the most important factors to be considered for getting increased rice production. Use of high yielding varieties and hybrid varieties in Bangladesh has been increased remarkably in recent years and the country has almost reached a level of self sufficiency in rice production. Selection of potential variety, planting in appropriate method and application of optimum amount of plant nutrients and optimum insistence can play important role in increasing yield and national income. 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. Irrigation is one of the costly inputs of *boro* rice cultivation in Bangladesh. The MVs that are recommended for *boro* season have high yield potential and they require huge amount of irrigation water and without much irrigation they cannot produce desired yield. 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. Insufficient water affects the uptake of nutrients from soil. Nutrients from soil reach the root surface by mass flow and diffusion process which are related to moisture content of the soil. Movement of nutrients through the plant body by physiological activities is also associated with soil water (Tisdale *et al.*, 1985). But as a matter of fact, irrigation water in Bangladesh is limited resource and hence irrigation practices must be rationalized for high water use efficiency. Application of irrigation water without proper planning based on actual requirement of the crops results not only its wastages but also hampers crop growth and yield (Sekhon *et al.,* 1986). 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. Irrigation frequency has a significant influence on the growth and yield of rice. With the increasing of irrigation frequencies the grain yield of rice can be increased. Therefore the present study was undertaken to evaluate the performance of three *boro* rice varieties, to find out suitable water management system for *boro* rice cultivation and to verify the effect of interaction (if any) in between variety and water management system on the performance of *boro* rice.

Materials and Methods

A field experiment was carried out at the Agronomy Field laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from December 2014 to May 2015 in order to study the growth and yield of *boro* rice as affected by water management system. The experimental consisted of the following treatments. i) Rice Cultivars viz. BRRI dhan28 (V_1), BRRI dhan29 (V_2) and Binadhan-14 (V_3) ii) Water management systems viz. Traditional flooding (M_1), Non-flooded rice straw mulching (M_2), Non-flooded water hyacinth mulching (M_3) and Non-flooded no mulching (M_4). The experiment field was Non-calcareous Dark Grey Floodplain under the Agro-Ecological Region of the Old Brahmaputra Floodplain-AEZ9 (UNDP and FAO, 1988).The experiment was laid out in a split-plot design with three replications. Water management treatments were assigned to the main plot and variety to the sub plot, respectively, at random. The size of a unit plot was $10m^2$ (4m×2.5 m). The number of plot is 36. During final land preparation each unit plot was fertilized with Triple Super Phosphate (TSP), Muriate of Potash (MOP), Gypsum and $ZnSO_4$ @ 90, 60, 20 and 5 kg ha^{-1} respectively. Urea was applied @ 300 kg ha^{-1} in three installments at 15, 30 and 45 days after transplanting (DAT). All management practices were done as and when necessary. Harvesting was done when 90% of the grains became golden (Binadhan-14), golden yellow (BRRI dhan29), fading golden (BRRI dhan28) in color. Five hills (excluding border hills) were selected randomly from each harvested plot to record the crop characters and yield components. After recording data, the grains and straws of each the sampling were added

to the total grain and straw yields of respective plots. The harvested crops of each plot were separately bundled, tagged and then brought to threshing floor. Threshing was done by pedal thresher. After threshing the grains were cleaned and sun dried to maintain moisture content of 14%. Straws were also dried properly. Finally the grain and straw yields were recorded and converted to t ha^{-1}.Data collected on different parameters were statistically analyzed using a software, named MSTAT. Mean comparisons of the effect of treatment and interactions from the analysis of variance (ANOVA) were made by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Growth performance of boro rice

