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Effect of weeding regime on the performance of *boro* rice cultivars

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from December 2016 to May 2017 to investigate the effect of weeding regime on the performance of boro rice cultivars. The experiment comprised of two factors, Factor A- Rice cultivars: BRRI dhan28, BRRI dhan29, and BRRI dhan74, Factor B: Methods of weeding- no weeding, two hand weedings at 15 and 35 DATs, application of pre-emergence herbicide Commit, application of early post-emergence herbicide Pediplus, application of pre-emergence herbicide Commit followed by application of early post-emergence herbicide Pediplus, application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT, and application of early post-emergence herbicide Pediplus followed by one hand weeding at 35 DAT. The experiment was laid out in a split plot design assigning rice cultivars in the main plots and weed management practices in the sub-plots with three replications. Fourteen weed species infested the experimental field belonging to six families. Among the weed species, four were grasses, four were broad leaves and six were sedges. Cultivar exerted significant effect on weed density and dry weight. Both the highest weed density and dry weight were found in BRRI dhan28 and the lowest ones were observed in BRRI dhan29 rice cultivar. Weed density and weed dry weight were significantly influenced by weeding regime. The highest weed density and dry weight were observed in no weeding condition and application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT showed the best performance. BRRI dhan29 produced the highest grain and straw yields among the cultivars. Weed control had pronounced influence on yield of rice. The highest grain yield was obtained in application of pre-emergence herbicide Pretilachlor (Commit)followed by one hand weeding at 35 DAT and the lowest one was obtained in control (no weeding) treatment. From the results of the study it may be concluded that rice cultivar BRRI dhan29 with application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT might be the best treatment for controlling weed effectively as well as obtaining highest yield and highest economic return.

Introduction

Rice (*Oryza sativa* L.) is the dominant food crop of Bangladesh. The area and production of *boro* rice in the country were 4.44 million hectares and 18.01 million tons, respectively in 2016-2017 with the yield of 4.05 t ha^{-1} (BBS, 2018). The output of *boro* rice, which accounts for 55% of the total annual rice production, fell by 1.32% from a year earlier to 189.38 lakh tons during the production of fiscal year 2015-16, according to preliminary estimate of BBS (2016). Bangladesh is the fourth largest rice producer in the world but its productivity is low compared to other Asian countries. The average yield of rice is almost less than 50% of the world average rice grain yield. The increasing rate of population is 1.05% (BBS, 2018) and decreasing rate of agricultural land is by 1% per annum (Hussain *et al*., 2006) which limits the horizontal expansion of rice area. So, rice yield should be increased to meet this ever increasing demand of food. To overcome the situation, increment of rice production per unit area is only the alternative to bring self-sufficiency in food production.

Infestation of weed is one of the most important causes for low yield of rice. There is no doubt that maximum benefit from costly inputs like fertilizers and pesticides in rice can fully be derived when the crop is kept free from weed infestation. Production cost of rice increases due to increase in weed control cost. The present weed management system which is done manually is laborious, time consuming, expensive and cannot be done in time due to various reasons (Ahmed *et al*., 2005). Labour availability in agricultural operations has decreased in

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recent years due to migration of landless people towards the urban areas with a dream to earn more.

Rice cultivars have tremendous impact on the growth and infestation of weed in the field. Usually short stature cultivars face more weed infestation than the taller ones (Sarker, 1979). So, to avoid the weed competition and to get maximum yield from rice, appropriate cultivar should be selected. Again, 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 (Prasad and Rafy, 1995; Sathyamoorthy *et al*., 2004). Weed competition at early growth stage can be eliminated through application of herbicide. Replacement of traditional weeding in *Boro* rice by pre-emergence herbicide and early post-emergence herbicide or herbicides in combination with hand weeding would help to obtain higher crop yield. Therefore, the best weed control method needs to be found out with a view to reducing losses due to weed infestation and thus getting maximum yield. A few research works on the productivity of *Boro* rice and weed growth due to cultivar and weeding regimes have been done in Bangladesh. The present research work was, therefore, undertaken to evaluate the effect of cultivars on weed growth and yield performance of *Boro* rice, to assess the effect of weeding regime on weed growth and yield of *Boro* rice, to see the interaction effect of cultivar and weeding regime on weed growth and yield of *Boro* rice. Economics of different weeding regimes were also evaluated.

Materials and Methods

Experimental site

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2016 to May 2017 to study the effect of cultivar and weeding regime on weed growth and the performance of *Boro* rice. The experimental site belongs to the non-calcareous dark grey floodplain soil under the Agro-ecological Zone of the Old Brahmaputra Floodplain (AEZ-9) (FAO and UNDP, 1988). The soil of the experimental field was more or less neutral in reaction with pH 6.5, low in organic matter and fertility level. The land type was medium high with silt loam in texture.

