Effect of weeding regime on the performance of transplanted aman rice

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Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from June to December 2016 to evaluate the effect of weeding regime on the performance of transplanted *aman* rice. The experiment consisted of three transplanted *aman* rice cultivars i.e., Nizershail, BRRI dhan62 and BRRI dhan73 with eight weeding regime treatments such as no weeding, application of pre-emergence herbicide (Rifit 500EC), application of early post-emergence herbicide (Changer 18 WP), application of pre-emergence followed by early post-emergence herbicide, application of pre-emergence herbicide followed by one hand weeding at 35 DAT , application of early post-emergence herbicide followed by one hand weeding at 35 DAT, stale seed bed technique and stale seed bed technique followed by application of early post-emergence herbicide (Changer18 WP). The experiment was laid out in a split plot design with three replications. Twelve weed species belonging to six families infested the experimental plots. Weed density and weed dry weight were significantly affected by cultivars and weeding regimes. The maximum weed growth was noticed with the dwarf cultivar BRRI dhan62 and the minimum weed growth with long stature cultivar Nizershail. Weeding regime had also significant effect on all the studied crop parameters. Among the cultivars, grain yield was the highest in BRRI dhan73 due to highest number of grains panicle^{-1} in this cultivar. The highest grain yield was obtained from application of early post-emergence herbicide (Changer18 WP) due to the highest number of effective tillers hill^{-1}, highest number of grains panicle^{-1} and heaviest 1000-grain weight in this treatment. Rice cultivar BRRI dhan73 × application of early post-emergence herbicide Changer 18WP produced the highest grain yield which was statistically similar with application of pre-emergence herbicide, application of pre-emergence herbicide followed by early post-emergence herbicide, application of pre-emergence herbicide followed by one hand weeding at 35 DAT and application of early post-emergence herbicide followed by one hand weeding at 35 DAT with the same cultivar. From the economic analysis it is observed that the highest BCR was observed from the application of early post-emergence herbicide Changer 18WP @ 1 L ha^{-1} followed by one hand weeding at 35 DAT in BRRI dhan62. Therefore, application of early post-emergence herbicide Changer 18WP @ 1 L ha^{-1} followed by one hand weeding at 35 DAT was effective and economic than other weed control treatments in controlling weeds and in producing highest net return.

Key words: Weeding regime, Yield performance. T. *aman* rice.

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops of the world, grown in wide range of climatic zones, to nourish the mankind (Chaturvedi, 2006). It is the vital food for more than two billion people in Asia and four hundred million people in Africa and Latin America (IRRI, 2006). It is the staple food in Bangladesh where it constitutes a major part of human diet. Production of rice sector contributes one-half of the agricultural GDP and one sixth of the national income in Bangladesh. About 1,14,20,725 hectare of cropped area of Bangladesh is used for rice production, with annual production of 3,47,10, 417 metric tons (BBS, 2016). Total area under *aman* crop has been estimated 55,30,014 hectare of lands (BBS, 2016). Total *aman* production of financial year 2014-15 has been estimated 1,31,90,163 metric tons compared to 1,30,23,312 metric tons of financial year 2013-14 which is 1.28% higher (BBS, 2016). Rice cultivar has tremendous impact on the growth and infestation of weed in the rice field. Weeds grow in the crop fields throughout the world. It is often said, "Crop production is a fight against weeds" (Mukhopadhyay and Ghosh, 1981). Weeds are the most competitors in their early growth stages than the later and hence the growth of crops slows down and grain yield decreases (Jacob and Syriac, 2005). Studying competition between weeds and crops can help many societies reach their goals of increased food production (Ehteshami and Esfehani, 2005). Infestation of weed is one of the most important causes for low yield of rice. In Bangladesh, weed infestation reduces the grain yield by 70-100% in *aus* rice (early summer), 30-40% for transplanted (T.) *aman* rice (late summer) and 22-36% for modern *boro* rice cultivars (summer rice) (BRRI, 2006). Production cost of rice increases due to increases in weed control cost. Timely weeding is necessary for having higher grain yield and better economic return (Gaffar *et al*., 1998). In Bangladesh, few studies have attempted to establish suitable and economic weed management system in T. *aman* rice. The present study was, therefore, undertaken to find out the effect of cultivar on the yield of transplanted *aman* rice; to evaluate the effect of different weed management practices on the performance of transplanted *aman* rice cultivars; to see the interaction effect of cultivar and weed management practices on the performance of transplanted *aman* rice and to observe the economics of different weed management practices in transplanted *aman* rice.