Effect of variety: Plant height, number of tillers $hill^{-1}$, dry matter of shoot $hill^{-1}$ and dry matter of root $hill^{-1}$ were significantly influenced by variety. The highest plant height (90.27 cm), number of total tillers $hill^{-1}$ (7.24), dry matter of shoot $hill^{-1}$ (26.38 g) and dry matter of root $hill^{-1}$ (11.00 g) were found in BRRI dhan29 at 100 DAT and the lowest plant height, number of tillers $hill^{-1}$, dry matter of shoot $hill^{-1}$ and dry matter of root $hill^{-1}$was found in Binadhan-14 at all sampling dates (Table 1 & 4). Variable effect of variety on plant height was also reported by Om *et al.* (1998) and Krisna (2002) who also recorded variable plant height among varieties. Variable effect of variety on number of total tillers $hill^{-1}$ was also reported by BINA (1998) and Nuruzzaman *et al*. (2000) who noticed that number of total tillers $hill^{-1}$ differed among varieties. These might be due to genetic make-up of the varieties.

Effect of water management system: Water management system significantly influenced plant height, number of tillers $hill^{-1}$, dry matter of shoot $hill^{-1}$ and dry matter of root $hill^{-1}$ at all sampling dates. The highest plant height (82.15 cm), number of tillers $hill^{-1}$ (7.07), dry matter of shoot $hill^{-1}$ (27.71 g) and dry matter of root $hill^{-1}$ (11.47 g) were produced by non-flooded rice straw mulching (M_2) treatment and the lowest plant height, number of total tillers $hill^{-1}$, dry matter of shoot $hill^{-1}$ and dry matter of root $hill^{-1}$ was produced by non-flooded no mulching (M_4) treatment (Table 2 & 5).

Interaction effect of variety and water management system: The data showed that the plant height and number of tillers $hill^{-1}$ was non-significant for all sampling dates except for 100 DAT (Table 3).

Table 1. Effect of variety on growth of *boro* rice at different dates after transplanting (DAT)

Variety	Plant height (cm)				No of tillers $hill^{-1}$			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
V_1	28.76b	54.42b	72.60b	80.07b	6.56ab	6.44ab	6.56ab	6.40ab
V_2	38.12a	62.61a	79.26a	90.27a	6.95a	6.84a	6.95a	7.24a
V_3	23.52c	50.10c	69.40c	68.52c	5.84b	5.80b	5.84b	6.06b
CV (%)	6.05	8.94	2.17	2.75	7.14	12.74	7.25	11.42
Level of significance	**	**	**	**	**	*	**	**

Here, in a column figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.V_1 = BRRI dhan28,V_2 =BRRI dhan29,V_3 =Binadhan-14,** = Significant at 1% level of probability,*= Significant at 5% level of probability, DAT= Days after transplanting

Table 2. Effect of water management system on growth of *boro* rice at different dates after transplanting (DAT)

Water management system	Plant height (cm)				No of tillers hill^{-1}			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
M_1	29.75c	54.04c	72.58c	78.63c	6.35b	6.36	6.35c	6.62b
M_2	32.33a	60.67a	76.74a	82.15a	6.84a	6.67	6.84a	7.07a
M_3	31.17b	57.84b	74.46b	80.91b	6.58ab	6.58	6.58b	6.76b
M_4	27.27d	50.28d	71.24d	76.79d	6.03c	5.83	6.03d	5.83c
CV (%)	6.05	8.94	2.17	2.75	7.14	12.74	7.25	11.42
Level of significance	**	**	**	**	**	NS	**	**

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.M_1 = Traditional flooding,M_2 =Non-flooded rice straw mulching,M_3 = Non-flooded water hyacinth mulching,M_4 = Non-flooded no mulching,** = Significant at 1% level of probability, NS=Non significant, DAT= Days after transplanting

Table 3. Interaction effect of variety and water management system on growth of *boro* rice at different dates after transplanting (DAT)

