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Original Article

Effect of weed management on the growth and yield performances of *boro* rice cultivars

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A B S T R A C T

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2017 through May 2018 to evaluate the effect of weed management practices on the performance of *boro* rice cultivars. The experiment consisted of three *boro* rice cultivars *viz*., BRRI dhan28, BRRI dhan29 and BRRI dhan74 along with six different weed management practices such as no weeding, application of pre-emergence herbicide Superhit, application of early post-emergence herbicide Changer, application of pre-emergence herbicide Superhit followed by one hand weeding at 40 DAT (days after transplanting), application of early post-emergence herbicide Changer followed by one hand weeding at 40 DAT, and two hand weedings at 20 and 40 DATs. Cultivars had no significant effect on weed density at 20 and 40 DATs but showed significant effect at 60 DAT and weed dry weight was not significantly affected by cultivars at different DATs. Weeding regime had significant effect on weed density and dry weight at different DATs. The highest weed dry weight was observed in no weeding treatment and the lowest one was recorded in application of early post-emergence herbicide followed by one hand weeding at 40 DAT. BRRI dhan29 with no weeding treatment produced the highest weed dry weight and BRRI dhan28 with application of early post-emergence herbicide followed by one hand weeding produced the lowest weed dry weight at different DATs. BRRI dhan74 produced the highest grain and straw yields among the studied cultivars. The highest grain yield was obtained from application of pre-emergence herbicide Superhit (Pretilachlor) followed by one hand weeding at 40 DAT due to the highest number of effective tillers hill^{-1} and highest number of grains panicle^{-1}in this treatment. Rice cultivar BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT produced the highest grain yield and the lowest one was resulted from BRRI dhan29 in combination with no weeding treatment. From the economic analysis it is observed that cultivar BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT maximized the BCR. So, for controlling weeds in effective manner and in order to get the highest grain yield and the highest economic return in *boro* rice, BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT might be recommended.

Introduction

Rice (*Oryza sativa* L.) is the most important food crop and a primary food source for more than one-third of world's population (Sarkar *et al.*, 2017). World's rice demand is projected to increase by 25% from 2001 to 2025 to keep pace with population growth (Maclean *et al.*, 2002), and therefore, meeting this ever increasing rice demand in a sustainable way with shrinking natural resources is a great challenge. In Bangladesh, majority of food grains comes from rice. Rice has tremendous influence on agrarian economy of the country. Annual production of rice in Bangladesh is about 36.28 million tons from 11.52 million ha of land (BBS, 2018). There are three distinct growing seasons of rice in Bangladesh according to changes in seasonal conditions such as *aus*, *aman* and *boro*. The average yield of rice in Bangladesh is around 3.12 m t ha^{-1} and yield of *boro* rice (4.03 t ha^{-1}) is comparatively higher than that of *aus* and *aman* rice (BBS, 2018). The average yield of rice is almost less than 50% of the world average rice grain yield. Now-a-days, food security especially attaining self-sufficiency in rice production is a burning issue in Bangladesh. In such condition, increasing rice production can play a vital role. The increased rice production has been possible largely through the adoption of modern technology. Crop performance is closely related with weed growth. Weeds are the most important threat under upland or aerobic rice systems, resulting in yield losses between 30 and 98 percent (Ramana *et al.,* 2014). Among the harmful pest, weeds contribute maximum losses in crop production, which may potentially reduce crop production by 34%, followed by animal pests (18%) and pathogens by 16% (Abbas *et al.*, 2018). High competitive ability of weeds exerts a serious negative effect on crop production. Globally, actual yield losses due to pests have been estimated approximately 40%, of which weeds caused the highest loss (32%) (Rao *et al.*, 2007). Weeds compete with rice plants severely for space, nutrients, air, water and light and adversely affect the plant height, leaf architecture, tillering habit and crop growth (Miah *et al.,* 1990). In Bangladesh, weed infestation reduces the grain yield by 70-80% in *aus* rice (early summer), 30-40% for transplanted *aman* rice (autumn) and 22-36% for modern *boro* rice cultivars (winter rice) (BRRI, 2008).

Hand weeding is the popular weed control method in Bangladesh. But weed control is often imperfect or delayed due to unavailability of labor during the peak period. Mechanical weeding and chemical weed control are the alternatives to hand weeding. In recent years, chemical weed control has increased in Bangladesh (Ahmed *et al*., 2014). Herbicides are effective in controlling weeds alone or in combination with hand weeding (Ahmed *et al*., 2005). Herbicides in combination with hand weeding would help to obtain higher crop yield with less efforts and cost (Sathyamoorthy *et al.,* 2004; Parvez *et al*., 2013).Weed free condition during the critical period of competition is essential for optimum rice yield.