Materials and Methods

An experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from July to November 2016 to study the effect of different weed management practices on the performance of T. *aman* rice cultivars. The soil of the experimental field was more or less neutral in reaction with pH value 6.8, low in organic matter and fertility level. The experimental treatments were as follows: Factor A: Rice Cultivar (3), V_1 = Nizershail, V_2 = BRRI dhan62, V_3 = BRRI dhan73, Factor B: Weed Management Practices (8), W_0= No weeding, W_1=Application of pre-emergence herbicide Rifit 500EC (Pretilachlore), W_2= Application of early post-emergence herbicide Changer18 WP (Acetachlor + Bensulfuron methyl), W_3 = Application of pre-emergence herbicide followed by early post-emergence herbicide, W_4 = Application of pre-emergence herbicide followed by one hand weeding at 35 DAT, W_5 = Application of early post-

emergence herbicide followed by one hand weeding at 35 DAT, W_6 = Stale seed bed technique, W_7 = Stale seed bed technique followed by application of early post-emergence herbicide. The experiment was laid out in a split plot design assigning variety in the main plot and weed control method in the sub plot with three replications. Total number of plots was 72 having plot size was 4.0 m × 2.5 m. The distance maintained between the individual unit plots was 0.75m and that between the replications was 1.0 m. Rice cultivars BRRI dhan62, BRRI dhan73 and Nizershail were fertilized with 123-45-82.5-52.5 kg ha^{-1} of urea, triple super phosphate, muriate of potash and gypsum, respectively. Seedlings were transplanted in the well prepared puddled field on 26 July at the rate of two to three seedlings $hill^{-1}$, maintained row and hill distances of 25 cm and 15 cm, respectively. The crops were harvested at full maturity. Maturity of crops was determined when 90% of the grains became golden yellow in color. The crops were harvested on 23 October 2016 (BRRI dhan62), 27 October 2016 (BRRI dhan73) and 27 November 2016 (Nizershail). Five hills were selected randomly from each plot prior to harvesting for collecting yield and yield components. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw $plot^{-1}$ were recorded and converted to t ha^{-1}. Data were recorded on weed density and weed dry weight and yield and yield contributing characters of rice. The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package program, MSTATC. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Effect of cultivar on weed density and weed dry weight: Weed density was significantly affected at 40 and 60 DATs by cultivars (Table 1). At 40 DAT, the highest weed density (33.67 m^{-2}) was observed in the variety BRRI dhan73 and the lowest weed density (19.04 m^{-2}) was found in Nizershail. At 60 DAT, the highest weed density (42.38 m^{-2}) was found in BRRI dhan62 and the lowest one (33.54 m^{-2}) was found in Nizershail. This result shows that the highest weed density was found with the shortest cultivar BRRI dhan62 and the lowest one with the tallest cultivar Nizershail. The observation is in agreement with the findings of Sarker (1979) who reported that the tall cultivar produced lower weed population than the dwarf cultivar. Singlacher *et al.* (1978) also reported that dwarf plant with its erect leaf habit promoted more weed growth and caused more loss than that of tall cultivar. Cultivar showed significant effect on weed dry weight at 20, 40 and 60 DATs. At 20 DAT, the highest weed dry weight (34.76 g m^{-2}) was found in BRRI dhan62 and the lowest one (22.29 g m^{-2}) was found in Nizershail. At 40 DAT, the highest weed dry weight (39.00 g m^{-2}) was found in BRRI dhan62 which was significantly differ with another variety BRRI dhan73 (33.67 g m^{-2}) and Nizershail (19.04 g m^{-2}). At 60 DAT, the highest weed dry weight (51.42 g m^{-2}) was found in BRRI dhan62 and the lowest one (43.84 g m^{-2}) was found in Nizershail. It is evident that highest weed dry weight m^{-2} was observed in dwarf variety BRRI dhan62 and the lowest weed dry weight m^{-2} was observed in taller variety Nizershail. This might be due to higher competitive ability of tall rice cultivar than dwarf one against weed. This observation was in agreement with the study of Sarker (1979).