Interaction combination	Plant height (cm)				No of tillers hill^{-1}			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
V_1M_1	28.60	52.67	71.04	77.94f	6.49	6.45	6.49	6.40
V_1M_2	30.64	59.45	76.10	82.45d	6.78	6.67	6.78	6.80
V_1M_3	29.62	55.45	72.74	80.63de	6.71	6.71	6.71	6.47
V_1M_4	26.19	50.12	70.53	79.26ef	6.26	5.93	6.26	5.93
V_2M_1	37.37	60.67	78.63	89.29b	6.70	6.67	6.70	7.33
V_2M_2	40.81	68.00	81.56	94.00a	7.45	7.33	7.45	7.87
V_2M_3	38.59	66.60	80.11	92.67a	7.08	7.08	7.08	7.50
V_2M_4	35.69	55.18	76.74	85.12c	6.58	6.27	6.58	6.27
V_3M_1	23.28	48.78	68.08	68.67g	5.85	5.97	5.85	6.13
V_3M_2	25.53	54.57	72.55	70.01g	6.30	6.00	6.30	6.53
V_3M_3	25.31	51.49	70.53	69.42g	5.97	5.97	5.97	6.30
V_3M_4	19.94	45.55	66.45	66.00h	5.25	5.29	5.25	5.29
CV (%)	6.05	8.94	2.17	2.75	7.14	12.74	7.25	11.42
Level of significance	NS	NS	NS	**	NS	NS	NS	NS

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.V_1 = BRRI dhan28, V_2 =BRRI dhan29,V_3 =Binadhan-14, M_1 = Traditional flooding,M_2 =Non-flooded rice straw mulching, M_3 = Non-flooded water hyacinth mulching,M_4 = Non-flooded no mulching, **= Significant at 1% level of probability, *= 5% level of significance, NS= = Non significant, DAT=Days after transplanting

Table 4. Effect of variety on shoot and root dry weight of *boro* rice at different days after transplanting (DAT)

Variety	Shoot weight (g)				Root weight (g)			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
V1	0.59b	5.50b	18.54b	22.58b	0.45b	2.80b	6.73b	9.22ab
V2	0.70a	6.44a	21.52a	26.38a	0.57a	3.57a	8.28a	11.00a
V3	0.49c	4.64c	13.42c	16.06c	0.38c	2.11c	5.55c	7.58b
CV (%)	3.63	2.80	1.85	1.95	3.46	3.67	2.98	18.60
Level of significance	**	**	**	**	**	**	**	*

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT,V_1 = BRRI dhan28,V_2 =BRRI dhan29,V_3 =Binadhan-14,** = Significant at 1% level of probability,*= Significant at 5% level of probability, DAT=Days after transplanting

Table 5. Effect of water management system on shoot and root dry weight of *boro* rice at different days after transplanting (DAT)

Variety	Shoot weight (g)				Root weight (g)			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
M_1	0.55c	5.11c	16.38c	19.68c	0.42c	2.49c	6.23c	8.45bc
M_2	0.70a	6.50a	22.44a	27.71a	0.60a	3.80a	8.50a	11.47a
M_3	0.63b	5.89b	19.18b	23.49b	0.50b	3.02b	7.13b	9.97ab
M_4	0.49d	4.59d	13.30d	15.81d	0.34d	2.00d	5.56d	7.18c
CV (%)	3.63	2.80	1.85	1.95	3.46	3.67	2.98	18.60
Level of significance	**	**	**	**	**	**	**	**

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, M_1 = Traditional flooding, M_2 =Non-flooded rice straw mulching,M_3 = Non-flooded water hyacinth mulching, M_4 = Non-flooded no mulching,** = Significant at 1% level of probability, DAT=Days after transplanting

At this date, highest plant height (94.00 cm) was obtained from the combination of BRRI dhan29 and non-flooded rice straw mulching (V_2M_2) Dry matter of shoot hill^{-1} and dry matter of root hill^{-1}were significantly influenced by interaction of variety and water management system at all sampling dates except 25 DAT for shoot dry weight and 100 DAT for root dry weight (Table 6). The highest dry matter of shoot hill^{-1} (32.30 g) and dry matter of root hill^{-1} (14.11 g) at 100 DAT was obtained from the combination of BRRI dhan29 and non-flooded rice straw mulching (V_2M_2) and the lowest dry matter of shoot hill^{-1} and dry matter of root hill^{-1}was obtained from the combination of Binadhan-14 and non-flooded no mulching (V_3M_4) treatment at all sampling dates.