Treatments and design

The experiment consists of two factors, Factor A: Rice cultivars- BRRI dhan28 (V_1), BRRI dhan29 (V_2), and BRRI dhan74 (V_3), Factor B: Methods of weeding- No weeding (W_0), Two hand weedings at 15 and 35 DATs (W_1), application of pre-emergence herbicide (Pretilchlor) @ 2 L ha^{-1}) (W_2), application of early post-emergence herbicide Pediplus (Acetachlor +Bensufuron methyl) @750 g ha^{-1}) (W_3), application of pre-emergence herbicide (Pretilchlor) followed by early post-emergence herbicide (Acetachlor +Bensufuron methyl) (W_4), application of pre-emergence herbicide (Pretilchlor) followed by one hand weeding at 35 DAT (W_5) and application of early post-emergence herbicide (Acetachlor + Bensufuron methyl) followed by one hand weeding at 35 DAT (W_6). The experiment was laid out in a split plot design assigning cultivars in the main plot and weed management practices in the sub-plots with three replications.

In no weeding treatment weeds were allowed to grow up to harvesting of the crop. In two hand weedings treatment, weeds were allowed to grow with the first 15 DAT. At 15 days one hand weeding was done. Weeds were allowed to grow with the crop till 35 DAT and then another hand weeding was given and afterwards no weeding was done till harvesting. In application of pre-emergence herbicide treatment, Pretilachlor @ 2 L ha^{-1} was applied at 4 DAT in 4 to 5 cm standing water by hand sprayer in the plots and no weeding was done till harvesting. In Application of early post-emergence herbicide treatment, Pediplus 18WP (Acetachlor + Bensufuron methyl) @ 750 g ha^{-1} mixed with urea and was applied at 12 DAT in 4-5 cm standing water in the plots and no weeding was done till harvesting. In application of pre-emergence herbicide followed by early post-emergence herbicide, pre emergence herbicide (Pretilachlor) was applied at 4 DAT and early post emergence herbicide Pediplus 18WP (Acetachlor + Bensufuron methyl) @750 g ha^{-1} mixed with urea was applied at 12 DAT in 4 to 5 cm standing water by hand sprayer in the plots and no weeding was done till harvesting. In application of pre-emergence herbicide followed by one hand weeding at 35 DAT, pre-emergence herbicide Pretilachlor @ 2 L ha^{-1} was applied at 4 DAT in 4 to 5 cm standing water by hand sprayer in the plots and at 35 days one hand weeding was done. In case of application of early post-emergence herbicide followed by one hand weeding at 35 DAT treatment, Pediplus 18WP (Acetachlor + Bensufuron methyl) @ 750 gha^{-1} mixed with urea was applied at 12 DAT in 4-5 cm standing water in the plots and at 35 days one hand weeding was done.

Agronomic management

Seeds of rice variety BRRI dhan28, BRRI dhan29 and BRRI dhan74 were collected from Bangladesh Rice Research Institute, Joydebpur, Gazipur. The sprouted seeds were sown in the nursery bed on 20 November 2016. 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. After laying out the land fertilized with urea, triple super phosphate, gypsum and zinc sulphate@ 300-100-120-110-10 kg ha^{-1}, respectively as per recommendation of BRRI (2018). The entire amounts of TSP, MoP, gypsum and zinc sulphate were applied at the time of final land preparation. Urea was applied in three equal instalments at 15, 30 and 45 days after transplanting. Seedlings were

transplanted in the well prepared puddle field on 3 January 2017 @ two seedlings hill^{-1}, maintaining row and hill distances of 25 cm and 15 cm, respectively. The experimental plots were irrigated as and when necessary. At the time when 80% of the panicles turned into golden yellow color, the crop was assessed to attain maturity. Rice cultivar BRRI dhan28 was harvested on 30 April 2017. BRRI dhan29 and BRRI dhan74 were harvested on 04 May 2017. Five hills (excluding border rows and central 1.0 m × 1.0 m area) were selected randomly from each unit plot and uprooted before harvesting for recording the data of yield and yield attributes of rice. After sampling a harvest area of central 1m × 1m was selected from each unit plot. Then the harvested crops of each plot was bundled separately and properly tagged and brought to the threshing floor. Grains were separated from the plants by pedal thresher. The collected grains and straw were cleaned and weighed. The moisture content of the collected grains was measured by grain moisture meter. Then the grain moisture content was adjusted to 14% moisture content. Finally grain and straw yields per unit area were converted to t ha^{-1}. Weed density and dry weight were recorded for weed growth data. Weeds were collected from three spots of each plot at 20, 40 DAT, 60 DAT and 80 DAT of the rice plants by using a 0.25 m × 0.25 m quadrate as per described by Cruz *et al*. (1986). The weeds within the quadrate were counted and converted to number m^{-2} multiplying by four. At 20, 40, 60 and 80 DAT weeds m^{-2} area was uprooted from all individual plots, soil from roots was cleared and the weed plant was oven dried for 72 hours at a temperature of 80^{o}C until constant weight was reached.