Rice varieties have tremendous impact on the growth and infestation of weed in the field. Usually short stature varieties face more weed infestation than the taller ones (Sarker, 1979). So, to avoid the weed competition and to get maximum yield from rice, appropriate variety should be selected. Weeding regime influences on the performance of *boro* rice. Thus the best weed management practice needs to reduce weed infestation and maximize rice yield. Based on the above information, the present study was undertaken to observe the effect of cultivar on weed suppression and yield performance of *boro* rice, to determine the effect of weed management on weed suppression and yield performance of *boro* rice and to find out the interaction effect of cultivar and herbicide on weed suppression and yield performance of *boro* rice.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from December 2017 through May 2018 to study the effect of weed management on the performance of *boro* rice cultivars. The experimental area is characterized by non-calcareous dark grey floodplain soil belonging to the Sonatola Soil Series under the Old Brahmaputra Floodplain, Agro-Ecological Zone 9 (UNDP and FAO, 1988). The experiment consisted of two factors, Factor A- **c**ultivars of *boro* rice: BRRI dhan28 (V_1), BRRI dhan29 (V_2) and BRRI dhan74 (V_3) and Factor B- Weed management: control (no weeding) (W_0), application of pre-emergence herbicide Superhit (Pretilachlor) (W_1), application of early post-emergence herbicide Changer (Acetachlor 14% + Bensulfuronmethyl 4%) (W_2), application of pre-emergence herbicide Superhit followed by one hand weeding at 40 DAT (W_3), application of early post-emergence herbicide Changer followed by one hand weeding at 40 DAT (W_4) and two hand weedings at 20 and 40 DAT_s (W_5). The experiment was laid out in a randomized complete block design with three replications. Each of the replication represented a block in the experiment. Each block comprised 18 unit plots which were assigned with the combination of three rice cultivars and six weed management practices. Thus the total number of unit plots were 3×6×3= 54 and each unit plot size was 4.0 m × 2.5 m. Sprouted seeds were sown in the wet nursery bed on 6 December 2017. Proper care was taken to raise the healthy seedlings in the nursery bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary. The land was opened on 1 January 2018 with a power tiller. Then the land was puddled thoroughly by ploughing and cross ploughing four times with country plough followed by laddering. Weeds and stubbles were removed from the field. The layout of the experimental field was done on 19 January 2018 in accordance with the experimental design. The experimental plots were fertilized with urea, TSP, MoP, gypsum and $ZnSO_4$ @ 300-100-150-110-10 kg ha^{-1}, respectively as per recommendation of fertilizer recommendation guide (BARC, 2012). The entire amounts of triple superphosphate, muriate of potash, gypsum and zinc sulphate were applied at the time of final land preparation. Urea was top dressed in three equal installments at 15, 30 and 45 days after transplanting (DAT). Healthy seedlings were uprooted on 20 January 2018 without causing much mechanical injury to the roots and they were immediately transferred to the main field. Forty five days old seedlings were transplanted in the well prepared puddled field on 20 January 2018 at the rate of three seedlings $hill^{-1}$, maintained row and hill distance of 25 cm and 15 cm, respectively. Seedlings in some hills died off and these were replaced by gap filling after one week of transplanting with seedlings from the same source. The experimental plots were irrigated as and when it was necessary. The crops were harvested at full maturity. Maturity of crops was determined when 90% of the grains became golden yellow in color. Five hills (excluding border hills) and central 1 m × 1 m were randomly selected from each plot for recording necessary data on various crop characters and yield contributing characters. An area of 1 m^2 was selected in the middle portion of each plot to record yields of grain and straw. BRRI dhan28 and BRRI dhan74 were harvested on 28 April and BRRI dhan29 was harvested on 7 May 2018. The grains were then threshed, cleaned, sun dried and weighed to record the grain yield. The grain yield was adjusted to 14% moisture content. Straws were also sun dried and weighed to record the straw yield. Grain and straw yields were finally expressed in t ha^{-1}. Data were collected on weed density, weed dry weight and plant height, total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$, sterile spikelets $panicle^{-1}$, 1000-grain weight, grain yield, straw yield and harvest index. Harvest index was calculated using the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Economic Yield}}{\text{Biological Yield}} \times 100$$