Table 1. Weed density and dry weight at 20, 40 and 60 DAT in transplanted *aman* rice as influenced by cultivar

Cultivar	Weed density (no. m^{-2})			Weed dry weight (g m^{-2})		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
Nizershail (V_1)	27.33	19.04b*	33.54b	22.29b	19.04b	43.84c
BRRI dhan62 (V_2)	33.90	26.08ab	42.38a	34.76a	26.08ab	51.42a
BRRI dhan73 (V_3)	33.75	33.67a	39.29a	34.44a	33.67a	46.51b
CV (%)	17.35	24.16	10.67	17.75	24.16	10.62
Level of significance	NS	0.01	0.01	0.01	0.01	0.05

In a column figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS = Not significant

Effect of weed management practices on weed density and weed dry weight: Weed population m^{-2} was significantly influenced by weeding regimes at 20, 40 and 60 DATs. At 20 DAT, the highest weed density (70.97 m^{-2}) was found in W_0 (No weeding) and the lowest one (20.11 m^{-2}) was found in W_3 (Application of pre-emergence herbicide followed by early post-emergence herbicide) treatment which was significantly different from other treatments (Table 2). At 40 DAT, the highest weed density (49.33 m^{-2}) was found in W_0 (No weeding) and the lowest one (17.89 m^{-2}) was found in W_3 (Application of pre-emergence herbicide followed by early post-emergence herbicide) treatment. At 60 DAT, the highest weed density (53.89 m^{-2}) was also found in W_0 (No weeding) and the lowest one (30.89 m^{-2}) was found in W_3 (Application of pre-emergence followed by early post-emergence herbicide) treatment. There was significant variation in weed dry weight due to different weed control practices at 20, 40 and 60 DATs. At 20 DAT, the highest weed dry weight (58.71g m^{-2}) was observed in W_0 (no weeding) treatment and the lowest one (19.93 g m^{-2}) was observed in W_3 (Application of pre-emergence followed by early post-emergence herbicide) treatment. At 40 DAT, the highest weed dry weight (49.33 g m^{-2}) was observed in no weeding treatment and the lowest weed dry weight (17.89 g m^{-2}) was observed in application of pre-emergence herbicide (Rifit 500EC). At 60 DAT, the highest weed dry weight (70.30 g m^{-2}) was observed in W_0 (no weeding) treatment and the lowest weed dry weight (38.94 g m^{-2}) was observed in W_3 (Application of pre-emergence herbicide followed by early post-emergence herbicide) treatment.

Table 2. Weed density and total dry weight at 20, 40 and 60 DATs in transplanted *aman* rice as influenced by weed management practices.

Weed management practices	Weed density (no. m^{-2})			Weed dry weight (g m^{-2})		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
W_0	70.97a	49.33a*	53.89a	58.71a	49.33a	70.30a
W_1	26.90bcd	22.78b	33.6cd	25.28cd	22.78b	44.59bc
W_2	21.33d	20.56b	33.11cd	20.10d	20.56b	40.66c
W_3	20.11d	17.89b	30.89d	19.93d	17.89b	38.94c
W_4	24.22cd	25.67b	35.22cd	29.04bc	25.67b	40.13c
W_5	20.41d	19.56b	34.89cd	21.69d	19.56b	42.17c
W_6	35.93b	28.11b	46.56b	35.44b	28.11b	54.37b
W_7	33.59bc	26.22b	39.00c	33.78b	26.22b	46.88bc
CV (%)	21.53	33.40	18.89	22.31	33.40	21.30
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01

*In a column figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, W_0 = No weeding, W_1 = Application of pre-emergence herbicide (Rifit 500EC), W_2 = Application of early post-emergence herbicide (Changer 18WP), W_3 = Application of pre-emergence herbicide followed by application of early post-emergence herbicide, W_4 = Application of pre-emergence herbicide followed by one hand weeding at 35DAT, W_5 = Application of early post-emergence herbicide followed by one hand weeding at 35 DAT, W_6 = Stale seed bed technique, W_7 = Stale seed bed technique followed by application of early post-emergence herbicide (Changer 18WP)

Table 3. Interaction effect of cultivar and weed management practices on weed density and dry weight at 20, 40 and 60 DAT