Statistical analysis

Data were compiled and tabulated in proper form for statistical analysis. The recorded data were statistically analyzed to find out the significance of variation resulting from the experimental treatments. All the collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated program MSTAT-C.

Results and Discussion

Infested weed species in the experimental field

Fourteen weed species infested the experimental field belonging to six families. Among the weed species four were grasses, four were broad leaves and six were sedges. Local name, scientific name, family, morphological type and life cycle of the weed in the experimental plots are presented in Table 1. The common weeds of the experimental plots were *Paspalum scrobiculatum, Echinochloa crusgalli, Leersia hexandra, Oxalis europea, Monochoria vaginalis, Ludwigia hyssopifolia, Cyperus difformis* and *Scirpus juncoides.* Bari *et al.* (1995) reported that in BAU farm the major weeds of *Boro* rice fields were *Fimbristylis miliacea, Paspalum scrobiculatum* and *Cyperus rotundus.* But from the same location Mamun *et al.* (1993) reported that *Fimbristylis miliacea, Lindernia antipola* and *Eriocaulen cenerseem* were the important weeds in transplanted *Boro* rice field.

Effect of cultivar on weed density and dry weight

Weed density and dry weight at 20, 40, 60 and 80 days after transplanting (DAT) were significantly affected by cultivar (Figure 1 and Figure 3). Over the cropping season, the highest weed density and dry weight were recorded in BRRI dhan28 and the lowest ones were observed in BRRI dhan29 (Figure 1 and Figure 3). This study shows that the highest weed density was found with the dwarf cultivar BRRI dhan28 and the lowest one with the tallest cultivar BRRI dhan29. The observation is in agreement with the finding of Sarker (1979) who reported that the tall cultivar produced lower weed density and lower weed dry weight than the dwarf cultivar.

Table 1. Infesting weed species found growing in the experimental plots of *Boro* rice

SI. No.	Local name	Scientific name	Family	Morphology	Life cycle
1.	Shama	*Echinochloa crusgalli* (L.) P. Beauv.	Poaceae	Grass	Annual
2.	Angta	*Paspalum scrobiculatum* L.	Poaceae	Grass	Perennial
3.	Arail	*Leersia hexandra Swartz*	Poaceae	Grass	Annual
4.	SabujNakful	*Cyperus difformis* L.	Cyperaceae	Sedge	Annual
5.	Pani chaise	*Eleocharis atropurpurea* (Retz.) J.Presl & C. Pres	Cyperaceae	Sedge	Annual
6.	ChotoAnguli gash	*Digitaria setigera* Roth	Cyperaceae	Grass	Annual
7.	SabujNakful	*Cyperus difformis* L.	Cyperaceae	Sedge	Annual
8.	Joina	*Fimbristylis miliacea* L.	Cyperaceae	Sedge	Annual
9.	Mutha	*Cyperus rotundus*L.	Cyperaceae	Sedge	Perennial
10.	Chesra	*Scirpus juncoides* Roxb.	Cyperaceae	Sedge	Annual
11.	Amrulshak	*Oxalis europea* L.	Oxaledaceae	Broad leaved	Annual
12.	Keshuti	*Eclipta alba* L.	Compositae	Broad Leaved	Annual
13.	Malancha	*Alternathera philoxeroides*L.	Araceae	Broad leaved	Annual
14.	Panikachu	*Monochoria vaginalis* (Burm. F.) C. Presl	Pontederiaceae	Broad leaved	Annual

Hoque *et al.* (2003) and Sunyob *et al.* (2015) also reported that short stature plant with its erect leaf habit promoted more weed growth and caused more loss than that of tall cultivar.