Where, Biological yield = Grain yield+ Straw yield

Data on weed density were collected from each plot at 20 DAT, 40 DAT and 60 DAT of the rice plants by using 0.5 m × 0.5 m quadrate as per method described by Cruz *et al.* (1986). The quadrate was placed in three spots at random. The weeds within the quadrate were counted and converted to number m^{-2} multiplying by four. After counting the weed density, the weeds inside each quadrate were uprooted, cleaned, separated species-wise and dried first in the sun and then in an electrical oven for 72 hours at a temperature of 80°C. The dry weight of each species was taken by an electrical balance and expressed in g m^{-2}. From each of the unit plots five hills were selected at random and uprooted carefully and tagged before harvesting for recording data. The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package, MSTAT-C. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Economic analysis

The cost of individual head of expenditure was recorded and partial budget analysis was done. The budget consists of the following heads: A. Variable cost: All non-material and material costs constituted the variable cost. Eight working hours of a labour and a pair of bullocks were considered as a man-day and an animal-day, respectively. B. Gross income: Gross income was computed by adding market values of grain and straw yields. C. Benefit cost ratio (BCR): BCR was calculated by using the following formula:

$$\text{BCR} = \frac{\text{Gross income}}{\text{Total cost of production}}$$

Results and Discussion

Effect of cultivar on weed density and dry weight

Cultivars did not exert any significant effect on weed density at 20 and 40 days after transplanting (DAT) but showed significant effect on weed density at 60 DAT. At 60 DAT, the highest weed density (15.17 m^{-2}) was found in BRRI dhan74 and the lowest one (12.44 m^{-2}) was obtained in BRRI dhan28 (Table 1). This study shows that the highest weed density was found with the dwarf cultivar BRRI dhan74 and the lowest one with the tallest cultivar BRRI dhan28. This observation was in agreement with the finding of Hoque *et al.* (2003) who reported that the tall cultivar produced lower weed density and dry weight than the dwarf cultivar. Similar research finding was also reported by Afroz *et al.* (2019) who opined that dwarf cultivar had the highest weed density and tall stature cultivar had the lowest weed density. Cultivar did not show any significant effect on weed dry weight at 20, 40 and 60 DATs (Table 1). Numerically the lowest weed dry weight was obtained in BRRI dhan28 showing the values of 4.70, 8.32 and 10.44 at 20, 40 and 60 DATs, respectively. The highest weed dry weight was obtained in BRRI dhan29 showing the values of 9.94, 9.59 g m^{-2} at 20 and 40 DATs, respectively. But at 60 DAT, the highest weed dry weight (11.41g m^{-2}) was found in BRRI dhan74 (Table 2). The lowest weed dry weight at different DATs was observed in tall stature cultivar BRRI dhan28. Hoque *et al.* (2003) and Sunyob *et al.* (2015) also reported that short stature plant with its erect leaf habit promoted more weed growth than that of tall cultivar.

Table 1. Weed density and dry weight of *boro* rice as influenced by cultivar

Cultivar	Weed density (no. m^{-2}) at different DAT			Weed dry weight(g m^{-2}) at different DAT		
	20	40	60	20	40	60
BRRI dhan28	13.44	16.72	12.44b*	4.70	8.32	10.44
BRRI dhan29	15.22	15.83	13.89ab	9.94	9.59	10.88
BRRI dhan74	14.39	15.28	15.17a	5.77	9.43	11.41
CV (%)	30.79	26.74	18.61	15.60	27.05	26.16
Level of sig.	NS	NS	0.05	NS	NS	NS

*In a column figures having common letter(s) do not differ significantly as per DMRT

NS= Non significant

Effect of weed management practices on weed density and dry weight

Weed density was significantly influenced by weed management practices at 1% level of significance (Table 2). The highest weed density was found in no weed management practices showing the highest values of 22.67, 23.00 and 19.89 m^{-2} at 20, 40, 60 DATs, respectively. At 20 and 40 DATs the lowest weed density was found in application of pre-emergence herbicide Superhit followed by one hand weeding at 40 DAT but at 60 DAT the lowest weed density was found in both treatment of application of early post-emergence herbicide Changer (W_2 treatment) and application of Changer followed by one hand weeding at 40 DAT (W_4) treatment (Table 2). This finding partially corroborates the finding of Afroz *et al.* (2019) who found the highest weed density in no weeding treatment and the lowest one in application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 40 DAT at 20, 40 and 60 DATs. Weed dry weight was the highest in no weeding treatment and the lowest in application of early post-emergence herbicide Changer followed by one hand weeding at 40 DAT (Table 2). Weed crop competition was the highest in no weeding treatment and weed dry was the highest in no weeding treatment at different DATs. On the other hand, application of early post-emergence herbicide Changer followed by one hand weeding at 40 DAT controlled the weed effectively and this was the probable cause of lowest weed dry weight in this treatment.