Yield and yield contributing characters of boro rice

Effect of variety: Plant height was significantly influenced by variety at harvest. The highest plant height was observed from BRRI dhan29 and that of lowest was recorded from Binadhan-14 (Figure 1). The number of total tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, 1000 grain weight, biological yield and harvest index of *boro* rice at maturity was significantly influenced by variety (Table 7). BRRI dhan29 produced the highest number of total tillers hill^{-1} (7.24), number of effective tillers hill^{-1} (5.62), panicle length (20.16), number of grains panicle^{-1} (95.03), 1000 grain weight (20.74 g), biological yield (11.77 t ha^{-1}) and harvest index (43.79) among the varieties. Binadhan-14produced the lowest plant height number of total tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, 1000 grain weight, biological yield and harvest index among the varieties. These differences are mostly due to the genetic variation between these three rice varieties. Variable effect of variety on number of total tillers hill^{-1} was also reported by BINA (1998). Nuruzzaman *et al*. (2000) noticed that number of total tillers hill^{-1} differed among the varieties. This finding corroborates with those reported by BINA (1998), Om *et al.* (1998) who stated that effective tillers hill^{-1}was varied with variety.

Table 6. Interaction effect of variety and water management system on shoot and root dry weight of *boro* rice at different days after transplanting (DAT)

Treatment combination	Shoot weight (g)				Root weight (g)			
	25 DAT	50 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT
V_1M_1	0.54	5.03f	17.51g	20.76f	0.40g	2.40f	6.13f	8.40
V_1M_2	0.70	6.53c	22.11c	28.70b	0.60c	3.83b	8.20c	11.30
V_1M_3	0.62	5.90d	19.63e	24.23d	0.48e	2.97cd	7.20d	9.88
V_1M_4	0.48	4.52g	14.90i	16.63h	0.31i	2.00h	5.40gh	7.30
V_2M_1	0.67	6.00d	20.00d	24.08d	0.52d	3.07c	7.33d	9.77
V_2M_2	0.81	7.55a	27.10a	32.30a	0.71a	4.73a	10.63a	14.11
V_2M_3	0.74	6.83b	22.86b	28.17c	0.62b	3.90b	8.60b	12.03
V_2M_4	0.59	5.37e	16.10h	20.97f	0.43f	2.60e	6.57e	8.10
V_3M_1	0.45	4.30h	11.62j	14.20i	0.35h	2.00h	5.23h	7.19
V_3M_2	0.59	5.41e	18.10f	22.13e	0.50de	2.83d	6.67e	9.00
V_3M_3	0.52	4.93f	15.04i	18.07g	0.40g	2.20g	5.60g	8.00
V_3M_4	0.38	3.90i	8.90k	9.83j	0.27j	1.40i	4.70i	6.13
CV (%)	3.63	2.80	1.85	1.95	3.46	3.67	2.98	18.60
Level of significance	NS	**	**	**	**	**	**	NS

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. V_1 = BRRI dhan28, V_2 =BRRI dhan29, V_3 =Binadhan-14, M_1 = Traditional flooding, M_2 =Non-flooded rice straw mulching, M_3 = Non-flooded water hyacinth mulching, M_4 = Non-flooded no mulching, ** = Significant at 1% level of probability, NS= Non significant and DAT=Days after transplanting

Table 7. Effect of variety on yield and yield contributing characters of *boro* rice

Variety	Total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Wt. of 1000 grain (g)	Biological yield (t ha^{-1})	Harvest index (%)
V_1	6.47b	5.12b	1.35	19.26b	90.34b	20.17b	10.77b	42.04b
V_2	7.24a	5.62a	1.63	20.16a	95.03a	20.74a	11.77a	43.79a
V_3	6.06c	4.69c	1.37	18.28c	74.77c	19.27c	9.30c	40.18c
CV (%)	11.40	8.98	44.00	2.32	2.24	3.54	3.80	5.54
Level of significance	*	**	NS	**	**	**	**	**