Effect of weeding regime on weed density and dry weight

Weed density was significantly influenced by weeding regimes at 20, 40, 60 and 80 DATs (Figure 2). At 20 DAT, the highest weed density (83.55 m^{-2}) was found in W_0 (No weeding) and the lowest one (18.78 m^{-2}) was found in W_5 (Pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. At 40 DAT, the highest weed density (90.67 m^{-2}) was found in W_0 (No weeding) and lowest one (8.44 m^{-2}) was found in W_5 (Pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT). At 60 DAT, the highest weed density (105.1 m^{-2}) was found in W_0 (No weeding) and the lowest one (18.22 m^{-2}) was found in W_5 (Pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT). At 80 DAT, the highest weed population (152.4 m^{-2}) was found in W_0 (No weeding) and the lowest one (20.45 m^{-2}) was found in W_5 (Pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) (Figure 2). Similar trend was observed in weed dry weight at 20, 40, 60 and 80 DATs (Figure 4). Weed crop competition was highest in no weeding treatment and weed dry was highest in no weeding treatment at different DATs. On the other hand, application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT controlled the weed effectively and this was the probable cause of lowest weed dry weight in this treatment.

Interaction effect of cultivar and weeding regime on weed density and dry weight

The interaction effect of cultivar and weeding regime on weed density and dry weight was found significant at 20, 40, 60 and 80 DATs (Table 2). At 20, 40, 60 and 80 DATs, the highest weed density and dry weight were recorded in BRRI dhan28 under No weeding condition and the lowest weed density and dry weight were found in BRRI dhan29 when pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT were applied (Table 2).

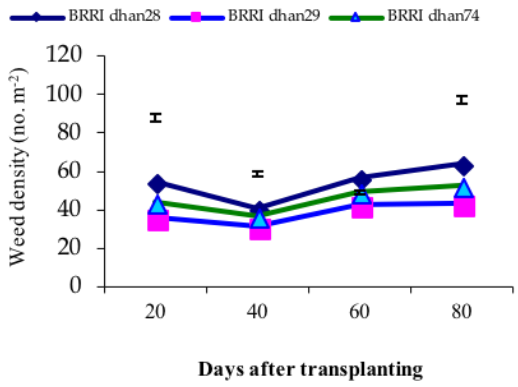

Fig.1 Effect of cultivar on weed density at 20, 40, 60, and 80 DATs

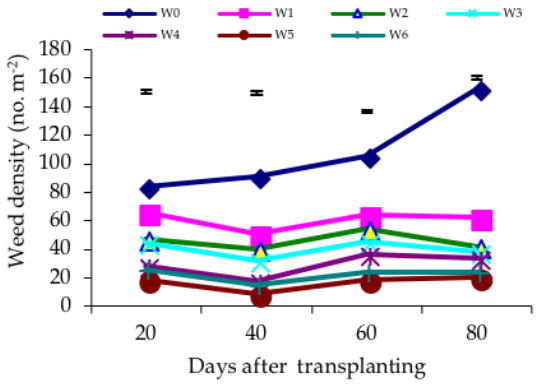

Fig. 2 Effect of weeding regimes on weed density at 20, 40, 60, and 80 DATs

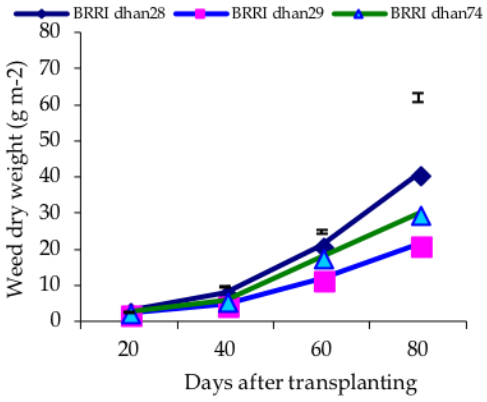

Fig.3 Effect of cultivar on weed dry weight at 20, 40, 60, and 80 DATs

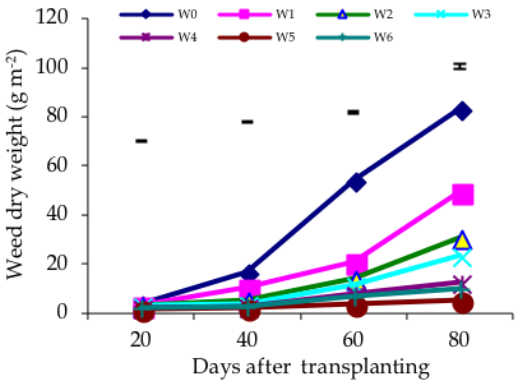

Fig. 4 Effect of weeding regimes on weed dry weight at 20, 40, 60, and 80 DATs

Table 2. Interaction effects of cultivar and methods of weeding on weed density and weed dry weight of *Boro* rice at different days after transplanting