Interaction effect of cultivar and weed management practices on weed density and dry weight

Weed density and dry weight were not significantly influenced by interaction of cultivar and weed management practices at different DATs (Table 3). Numerically the highest weed density (25.33, 26.00 and 22.00 m^{-2}, respectively) was found in BRRI dhan29 × no weed management practices (V_2W_0), showing the highest value at 20, 40 and 60 DAT and the lowest one (8.33 and 11.67 m^{-2}) at 20 and 40 DATs were found in BRRI dhan28 × application of pre emergence herbicide Pretilachlor followed by one hand weeding at 40 DAT (V_1W_3). At 60 DAT, the lowest weed density (8.67 m^{-2}) was found in BRRI dhan28 × application of Changer followed by one hand weeding at 40 DAT (V_1W_4) (Table 4). Numerically the highest weed dry weight (10.73, 17.00 and 19.64 g m^{-2}, respectively) was recorded in BRRI dhan29 × no weeding treatment (V_2W_0) at 20, 40 and 60 DAT. At 20 DAT, the lowest weed dry weight (3.63 g m^{-2}) was found in BRRI dhan28 × application of pre-emergence herbicide Superhit followed by one hand weeding at 40 DAT (V_1W_3), at 40 DAT the lowest weed dry weight (6.00 g m^{-2}) was found in BRRI dhan28 × two hand weedings at 20 and 40 DATs and at 60 DAT (V_1W_5), the lowest weed dry weight (7.00 g m^{-2}) was recorded in BRRI dhan28 × application of Changer followed by one hand weeding at 40 DAT (V_1W_4) (Table 3).

Table 2. Weed density and dry weight in *boro* rice as influenced by weed management practices

Weed management Practices	Weed density (no. m^{-2}) at different DAT			Weight dry weight (g m^{-2}) at different DAT		
	20	40	60	20	40	60
W_0	22.67a*	23.00a	19.89a	16.08	15.78a	19.07a
W_1	17.22b	17.56b	13.78b	6.21	9.51b	11.77b
W_2	12.56c	14.11bc	11.67b	4.68	8.34bc	9.77bc
W_3	9.78c	12.44c	12.00b	4.44	7.20bc	8.09c
W_4	10.89c	15.11bc	11.67b	4.54	6.73c	7.48c
W_5	13.00bc	13.44bc	14.00b	4.88	7.11bc	9.27bc
CV (%)	30.79	26.74	18.61	15.60	27.05	26.16
Level of sig.	0.01	0.01	0.01	NS	0.01	0.01

*In a column figures having common letter(s) do not differ significantly as per DMRT
NS = Non significant

W_0 = no weeding, W_1 = application of pre-emergence herbicide Superhit (Pretilachlor), W_2 = application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%), W_3 = Application of pre-emergence herbicide Superhit (Pretilachlor) followed by one hand weeding at 40 DAT, W_4 = application of Changer followed by one hand weeding at 40 DAT, W_5 = Two hand weedings at 20 and 40 DATs

Table 3. Weed density and dry weight in *boro* rice as influenced by interaction of cultivar and weed management practices

Cultivar × weed management practices	Weed density (no. m^{-2})			Dry weight (g m^{-2})		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
V_1W_0	21.00	23.67	19.33	7.00	14.67	19.28
V_1W_1	15.33	17.67	12.00	5.53	8.53	10.69
V_1W_2	12.00	15.00	10.33	4.10	8.10	8.61
V_1W_3	8.33	11.67	11.67	3.63	6.40	7.37
V_1W_4	10.33	14.67	8.67	3.70	6.20	7.00
V_1W_5	13.67	17.67	12.67	4.23	6.00	9.67
V_2W_0	25.33	26.00	22.00	10.73	17.00	19.64
V_2W_1	20.00	18.00	13.33	6.77	10.20	11.63
V_2W_2	12.33	13.33	10.67	5.03	9.00	9.00
V_2W_3	10.67	12.67	11.33	4.93	7.33	8.56
V_2W_4	11.00	12.00	12.33	4.87	7.00	7.67
V_2W_5	12.00	13.00	13.67	5.33	7.00	8.80
V_3W_0	21.67	19.33	18.33	8.50	15.67	18.29
V_3W_1	16.33	17.00	16.00	6.33	9.80	13.00
V_3W_2	13.33	14.00	14.00	4.90	7.93	11.70
V_3W_3	10.33	13.00	13.00	4.77	7.87	8.33
V_3W_4	11.33	13.67	14.00	5.07	7.00	7.77
V_3W_5	13.33	14.67	15.67	5.07	8.33	9.33
CV (%)	30.79	26.74	18.61	15.60	27.05	26.16
Level of sig.	NS	NS	NS	NS	NS	NS