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.V_1 = BRRI dhan28, V_2 =BRRI dhan29, V_3 =Binadhan-14, ** = Significant at 1% level of probability,* =Significant at 5% level of probability, NS= = Non significant

Table 8. Effect of water management system on yield and yield contributing characters of *boro* rice

Water management system	Total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non effective tillers hill^{-1}	Panicle Length (cm)	No. of grains panicle^{-1}	Wt. of 1000 grain(g)	Biological yield (t ha^{-1})	Harvest index (%)
M_1	6.62b	5.09c	1.53	18.80c	86.89c	19.94c	9.85c	43.31a
M_2	7.13a	5.50a	1.63	20.24a	89.27a	20.69a	12.49a	41.83c
M_3	6.76b	5.24b	1.51	19.63b	88.30b	20.29b	11.70b	42.80b
M_4	5.85	4.73d	1.12	18.27d	82.39d	19.32d	8.42d	40.07d
CV (%)	11.40	8.98	44.00	2.32	2.24	3.54	3.80	5.54
Level of significance	*	**	NS	**	**	**	**	*

Similar results were reported by Srivastava and Thipathi, 1998. Varietal differences regarding the number of grains panicle^{-1} might be due to their differences in genetic constitution. Accordingly, the highest grain yield (5.16 t ha^{-1}) and straw yield (6.60 t ha^{-1}) was obtained from BRRI dhan29 (Figure 2).

Effect of water management system: Water management system had significant influenced on plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, 1000 grain weight, grain yield, straw yield, biological yield and harvest index of *boro* rice. Non-flooded rice straw mulching produced the highest plant height ((82.15 cm) at maturity where as non-flooded no mulching produced the lowest plant height (Figure 1). Highest number of total tillers hill^{-1} (7.13), number of effective tillers hill^{-1} (5.50), panicle length (20.24), number of grains panicle^{-1} (89.27), biological yield (12.49) and harvest index (43.31%) was obtained from non-flooded rice straw mulching (Table 8). Non-flooded no mulching produced the lowest plant height, number of total tillers hill^{-1}, number of effective tillers

hill^{-1}, panicle length, number of grains panicle^{-1}, biological yield and harvest index among the water management systems. Similarly highest grain yield (5.24 t ha^{-1}) and straw yield (7.24 t ha^{-1}) was recorded from non-flooded rice straw mulching (Figure 2).

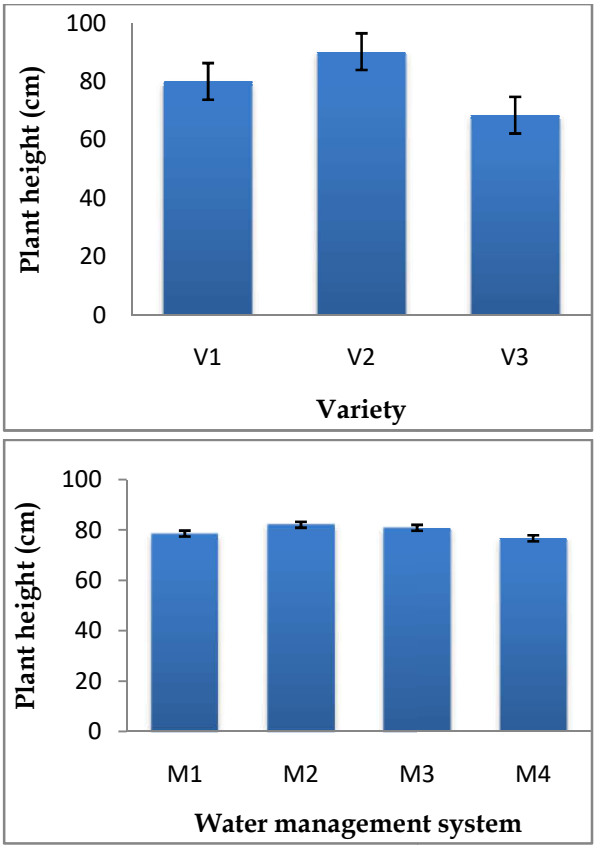
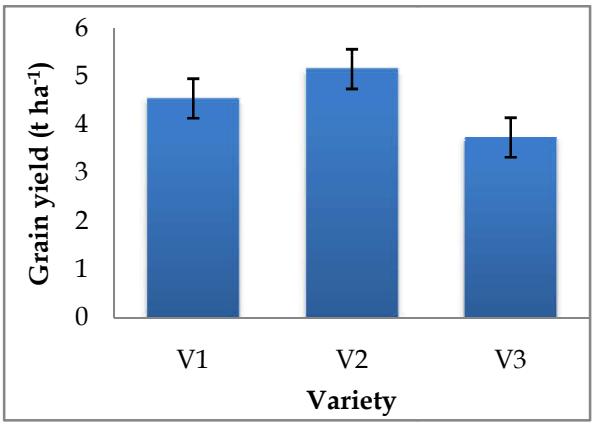