Cultivar × Weed management practices	Weed density (no. m^{-2})			Weed dry weight (g m^{-2})		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
V_1W_0	63.55	39.33*	43.66	44.80	34.92	63.00
V_1W_1	23.55	16.33	28.00	12.66	26.89	43.33
V_1W_2	16.22	15.00	27.00	12.66	21.33	37.66
V_1W_3	16.44	13.66	26.66	14.21	26.66	34.24
V_1W_4	13.33	16.33	30.33	18.33	30.33	36.50
V_1W_5	17.11	14.66	30.66	15.40	29.14	38.33
V_1W_6	38.66	20.33	46.00	31.00	43.33	48.33
V_1W_7	29.77	16.66	36.00	29.23	34.23	49.33
V_2W_0	76.47	48.00	67.00	58.66	56.06	84.00
V_2W_1	28.21	24.00	36.33	34.34	34.00	47.45
V_2W_2	24.22	21.33	36.66	25.92	35.58	41.68
V_2W_3	19.99	19.00	32.00	24.66	28.62	43.25
V_2W_4	25.77	25.33	34.33	29.70	34.68	38.76
V_2W_5	20.11	18.33	37.33	27.33	35.06	47.66
V_2W_6	40.66	25.33	51.33	40.66	46.33	61.24
V_2W_7	36.22	27.33	44.00	36.78	41.66	47.29
V_3W_0	72.88	60.66	51.00	72.66	67.66	63.88
V_3W_1	28.92	28.00	36.66	28.84	31.48	42.99
V_3W_2	23.55	25.33	35.66	21.70	32.96	42.64
V_3W_3	23.88	21.00	34.00	20.92	31.69	39.33
V_3W_4	33.55	35.33	41.00	39.07	39.01	45.12
V_3W_5	23.99	25.66	36.66	22.33	34.42	40.52
V_3W_6	28.44	38.66	42.33	34.66	39.22	53.54
V_3W_7	34.77	34.66	37.00	35.33	98.36	44.02
CV (%)	21.53	33.40	18.89	22.31	33.40	21.30
Level of significance	NS	NS	NS	NS	NS	NS

Interaction effect of cultivar and weed management practices on weed density and dry weight: The interaction of cultivar and weeding regime had no significant effect on weed density and dry weight at 20, 40 and 60 DATs (Table 3).

Effect of cultivar on yield and yield attributes of transplanted *aman* rice: All the yield and yield contributing characters except panicle length were significantly affected by the cultivars. The highest number of total tillers and effective tillers $hill^{-1}$ (13.34 and 10.28) was observed in BRRI dhan62 and the lowest ones (10.28 and 9.50) were found in BRRI dhan73 (Table 4). The highest number of grains $panicle^{-1}$ (116.6) was observed in BRRI dhan73 and the lowest one (98.81) was found both in Nizershail and BRRI dhan62 cultivars. The highest number of sterile spikelet $panicle^{-1}$ (32.39) was observed in Nizershail and the lowest one (18.54) was found in BRRI dhan62 which was statistically similar with BRRI dhan73. The heaviest 1000-grain weight (25.588g) was found in BRRI dhan62 (26.58 g) and the lowest one (18.54 g) was found in Nizershail. The highest grain yield (5.47 t ha^{-1}) was obtained in BRRI dhan73 and the lowest grain yield (2.91 t ha^{-1}) was obtained in Nizershail cultivar. The variation in grain yield among the cultivars might be due to the genetic constituents of the cultivars.

Table 4. Effect of cultivar on the crop characters, yield components and yield of transplanted *aman* rice

Cultivar	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Nizershail	155.90a*	12.93a	12.22a*	22.92	98.8b	32.39a	18.54c	2.91c	6.33b	31.60c
BRRI dhan62	114.50b	13.34a	12.6a	22.83	98.8b	18.54b	26.58a	4.32b	5.96c	44.03a
BRRI dhan73	125.80b	10.28b	9.5b	22.80	116.6a	19.45b	22.61b	5.46a	6.95a	43.86b
CV (%)	6.63	11	11.11	4.17	10.88	9.03	4.30	17.23	6.90	19.94
Level of significance	0.01	0.05	0.01	NS	0.01	0.01	0.01	0.01	0.01	0.05

In a column figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS = Not significant