Interaction (Cultivars × weeding methods)	Weed density (no. m^{-2}) at different DAT				Weed dry weight (g m^{-2}) at different DAT			
	20	40	60	80	20	40	60	80
V_1W_0	85.33a*	101.3a	116.0a	188.0a	3.99a	21.21a	69.17a	106.8a
V_1W_1	70.67b	53.33d	69.33d	72.00d	3.45bc	14.85bc	22.65d	72.91c
V_1W_2	68.00b	44.00ef	62.67e	45.33g	3.29bcd	5.97e	20.00e	37.81f
V_1W_3	68.00b	40.00f	49.33g	42.67gh	3.13de	5.33ef	14.40g	27.64gh
V_1W_4	34.67e	20.00j	45.33h	40.00h	2.85ef	3.75gh	8.733j	17.69i
V_1W_5	22.67ij	9.330mn	28.00kl	28.00j	1.87ijk	2.81hij	5.070 lm	6.790k
V_1W_6	32.00ef	18.67j	28.00kl	30.67ij	2.71fg	2.93hi	8.080 jk	16.09ij
V_2W_0	81.33a	78.67c	91.33c	128.0c	3.36bcd	14.0c	32.31c	58.87d
V_2W_1	61.33c	46.67e	61.33e	52.00f	3.17cd	6.13e	17.93f	31.55g
V_2W_2	30.67efg	36.00g	45.33h	34.67i	3.12de	4.68fg	9.512ij	25.99h
V_2W_3	25.33hi	24.00i	41.33i	30.67ij	2.57g	3.21hi	8.913j	17.13i
V_2W_4	20.00jk	16.00jkl	30.67jk	30.67ij	2.00hij	1.92ij	6.413kl	8.211k
V_2W_5	16.33k	6.670n	12.00n	14.67k	1.67k	1.56j	2.130n	2.170l
V_2W_6	17.33k	12.00lm	16.00m	14.67k	1.97hij	1.85ij	6.128l	7.091k
V_3W_0	84.00a	92.00b	108.0b	141.3b	3.49b	15.63b	61.77b	84.98b
V_3W_1	66.67b	52.00d	62.00e	64.00e	3.20bcd	10.33d	22.05d	44.00e
V_3W_2	43.00d	41.33f	56.00f	45.33g	3.13de	5.60ef	12.52h	27.97gh
V_3W_3	41.33d	32.00h	45.33h	41.33gh	3.11de	3.00hi	10.88hi	25.84h
V_3W_4	29.33fgh	17.33jk	33.33j	32.00ij	2.19h	2.85hij	8.172jk	12.41j
V_3W_5	17.33k	9.330mn	14.6mn	18.67k	1.77jk	2.23ij	3.677mn	6.750k
V_3W_6	26.67ghi	13.33klm	26.67l	26.67j	2.07hi	2.68hij	6.373kl	7.211k
Level of sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV (%)	5.41	6.51	3.48	5.44	5.71	11.28	5.97	7.86

*In a column, figures with same letter (s) 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 = BRRI dhan74; W_0 = No weeding, W_1 = Two hand weeding at 15 and 35 DAT, W_2 = Application of pre-emergence herbicide Commit, W_3 = Application of early post-emergence herbicide Pediplus, W_4 = Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Pediplus, W_5 = Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT, W_6 = Application of early post-emergence herbicide Pediplus followed by one hand weeding at 35 DAT

Effect on yield and yield contributing characters of rice

Effect of cultivar

Cultivar exerted significant effect on all the yield and yield contributing characters except length of panicle of *Boro* rice (Table 3). The tallest plant (86.59 cm) was observed in the cultivar BRRI dhan29 and the shortest one was observed in BRRI dhan28 cultivar. Tyeb *et al.* (2013) observed similar variation in plant height due varietal differences. Varietal differences in plant height might be due to the heredity or varietal character. The highest number (11.81 and 9.50) of total and effective tillers $hill^{-1}$ was recorded in BRRI dhan29 cultivar. The lowest number (10.10 and 7.50) of total and effective tillers $hill^{-1}$ was observed in BRRI dhan28 cultivar. This might be due to the fact that 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. The highest number (81.20) of grains $panicle^{-1}$ and the lowest number (17.43) of sterile spikelets $panicle^{-1}$were observed in BRRI dhan29 cultivar. On the other hand, the lowest number (76.82) of grains $panicle^{-1}$ was recorded in BRRI dhan28 cultivar. 1000-grain weight was the highest (29.00 g) in BRRI dhan29 cultivar and the lowest (22.18 g) in BRRI dhan28 cultivar. The highest grain yield (5.17 t ha^{-1}) was recorded in BRRI dhan29 cultivar. This might be due to the fact of producing highest number of total and effective tillers $hill^{-1}$, highest number of grains $panicle^{-1}$, lowest number of sterile spikelets $panicle^{-1}$ and heaviest 1000-grain weight of the cultivar BRRI dhan29. The lowest grain yield (3.89 t ha^{-1}) was found in BRRI dhan28 cultivar due to lowest number of total and effective tillers $hill^{-1}$, lowest number of grains $panicle^{-1}$, highest number sterile spikelets $panicle^{-1}$ and lightest 1000-grain weight. Variation in grain yield due to cultivar was also reported by IRRI (1978), Alam (1988) and Sunyob *et al.* (2015). The highest straw yield (5.80 t ha^{-1}) was found in BRRI dhan29 and the lowest one (4.99 t ha^{-1}) was observed in BRRI dhan29 (Table 3).