Figure 1. Effect of variety and water management system on plant height of *boro* rice



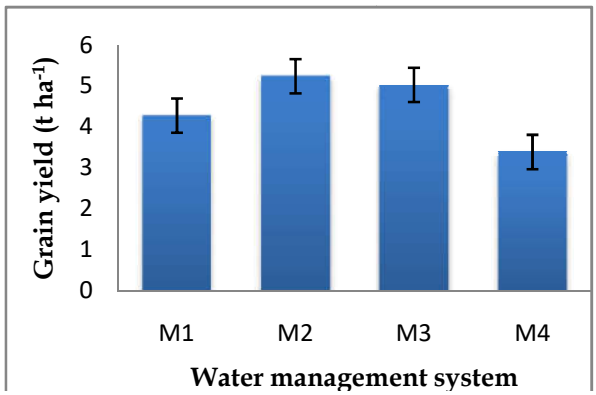
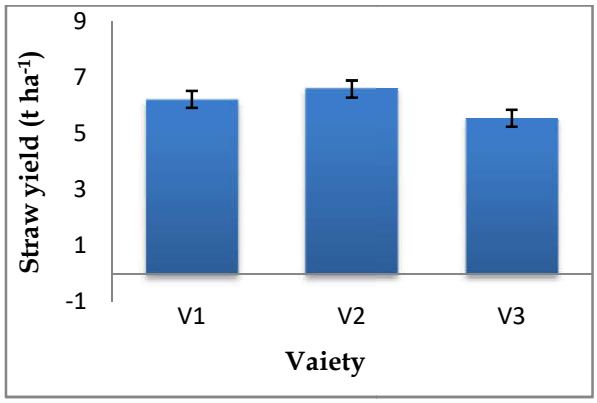


Figure 2. Effect of variety and water management system on grain yield of *boro* rice



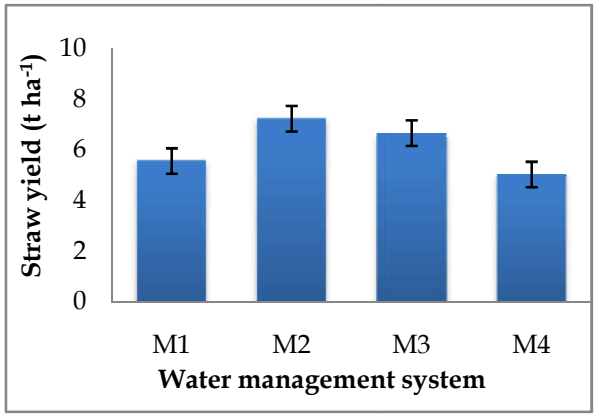


Figure 3. Effect of variety and water management system on straw yield of *boro* rice

Here, V_1= BRRI dhan28, V_2= BRRI dhan29, V_3= Binadhan-14, M_1= Traditional flooding, M_2= Non-flooded rice straw mulching, M_3= Non-flooded water hyacinth mulching and M_4= Non-flooded no mulching