NS = Non significant
V_1 = BRRI dhan28, V_2 = BRRI dhan29, V_3= BRRI dhan74
W_0 = no weeding, W_1 = application of pre-emergence herbicide Superhit (Pretilachlor), W_2 = application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%), W_3 = Application of pre-emergence herbicide Superhit (Pretilachlor) followed by one hand weeding at 40 DAT, W_4 = application of Changer followed by one hand weeding at 40 DAT, W_5 = Two hand weedings at 20 and 40 DATs

Yield contributing characters and yield

Effect of cultivars

Plant height was significantly influenced by cultivars (Table 4). The tallest plant (91.34 cm) was recorded from BRRI dhan28 and the shortest one (84.66 cm) was produced in BRRI dhan74 which was statistically identical to BRRI dhan29. Tyeb *et al.* (2013) observed similar variation in plant height due varietal differences. The variation of plant height is probably due to the genetic make-up of the cultivars. The number of effective tillers hill^{-1} was significantly influenced by cultivar (Table 4). The highest number of effective tillers hill^{-1} (7.43) was found in BRRI dhan29, while the lowest one (6.77) was obtained from BRRI dhan74. This was probably due to BRRI dhan29 had the highest tiller production potentiality than other cultivars. This research finding corroborates the finding of Babikar

(1986) who reported the variation of tiller production due to cultivars. Panicle length was significantly influenced by different cultivars. The longest panicle (22.17 cm) was recorded in BRRI dhan74 and the shortest one (21.74 cm) was produced by BRRI dhan28 (Table 4). Similar research finding was also reported by Afroz *et al.* (2019) who reported statistically similar panicle length of BRRI dhan29 and BRRI dhan74 in their study. Grains panicle^{-1} is a yield contributing characters and it varied due to cultivar. The highest number of grains panicle^{-1} (116.90) was observed in BRRI dhan74 and the lowest one (110.90) was found in BRRI dhan28. The heaviest 1000-grain weight (31.41 g) was obtained from BRRI dhan74 and the lowest one (21.28 g) was from BRRI dhan29 and (Table 4). Grain yield was significantly influenced by cultivar. The highest grain yield (6.08 t ha^{-1}) was recorded from BRRI dhan74 which was statistically similar with BRRI dhan29. The highest grain yield was recorded in BRRI dhan74 due to highest number of grains panicle^{-1} and heavier 1000-grain weight. The lowest grain yield (5.67 t ha^{-1}) was found in BRRI dhan28 (Table 4). Varietal variations regarding grain yield might be due to their variation in genetic constitution. The highest straw yield (7.05 t ha^{-1}) was found in BRRI dhan74 and the lowest one (6.49 tha^{-1}) was found in BRRI dhan28. Numerically the highest harvest index (46.39 %) was obtained from BRRI dhan28 while the lowest one (45.95 %) was obtained in BRRI dhan29 (Table 5).

Table 4. Effect of cultivar on yield contributing characters and yield of *boro* rice

Cultivar	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
BRRI dhan28	91.34a*	7.86	6.98ab*	21.74b	110.90b	23.06b	5.67b	6.49b	46.39
BRRI dhan29	85.82b	8.19	7.43a	21.77b	116.22ab	21.28c	5.92ab	6.90a	45.95
BRRI dhan74	84.66b	7.73	6.77b	22.17a	116.90a	31.41a	6.08a	7.05a	46.17
CV (%)	3.90	14.77	12.71	1.50	6.86	1.43	9.40	7.42	2.23
Level of sig.	0.01	NS	0.01	0.01	0.05	0.01	0.05	0.05	NS

*In a column figures having common letter(s) do not differ significantly as per DMRT
NS = Not significant

Table 5. Effect of weed management practices on yield contributing characters and yield of *boro* rice

Cultivar	Plant height (cm)	Total tillers hill^{-1} no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
W_0	85.91	5.27b*	4.98b*	21.87	94.73b	25.00b	4.00c	5.22b	43.32c
W_1	87.13	7.89a	7.02a	21.89	117.00a	25.14b	5.94b	6.78a	46.52b
W_2	88.24	8.78a	7.78a	21.93	118.20a	25.23b	6.07b	7.04a	46.29b
W_3	87.60	8.51a	7.52a	22.03	120.90a	25.68a	6.67a	7.30a	46.72b
W_4	87.62	8.53a	7.43a	21.82	119.00a	25.21b	6.29ab	7.25a	46.42b
W_5	87.13	8.59a	7.60a	21.83	118.11a	25.25b	6.39ab	7.30a	47.75a
CV (%)	3.90%	14.77	12.71	1.50	6.86	1.43	9.40	7.42	2.23
Level of sig.	NS	0.01	0.01	NS	0.01	0.01	0.01	0.01	0.01