Effect of weed management practices on the crop character, yield component and yield performance of transplanted *aman* rice: Plant height was not significantly affected by different weeding regimes. Number of total tillers hill^{-1} was significantly influenced by different weeding regimes. The highest number of total tillers hill^{-1} (13.84) was observed in W_2 (Application of early post-emergence herbicide, Changer 18 WP) which was statistically similar to W_5 (Application of early post-emergence herbicide followed by one hand weeding at 35 DAT), application of pre-emergence herbicide followed by early post-emergence herbicide treatment and application of pre-emergence herbicide followed by one hand weeding at 35 DAT treatment (Table 5). The lowest number of total tillers hill^{-1} (9.86) was observed in W_0 (No weeding) treatment. The highest number of effective tillers hill^{-1} (13.10) was produced by W_2 (Application of early post-emergence herbicide, Changer 18 WP) treatment. The lowest number of effective tillers hill^{-1} (8.90) was produced by W_0 (No weeding) treatment. Number of non-effective tillers hill^{-1} was not significantly influenced by different weeding regimes. Panicle length was significantly influenced by different weeding regimes. The longest panicle (23.93 cm) was obtained from W_2 (Application of early post-emergence herbicide Changer 18 WP) treatment which was statistically similar to W_1 (Application of pre-emergence herbicide Rifit 500EC), W_3 (Application of pre-emergence herbicide followed by early post-emergence herbicide), W_4 (Application of pre-emergence herbicide followed by one hand weeding at 35 DAT) and W_5 (Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatments. The shortest panicle (21.34 cm) was obtained from W_0 (No weeding) treatment. Number of grains panicle^{-1} was significantly influenced by different weeding regimes. The highest number of grains panicle^{-1} (108.8) was produced by W_2 (Application of early post-emergence herbicide Changer18 WP) treatment and the lowest number of grains panicle^{-1} (74.60) was produced by W_0 (No weeding) treatment. In this study application of early post-emergence herbicide (Changer 18 WP) produced the highest number of grains panicle^{-1} which might be attributed due to vigorous growth of rice plant because of less or no competition between weed and rice plant.

Table 5. Effect of weed management practices on the crop character, yield component and yield performance of transplanted *aman* rice

Weed management practices	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Sterile Spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
W_0	128.40	9.87c*	8.90*c	21.34c	21.24b	22.28	2.86e	6.41abc	29.40b
W_1	135.27	12.38b	11.69b	23.12b	21.12b	22.99	4.58abc	6.10c	45.54a
W_2	133.67	13.84a	13.10a	23.93a	25.21b	22.85	4.99a	6.36abc	45.64a
W_3	134.68	12.99b	12.39ab	23.42b	27.60a	23.11	4.74ab	6.25bc	46.35a
W_4	135.63	12.96b	12.28ab	23.58b	23.05ab	22.90	4.421bc	6.34abc	45.10a
W_5	132.41	13.13ab	12.32ab	23.19ab	19.49b	22.66	4.61abc	6.33abc	44.95a
W_6	129.18	9.87c	9.211c	21.50c	25.08ab	21.96	3.46d	6.75ab	40.10b
W_7	127.14	12.43b	11.71b	22.72b	24.89ab	21.84	4.21c	6.80a	40.86b
CV (%)	6.63	10.24	10.85	4.65	22.83	6.01	11.34	7.76	14.90
Level of significance	NS	0.01	0.01	0.01	0.05	NS	0.01	0.05	0.01

Number of sterile spikelet panicle^{-1} was significantly influenced by different weeding regimes. The highest number of sterile spikelet panicle^{-1} (27.60) was produced by W_3 (Application of pre-emergence followed by application of early post-emergence herbicide) treatment. The lowest number of sterile spikelet panicle^{-1} (19.49) was produced by W_5 (Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatment. Weight of 1000 grain was not significantly affected by weeding regime (Appendix IV). However, numerically the highest 1000-grain weight (23.11 g) was recorded in W_3 (Application of pre-emergence herbicide followed by early post-emergence herbicide and the lowest one (21.83 g) was found in W_7 (Stale seed bed technique followed by application of early post-emergence herbicide) treatment. Grain yield was significantly influenced by different weeding regimes. The highest grain yield (4.99 t ha^{-1}) was produced by W_3 (Application of early post-emergence herbicide Changer 18 WP) treatment which was statistically similar with W_1 (4.58 t ha^{-1}), W_2 (4.90 t ha^{-1}), W_4 (4.42 t ha^{-1}) and W_5 (4.61 t ha^{-1}). The lowest grain yield (2.67 t ha^{-1}) was produced in W_0 (No weeding) treatment. Straw yield was significantly influenced by different weeding regimes. The highest straw yield (6.80 t ha^{-1}) was observed in W_7 (Stale seed bed technique followed by application of early post-emergence herbicide) treatment. The lowest straw yield (6.11 t ha^{-1}) was observed in W_1 (Application of pre-

emergence herbicide, Rifit 500EC) treatment. Different weed management practices had significant effect on harvest index. The highest harvest index (46.35%) was observed in W_3 (Application of pre-emergence followed by early post-emergence herbicide) treatment and the lowest harvest index (29.40%) was observed in W_0 (No weeding) treatment.