Table 3. Effect of cultivars on yield and yield contributing characters of *Boro* rice cultivars

Cultivars	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Length of panicle (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
BRRI dhan28	80.50c*	10.10c	7.500c	20.69b	76.82c	20.19a	22.18b	3.890c	4.990c
BRRI dhan29	86.59a	11.81a	9.500a	22.26a	81.20a	17.43c	29.00a	5.167a	5.801a
BRRI dhan74	84.34b	10.67b	8.133b	21.54ab	78.82b	18.67b	22.63b	4.169b	5.337b
Level of sig.	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01
CV (%)	2.08	2.37	6.12	5.09	2.72	4.54	8.41	4.76	4.40

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

Table 4. Effect of methods of weeding on yield and yield contributing characters of *Boro* rice cultivars

Methods of weeding	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
W_0	80.59b *	9.556e	6.72f	19.89e	76.06c	22.11a	22.95c	1.92f	3.06f
W_1	81.21b	10.22d	7.39e	20.31de	76.49c	20.89b	23.57bc	3.88e	4.83e
W_2	81.62b	10.33d	7.67e	20.71cd	76.97c	20.22b	23.87bc	4.50d	5.31d
W_3	83.08b	10.89c	8.48d	21.03cd	78.44bc	18.11c	24.64abc	4.88c	5.71c
W_4	83.64b	11.34b	8.83c	21.27c	79.62abc	17.44cd	25.08abc	5.05bc	6.08b
W_5	89.62a	12.22a	10.33a	24.31a	83.05a	15.89e	26.62a	5.45a	6.38a
W_6	86.90a	11.45b	9.22b	22.98b	81.97ab	16.67de	25.50ab	5.18b	6.25a
Sig. lev.	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01
CV (%)	2.08	2.37	6.12	24.13	5.09	2.72	4.54	8.41	4.76

*In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly; W_0 = No weeding, W_1 = Two hand weeding at 15 and 35 DAT, W_2 = Application of pre-emergence herbicide Commit, W_3 = Application of early post-emergence herbicide Pediplus, W_4 = Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Pediplus, W_5 = Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT, W_6 = Application of early post-emergence herbicide Pediplus followed by one hand weeding at 35 DAT

Effect of weeding regime

All the yield and yield contributing characters of *boro* rice were significantly affected by weeding regime (Table 4). The tallest plant (89.62 cm) was found in W_6 (application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) treatment which was statistically identical with W_6 (application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) treatment. The shortest plant (80.59 cm) was found in W_0 (No weeding) treatment which was nearly similar with W_1 (Two hand weedings at 15 and 35 DATs) and W_2 (Application of pre-emergence herbicide Pretilachlor) treatments. Weed competition was severe in no weeding condition and thus plant height in rice was reduced. On the other hand, application of early post emergence herbicide or pre-emergence herbicide followed by one hand weeding at 35 DAT treatment through the crop growth period, competition of weeds with crop plant was less therefore, plant height increased. The highest number (12.22 and 10.33) of total and effective tillers hill^{-1} was observed in W_5 (Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. The lowest number (9.55 and 6.72) of total and effective tillers hill^{-1} was observed in W_0 (No weeding) treatment. In no weeding treatment weed crop competition was higher and weed suppressed the rice plant growth ultimately tiller production was reduced (Table 3). The longest panicle (24.31 cm) was observed in W_5 (application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment and the smallest one (19.89 cm) was observed in W_0 (No weeding) treatment. Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT produced the highest number (83.05) of grains panicle^{-1} while the lowest number (76.06) of grains panicle^{-1} was observed in no weeding treatment. In this study, application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT produced the highest number of grains panicle^{-1} which might be attributed due to vigorous growth of rice plant because of less competition of crop plants with weed. The highest number (22.11) of sterile spikelets panicle^{-1} was observed in W_0 (No weeding) treatment, while the lowest number (15.89) of grains panicle^{-1} was observed in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. The highest 1000-grain weight (26.62 g) was recorded in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment, while the lowest 1000-grain weight (22.95 g) was recorded in W_0 (No weeding) treatment. The highest grain yield (5.45 t ha^{-1}) was recorded in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT)