Table 9. Interaction effect of variety and water management system on yield and yield contributing characters of *boro* rice

Treatment combination	Plant height (cm)	Total tiller hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle Length (cm)	No of grains panicle^{-1}	Wt. of 1000 grain (g)	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1M_1	77.94f	6.40	5.00	1.40	18.80c	91.66cd	20.03	4.34cd	5.63d	9.97e	43.19
V_1M_2	82.45d	7.00	5.40	1.60	20.78a	93.73bcd	20.80	5.35b	7.31a	12.66b	42.25
V_1M_3	80.63de	6.47	5.20	1.27	19.40b	92.67cd	20.40	5.04b	6.82b	11.87c	42.50
V_1M_4	79.26ef	6.00	4.87	1.13	18.06d	83.28e	19.45	3.46f	5.13e	8.59f	40.21
V_2M_1	89.29b	7.33	5.73	1.60	19.60b	94.83abc	20.70	4.86bc	6.25c	11.11d	43.72
V_2M_2	94.00a	7.87	6.00	1.87	21.12a	98.08a	21.27	6.06a	7.73a	13.79a	43.97
V_2M_3	92.67a	7.50	5.73	1.77	20.73a	96.67ab	21.00	5.93a	7.35a	13.28ab	44.64
V_2M_4	85.12c	6.27	5.00	1.27	19.18bc	90.53d	20.00	3.81def	5.08e	8.89f	42.83
V_3M_1	68.67g	6.13	4.53	1.60	18.01d	74.17f	19.10	3.64ef	4.83e	8.48fg	43.03
V_3M_2	70.01g	6.53	5.10	1.43	18.81c	76.00f	20.00	4.31cd	6.69b	11.00d	39.25
V_3M_3	69.42g	6.30	4.80	1.50	18.75c	75.55f	19.48	4.10de	5.83cd	9.94e	41.25
V_3M_4	66.00h	5.29	4.33	0.95	17.57e	73.37f	18.52	2.90g	4.90e	7.80g	37.18
CV (%)	3.36	11.40	8.98	44.00	2.32	2.24	3.54	7.36	4.18	3.80	5.54
Level of significance	**	NS	NS	NS	**	*	NS	*	**	**	NS

Here, in a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. V_1 = BRRI dhan28, V_2 =BRRI dhan29, V_3 =Binadhan-14, M_1 =Traditional flooding, M_2 =Non-flooded rice straw mulching, M_3 = Non-flooded water hyacinth mulching, M_4 = Non-flooded no mulching, **= Significant at 1% level of probability, *= 5% level of significance and NS= Non significant

Interaction effect of variety and water management system: The effect of interaction between variety and water management system was significant for plant height, panicle length, number of grains panicle^{-1}, grain yield, straw yield and biological yield (Table 9). The highest plant height (94.00 cm), panicle length (21.12 cm), number of grains panicle^{-1} (98.08) grain yield (6.06 t ha^{-1}), straw yield (7.73 t ha-), biological yield (13.79 t ha^{-1}) and harvest index (43.97%) was obtained from V_2M_2 (BRRI dhan29 × non-flooded rice straw mulching) treatment and the lowest plant height, panicle length, number of grains panicle^{-1}, grain yield, straw yield, biological yield and harvest index was found in V_3M_4 (Binadhan-14 × non-flooded no mulching) treatment (Table 9).

Conclusion

It was found that variety and water management system had significant effect on grain yield. BRRI dhan29 performed the best in respect of grain yield at non-flooded rice straw mulching treatment. BRRI dhan29, BRRI dhan28, and Binadhan-14produced the grain yields of 6.06, 5.35 and 4.31 t ha^{-1} respectively at non-flooded rice straw mulching treatment. It can be concluded that BRRI dhan29 with non-flooded rice straw mulching treatment was found to be the best possible combination for achieving higher grain yield.

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