*In a column figures having common letter(s) do not differ significantly as per DMRT
NS = Not significant

W_0 = no weeding, W_1 = application of pre-emergence herbicide Superhit (Pretilachlor), W_2 = application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%), W_3 = Application of pre-emergence herbicide Superhit (Pretilachlor) followed by one hand weeding at 40 DAT, W_4 = application of Changer followed by one hand weeding at 40 DAT, W_5 = Two hand weedings at 20 and 40 DATs

Effect of weed management practices

Plant height was not significantly influenced by different weed management practices. Numerically the tallest plant (88.24 cm) was found in application of early post-emergence herbicide Changer (W_2) and the shortest one (85.91cm) was found in no weeding condition (W_0) treatment. Weed competition was severe in weedy check condition and thus plant height in rice was reduced. On the other hand, in different weed management treatments through the crop growth period, competition at weeds with crop plant was less therefore plant height was increased. The number of total tiller hill^{-1} was significantly influenced by different weed management practices. The highest number of total tillers hill^{-1} (8.78) was observed in application of early post-emergence herbicide Changer (W_2) and the lowest number of total tiller hill^{-1} (5.27) was observed in no weeding (W_0) treatment (Table 6). In no weeding condition weed-crop competition was higher and rice crop was suppressed by weed, thus tiller production was suppressed by weed. On the other hand, in different weed management treated plots, weed was effectively controlled and thus crop growth was vigorous and tiller production was higher. Similar research finding was also reported by Parvez *et al.* (2013), Mou *et al.* (2017) and Afroz *et al.* (2019). Effective tillers hill^{-1} were significantly influenced by different weed management treatments. The highest number of effective tillers hill^{-1} (7.78) was produced when early post-emergence herbicide Changer was applied (W_2), while the lowest number of effective tillers hill^{-1} (4.98) was produced by no weeding (W_0) treatment. Similar research finding was also reported by Parvez *et al.* (2013), Mou *et al.* (2017) and Afroz *et al.* (2019). Numerically, the longest panicle (22.03 cm) was observed in application Superhit followed by one hand weeding at 40 DAT (W_3) treatment and the shortest one

(21.82 cm) was observed in application of early post emergence herbicide Changer followed by one hand weeding at 40 DAT (W_4). Number of grains panicle^{-1} was significantly influenced by different weed management practices. The highest number of grains panicle^{-1} (120.90) was found in application of Superhit followed by one hand weeding at 40 DAT (W_3) while the lowest number of grains panicle^{-1} (94.73) was produced in no weeding treatment (W_0) (Table 5). This finding corroborates the finding of Parvez *et al.* (2013) who found the highest number of grains panicle^{-1} in application Pretilachlor herbicide followed by one hand weeding at 20 DAT. The highest 1000 grains weight (25.68 g) was recorded from application of Superhit followed by one hand weeding at 40 DAT (W_3) and the lowest one (25.00 g) was obtained from no weeding (W_0) treatment (Table 6). Grain yield of *boro* rice was significantly influenced by weed management practices. The highest grain yield (6.67 t ha^{-1}) was produced by application of Superhit herbicide followed by one hand weeding at 40 DAT treatment (W_3). This was supported by the finding of Parvez *et al.* (2013) who obtained the highest grain of transplant *aman* rice with application of Pretilachlor herbicide followed by one hand weeding at 20 DAT. The lowest grain yield (4.00 t ha^{-1}) was produced by no weeding treatment (W_0). The highest straw yield (7.30 t ha^{-1}) was observed in application of Superhit followed by one hand weeding at 40 DAT (W_3) and two hand weedings at 20 and 40 DATs (W_5) treatments. These findings corroborate the findings of Parvez *et al.* (2013). The lowest straw yield (5.22 t ha^{-1}) was observed in no weeding treatment (W_0) (Table 5). Harvest index was significantly influenced by weed management practices. The highest harvest index (47.75 %) was observed in W_5 (two hand weedings at 20 and 40 DATs) treatment and the lowest one (43.32 %) was observed in W_0 (no weeding) treatment (Table 5).