treatment followed by W_6 (Application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) (5.18 t ha^{-1}) treatment, while the lowest grain yield (1.92 t ha^{-1}) was observed in W_0 (No weeding) treatment (Table 4). The weeds compete with the crop for nutrient, water, air, sunlight and space in no weeding treatment and reduced the grain yield of rice. The increased yield was contributed in W_5 (Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment by higher number of effective tiller hill^{-1}, higher number of grains pancicle^{-1} and heaviest 1000-grain weight over no weeding treatment. These might be due to the fact that the different weeding regime treatments reduced the weed crop competition and soil was well aerated which facilitated the crop for absorption of greater amount of plant nutrients, moisture and greater reception of solar radiation for better growth. Straw yield was significantly influenced by different weeding regimes (Table 4). The highest straw yield (6.38 t ha^{-1}) was observed in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment which was statistically identical with W_6 (application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) (6.25 t ha^{-1}) treatment, while the lowest straw yield (3.06 t ha^{-1}) was observed in W_0 (No weeding) (Table 4).

Table 5. Interaction effect of variety and methods of weeding on yield and yield contributing characters of *Boro* rice

Interaction (Cultivar × weeding regime)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Length of panicle (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Net income (Tk.)
V_1W_0	77.70	8.66h*	5.66j j	19.05g	75.48	23.33	20.67	1.83j	2.83j	-21490
V_1W_1	78.70	9.67fg	6.66hi	19.86fg	75.69	23.00	21.11	3.11i	4.13h	9960
V_1W_2	79.30	9.67fg	7.00ghi	20.55def	75.72	22.67	21.20	3.91h	5.00g	19650
V_1W_3	81.21	10.00ef	7.50efg	20.84c-f	75.72	19.00	22.40	4.13h	5.28g	33890
V_1W_4	81.70	10.67cde	8.00de	20.95c-f	77.12	18.33	22.53	4.57efg	5.84def	37070
V_1W_5	82.70	11.33c	9.33b	21.86cd	80.13	17.33	24.37	4.99d	5.94c-f	50880
V_1W_6	82.17	10.67cde	8.33cd	21.75cdc	77.86	17.67	23.00	4.68def	5.91c-f	28370
V_2W_0	82.33	10.67de	8.00de	20.35efg	76.95	20.00	26.47	2.07j	3.35i	-12300
V_2W_1	83.04	11.00cd	8.33cd	20.57def	77.62	19.00	27.80	4.55fg	5.23g	22140
V_2W_2	83.31	11.00cd	8.33cd	20.83c-f	78.89	18.67	28.13	5.36c	5.74ef	55870
V_2W_3	84.60	12.00b	9.66b	21.26c-f	80.61	17.00	29.07	5.91b	6.150bc	67850
V_2W_4	85.65	12.67a	10.50a	21.57cde	81.92	16.33	30.19	5.95b	6.390b	72100
V_2xW_5	94.30	12.67a	11.00a	26.33a	86.31	15.00	30.97	6.37a	7.000a	76000
V_2W_6	92.91	12.67a	10.67a	24.96b	86.09	16.00	30.37	5.96b	6.750a	57620
V_3W_0	81.73	9.33g	6.50i	20.27efg	75.74	23.00	21.72	1.87j	3.00j	-17350
V_3W_1	81.90	10.00ef	7.16fgh	20.50def	76.17	20.67	21.80	3.99h	5.12g	10610
V_3W_2	82.27	10.33de	7.66ef	20.74def	76.30	19.33	22.27	4.23gh	5.20g	31650
V_3W_3	83.43	10.67cde	8.26cd	20.98c-f	78.99	18.33	22.44	4.59d-g	5.71f	37680
V_3W_4	83.58	10.67cde	8.00de	21.28c-f	79.83	17.67	22.53	4.64def	6.02cde	38670
V_3W_5	91.87	12.67a	10.67a	24.75b	82.73	15.33	24.51	4.98cde	6.21bc	50450
V_3W_6	85.63	11.00cd	8.667c	22.24c	81.96	16.33	23.12	4.88def	6.10cd	24290
Level of sig.	NS	0.01	0.01	0.01	NS	NS	NS	0.01	0.01	
CV (%)	4.00	3.28	3.62	3.51	4.47	6.51	9.26	5.02	3.00	

*In a column, figures with same letter (s) 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 = BRRI dhan74

W_0 = No weeding, W_1 = Two hand weeding at 15 and 35 DAT, W_2 = Application of pre-emergence herbicide Commit, W_3 = Application of early post-emergence herbicide Pediplus, W_4 = Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Pediplus, W_5 = Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT, W6 = Application of early post-emergence herbicide Pediplus followed by one hand weeding at 35 DAT.