Table 6. Effect of interaction between cultivar and weed management practices on the yield and yield components of transplanted *aman* rice

Cultivar × Weed management practices	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1W_0	153.3a	10.53f-i	9.55gh*	21.62	82.52hi	30.24bcd	18.72ef	2.13h	6.19	25.65
V_1W_1	161.7a	12.73c-g	12.18b-f	23.30	103.3de	30.25bcd	19.59cde	3.09fg	5.84	34.82
V_1W_2	158.3a	15.40ab	14.51ab	24.66	111.70bcd	33.51b	18.59ef	3.15efg	6.21	33.64
V_1W_3	156.5a	12.93c-f	12.35b-f	23.17	100.30d-g	45.16a	21.20bcd	3.16efg	6.32	33.21
V_1W_4	158.7a	13.73a-d	12.90a-d	23.51	103.30de	32.81b	19.00def	3.22efg	6.42	33.21
V_1W_5	153.4a	13.00c-e	12.34b-f	23.27	102.20def	25.64bcdef	17.27ef	3.02fg	6.27	32.56
V_1W_6	152.4a	10.60f-i	9.99f-h	21.65	88.30e-i	29.83bcd	16.85f	2.54gh	6.59	27.66
V_1W_7	152.7a	14.53a-c	13.94a-c	22.13	98.77d-h	31.68bc	17.10ef	2.10fg	6.83	30.56
V_2W_0	113.1e	11.20e-i	10.23f-h	20.87	56.08j	14.44gh	25.70a	3.17efg	5.83	35.07
V_2W_1	112.0e	13.27b-e	12.63b-e	22.52	80.16i	13.15h	26.68a	4.65bc	5.60	45.39
V_2W_2	110.9e	14.60a-c	13.91a-c	23.22	89.63e-i	17.32fgh	26.63a	5.14b	6.42	44.46
V_2W_3	113.7de	14.80a-c	14.15ab	23.33	74.23i	16.76fgh	25.97a	4.76bc	5.83	44.82
V_2W_4	111.1e	14.60a-c	13.92a-c	23.48	76.05i	14.63gh	26.48a	4.05cde	5.84	40.74
V_2W_5	113.9de	16.07a	15.18a	23.37	84.63ghi	15.17gh	27.88a	4.66bc	5.97	43.88
V_2W_6	121.1be	10.00h-g	9.32gh	22.57	72.65i	28.00bcde	26.42a	3.55def	5.90	37.53
V_2W_7	120.0cde	12.17d-h	11.55c-g	23.27	79.68i	28.87bcde	26.83a	4.58bc	6.32	29.61
V_3W_0	118.9cde	7.87j	6.92i	21.53	85.20f-i	19.04efgh	22.42b	3.28efg	7.21	31.24
V_3W_1	132.1bc	11.13e-i	10.26e-h	23.54	130.10a	19.97defgh	22.68b	6.00a	6.89	47.270
V_3W_2	131.9bc	11.53d-h	10.87d-g	23.90	125.10abc	24.80b-g	23.32b	6.67a	6.44	50.80
V_3W_3	133.8bc	11.23e-i	10.66d-h	23.75	126.3abc	20.87defgh	22.17b	6.31a	6.62	48.90
V_3W_4	137.1b	10.53f-i	10.01f-h	23.72	127.2a-d	21.72defgh	23.23b	6.00a	6.75	47.06
V_3W_5	129.9bcd	10.33g-i	9.44gh	22.91	114.70a-d	17.65fgh	22.83b	6.15 a	6.75	47.64
V_3W_6	114.1de	9.00ij	8.32hi	20.28	109.60cd	17.41fgh	22.62b	4.29bcd	7.76	35.60
V_3W_7	108.7e	10.60f-i	9.62gh	22.74	114.80a-d	14.12h	21.57bc	5.05b	7.24	41.08
CV (%)	6.63	10.24	10.85	4.65	9.37	22.83	6.01	9.50	7.76	14.90
Level of sign.	0.05	0.05	0.05	NS	0.05	0.01	0.05	0.01	NS	NS