Table 6. Interaction effect of cultivar and weed management practices on yield contributing characters and yield of *boro* rice

Cultivar × Weed management Practices	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	1000-grain weight(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1W_0	89.60	5.57	4.80	21.70	96.89	23.27c*	3.98	5.23	43.16
V_1W_1	91.47	7.67	6.90	21.59	113.95	22.99cd	5.72	6.43	46.76
V_1W_2	90.73	8.53	7.53	21.90	114.32	23.04cd	5.63	6.54	46.26
V_1W_3	93.27	8.40	7.47	21.92	113.97	23.44c	6.51	7.05	47.99
V_1W_4	91.33	8.40	7.33	21.66	115.13	22.56d	6.06	6.94	46.52
V_1W_5	91.67	8.60	7.80	21.70	111.23	23.06cd	6.13	6.74	47.67
V_2W_0	88.87	4.33	4.87	21.61	92.95	21.04ef	3.92	5.16	43.15
V_2W_1	84.20	8.40	7.63	21.81	116.98	20.95f	5.71	6.65	45.99
V_2W_2	86.80	9.00	8.07	21.92	121.81	21.28ef	6.16	7.23	45.99
V_2W_3	84.87	9.13	8.17	21.95	124.72	21.62e	6.79	7.43	47.74
V_2W_4	86.13	9.27	8.13	21.70	118.96	21.68e	6.33	7.34	46.32
V_2W_5	84.07	9.03	7.70	21.65	121.58	21.14ef	6.61	7.62	46.48
V_3W_0	79.27	5.90	5.27	22.29	94.35	30.69b	4.08	5.27	43.66
V_3W_1	85.73	7.60	6.53	22.27	120.20	31.49a	6.39	7.25	46.82
V_3W_2	87.20	8.80	7.73	21.98	118.47	31.38a	6.42	7.35	46.61
V_3W_3	84.67	8.00	6.93	22.21	124.01	32.00a	6.70	7.41	47.51
V_3W_4	85.40	7.93	6.83	22.09	122.88	31.38a	6.47	7.47	46.40
V_3W_5	85.67	8.13	7.30	22.14	121.62	31.54a	6.42	7.53	46.00
CV (%)	3.90%	14.77%	12.71%	1.50%	6.86%	1.43%	9.40%	7.42%	2.23%
Level of sig.	NS	NS	NS	NS	NS	*	NS	NS	NS

**In a column figures having common letter(s) do not differ significantly as per DMRT
NS = Not significant V_1 = BRRI dhan28, V_2 = BRRI dhan29, V_3 = BRRI dhan74, W_0 = No weeding, W_1 = Application of pre-emergence herbicide Superhit (Pretilachlor), W_2 = Application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%), W_3 = Application of Superhit followed by one hand weeding at 40 DAT, W_4 = Application of Changer 18WP followed by one hand weeding at 40 DAT, W_5 = Two hand weedings at 20 and 40 DATs.

Effect of interaction between cultivar and weed management practices

The interaction effect of cultivar and weed management was not significant for plant height. Numerically the tallest plant (91.67cm) was obtained from the treatment combination of V_1W_5 BRRI dhan28 × two hand weedings at 20 and 40 DAT$_s$ (V_1W_5) and the shortest one (79.27cm) was found in the treatment combination of BRRI dhan74 × no weeding V_3W_0 (Table 6). The effect of interaction between cultivar and weed management practices was statistically not significant for total tillers hill^{-1}. Apparently the highest number of total tillers hill^{-1} (9.27) was produced in BRRI dhan29 × application of early post mergence herbicide Changer followed by one hand weeding at 40 DAT) (V_2W_4), while the lowest number of total tillers hill^{-1} (4.33) was produced in treatment (BRRI dhan29 × no weeding condition) (V_2W_0). Significant variation was not found in number of effective tillers hill^{-1} due to interaction of cultivar and weed management practices. Apparently the highest number of effective tillers hill^{-1} (8.17) was produced in BRRI dhan29× application of pre emergence herbicide Superhit followed by one hand weeding at 40 DAT (V_2W_3), while the lowest number of effective tillers hill^{-1} (4.80) was produced in BRRI dhan28 × no weeding (V_1W_0) treatment.. Apparently the longest panicle (22.29 cm) was observed in BRRI dhan74 × no weeding treatment (V_3W_0) and the shortest one (21.59 cm) was found in BRRI dhan28 × application of pre-emergence herbicide Superhit (V_1W_1). Apparently the highest number of grains panicle^{-1} (124.72) was produced in BRRI dhan29 × application of pre emergence herbicide