Interaction effect of cultivar and weeding regime

Interaction of cultivar and weeding regime exerted significant effect on total and effective tillers hill^{-1}, length of panicle, grain yield and straw yield of and non-significant effect on plant height, grains panicle, sterile spikelets panicle^{-1} and 1000-grain weight (Table 5). The highest number of (12.67) total tillers hill^{-1} was produced by BRRI dhan29 in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. Treatments W_4 (application of pre-emergence herbicide Pretilachlor followed by early post-emergence herbicide Acetachlor + Bensufuron methyl), W_6 (application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) in BRRI dhan29 and treatment W_5

(application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) in BRRI dhan74 were statistically identical. The lowest number total tillers hill^{-1} (8.66) was produced by BRRI dhan28 in W_0 (No weeding) treatment. The highest number (11.00) of effective tillers hill^{-1} was produced by BRRI dhan29 in W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. Treatments W_4 (application of pre-emergence herbicide Pretilachlor followed by early post-emergence herbicide Acetachlor + Bensufuron methyl), W_6 (application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) in BRRI dhan29 and treatment W_5 (application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) in BRRI dhan74 were statistically identical. The lowest effective tillers hill^{-1} (5.66) was produced by BRRI dhan28 in W_0 (No weeding) treatment. The longest panicle (26.33 cm) was produced by BRRI dhan29 in W_5 (Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment and the smallest one (19.05 cm) was produced by BRRI dhan28 inW_0 (No weeding) treatment (Table 5). Numerically the highest number (86.31) of grains panicle^{-1} was produced with the cultivar BRRI dhan29 × application of pre-emergence herbicide

Pretilachlor followed by one hand weeding at 35 DAT. The highest grain yield (6.37 t ha^{-1}) was produced by BRRI dhan29 in W_5 (Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment. Treatments V_2W_3 (BRRI dhan29 × Application of early post-emergence herbicide Acetachlor + Bensufuron methyl), V_2W_4 (BRRI dhan29 × application of pre-emergence herbicide Pretilachlor followed by early post-emergence herbicide (Acetachlor + Bensufuron methyl) and V_2W_6 (BRRI dhan29 × pplication of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT) were statistically identical (Table 5). The integrated approach like herbicide followed by hand weeding performed better than herbicide or hand weeding alone, such as Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT. The lowest grain yield (1.83 t ha^{-1}) was produced by V_1W_0 (BRRI dhan28 × No weeding), which was followed by V_3W_0 (BRRI dhan74 × No weeding) (1.87 t ha^{-1}). The lowest grain yield ha^{-1}in the no weeding practices might be due to the poor performance of yield contributing characters like number of tillers hill^{-1} and grains panicle^{-1}. Because of severe weed infestation occurred in the plots due to competition for moisture, nutrients between weed and rice plants. Similar research findings were also reported by Gogoi *et al.* (2000) and Attalla and Kholosy (2002). Straw yield was significantly influenced by different cultivars and weeding regimes. The highest straw yield (7.00 t ha^{-1}) was produced by BRRI dhan29 in W_5 (Application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT) treatment which was statistically identical with V_2W_6 (BRRI dhan29 × Application of early post-emergence herbicide Acetachlor + Bensufuron methyl followed by one hand weeding at 35 DAT).The lowest straw yield (2.83 t ha^{-1}) was produced by V_1W_0 (BRRI dhan28 × No weeding) which was followed by V_3W_0 (BRRI dhan74 × No weeding) (3.00 t ha^{-1}) treatment (Table 5).

Economics of different weeding regime treatments

In case of no weeding, there was no involvement of cost for weed control. It could be seen from Table 5 that the application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT (W_5) maximized (Tk. 76000 ha^{-1}) the net income and the second highest (Tk. 72100 ha^{-1}) net income was obtained from the application of pre-emergence herbicide Pretilachlor followed by early post-emergence herbicide Acetachlor + Bensufuron methyl (W_4) in BRRI dhan29. From this experiment, it is observed that application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT maximized the highest net return in BRRI dhan29 yield increase in *Boro* rice.

Conclusion

From the present study it is observed that weeding treatment pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT produced the highest grain yield and highest net return. Therefore, it may be concluded that application of pre-emergence herbicide Pretilachlor followed by one hand weeding at 35 DAT might be the best treatment for controlling weed effectively as well as obtaining highest net income in BRRI dhan29. But further studies are needed in different locations to draw a concrete conclusion.

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