Superhit followed by one hand weeding at 40 DAT (V_2W_3) treatment, while the lowest number of grains panicle^{-1}(92.95) was produced in BRRI dhan29 × no weeding (V_2W_0) treatment. Weight of 1000-grain was significantly affected by the interaction of cultivar and weed management practices. Apparently the highest weight of 1000 grains (32.00 g) was recorded in BRRI dhan74 × application of Superhit followed by one hand weeding at 40 DAT (V_3W_3) treatment and the lowest one (20.95g) was recorded in BRRI dhan29 × application of pre-emergence herbicide Superhit (V_2W_1). Grain yield was not influenced by the interaction of cultivar and weed management practices. Numerically the highest grain yield (6.79 t ha^{-1}) was recorded in BRRI dhan29 × application of pre emergence herbicide Superhit followed by one hand weeding at 40 DAT V_2W_3) while the lowest grain yield (3.92 t ha^{-1}) was recorded in BRRI dhan29 × no weeding (V_2W_0) treatment. Apparently the highest straw yield (7.53 t ha^{-1}) was produced in BRRI dhan74 × two hand weedings at 20 and 40 DATs (V_3W_5) and the lowest one (5.16 t ha^{-1}) was obtained in BRRI dhan29 × no weeding (V_2W_0) treatment). Apparently the highest harvest index (47.99%) was observed in BRRI dhan28 × application of pre emergence herbicide Superhit followed by one hand weeding at 40 DAT (V_1W_3) treatment while the lowest one (43.15%) was observed in BRRI dhan29 × no weeding (V_2W_0) treatment.

Economic analysis

From the economic analysis of the study it is observed that the highest BCR was obtained from BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT (V_2W_3) which was close to BRRI dhan29 with application of early post emergence herbicide, BRRI dhan74 with application of pre-emergence herbicide Superhit and BRRI dhan74 with application of early post emergence herbicide. The lowest BCR was obtained from BRRI dhan28 with no weeding (control) treatment (Fig. 1).

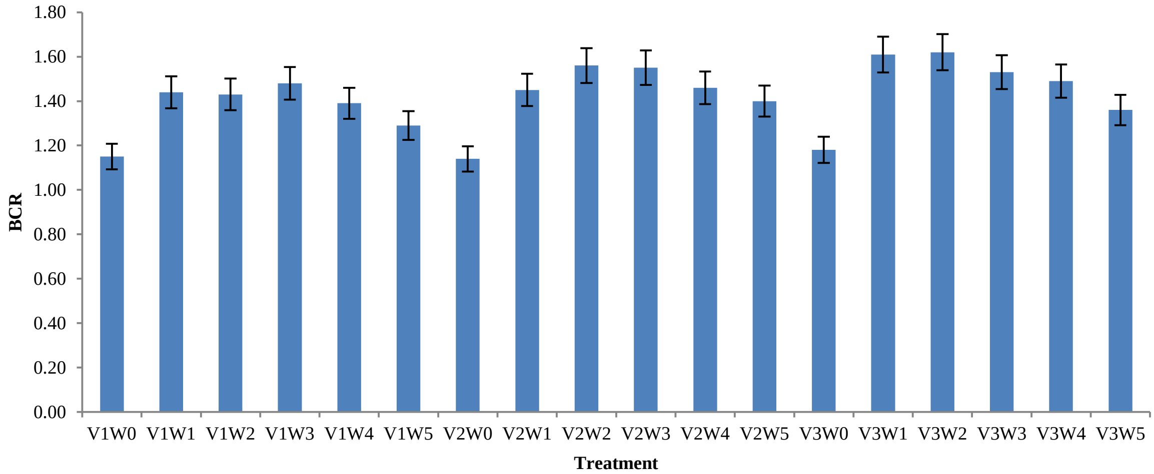

Fig. 1. Effect of interaction of variety and weed management practices on BCR

V_1 = BRRI dhan28, V_2 = BRRI dhan29, V_3 = BRRI dhan74
W_0 = No weeding, W_1 = Application of pre-emergence herbicide Superhit (Pretilachlor), W_2 = Application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%), W_3 = Application of Superhit + one hand weeding at 40 DAT, W_4 = Application of Changer 18WP + one hand weeding at 40 DAT, W_5 = Two hand weedings at 20 and 40 DATs.

Conclusion

Application of pre-emergence herbicide followed by one hand weeding at 40 DAT was effective and economic than the other weed control treatments in controlling weeds and in producing higher grain yield as well as highest economic return. So, to control weeds in effective manner and in order to get the highest grain yield as well as obtaining highest economic return in *boro* rice, BRRI dhan29 with application of pre-emergence herbicide followed by one hand weeding at 40 DAT might be recommended. However, further studies are necessary at different agro-ecological zones of the country to confirm this result.

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