Interaction effect of cultivar and weed management practices on the yield and yield components of transplanted *aman* rice: The effect of interaction between cultivar and weeding regime was significant for plant height. The tallest plant (161.70 cm) was obtained from Nizershail cultivar in W_1 (Application of pre-emergence herbicide, Rifit 500EC) treatment. Variety BRRI dhan73 produced the shortest plant (108.7cm) in W_7 (stale seed bed technique) treatments. The highest number of total tillers hill^{-1} (16.07) was produced by BRRI dhan62 in W_5 (Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatment, while the lowest number of total tillers hill^{-1} (7.86) was produced by BRRI dhan73 cultivar in W_0 (No weeding) treatment (Table 6). The highest number of effective tillers hill^{-1} (15.18) was produced by BRRI dhan62 in W_5 (Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatment, while the lowest number of effective tillers hill^{-1} (6.91) was produced by BRRI dhan73 cultivar in W_0 (No weeding) treatment. No significant variation was found on number of non-effective tillers hill^{-1} due to interaction of cultivar and weeding regime. Panicle length was not significantly influenced by interaction of cultivar and weeding regimes. The highest number of grains panicle^{-1} (130.10) was produced by V_3W_1 (BRRI dhan73 × Application of pre-emergence herbicide treatment which was statistically similar with BRRI dhan73 × application of pre-emergence herbicide followed by early post-emergence herbicide and BRRI dhan73 × application of early post-emergence herbicide. The lowest number of grains panicle^{-1} (56.08) was produced by V_2W_0. The highest number of sterile spikelets panicle^{-1} (45.16) was produced in V_1W_3 (Nizershail × Application of pre-emergence herbicide followed by early post-emergence herbicide) treatment. The lowest number of sterile spikelets panicle^{-1} (13.15) was produced by BRRI dhan62 cultivar in W_1. 1000-grain weight was significantly affected by interaction of cultivar and weeding regime. The highest 1000-grain weight (27.88 g) was recorded in V_2W_5 (BRRI dhan62 × Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatment which was statistically identical with BRRI dhan62 and other weed management practices. The lowest 1000-grain weight (16.85 g) was found in V_1W_6 (Nizershail × Stale seed bed technique). Grain yield was significantly influenced by interaction of cultivar and weeding regime. The highest grain yield (6.67 tha^{-1}) was produced by V_3W_2 (BRRI dhan73 × Application of early post-emergence herbicide) treatment which was statistically identical to V_3W_3 (BRRI dhan73 × Application of pre-emergence herbicide followed by application of early post-emergence herbicide), V_3W_4 (BRRI dhan73 × Application of pre-emergence herbicide followed by one hand weeding at 35 DAT) and V_3W_5 (BRRI dhan73 × Application of early post-emergence herbicide followed by one hand weeding at 35 DAT) treatment. The lowest grain yield (2.12 t ha^{-1}) was produced by V_2W_0 (BRRI dhan62 × no weeding)

treatment. 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 effective tillers $hill^{-1}$ and number of grain $panicle^{-1}$. Because there were severe weed infestation occurred in un-weeded plots due to competition for moisture, nutrients between weed and rice plants. Similar results were also reported by Gogoi *et al.* (2000), Islam *et al*. (2001) and Attala and Kholosy (2002). Straw yield was not significantly influenced by cultivar and weeding regime. Numerically, the highest straw yield (7.76 t ha^{-1}) was produced by V_3W_7 (BRRI dhan73 × Stale seed bed technique followed by application of early post-emergence herbicide) and the lowest straw yield (5.83 t ha^{-1}) was produced by V_2W_0 (BRRI dhan62 × No weeding) treatment. Harvest index was not significantly influenced by cultivar and weeding regime. Numerically the highest harvest index (48.23%) was observed in V_3W_2 (BRRI dhan73 × Application of early post-emergence herbicide, Changer 18 WP) treatment and the lowest harvest index (28.43%) was observed in V_1W_0 (Nizershail × no weeding) treatment.

Economics of different weed management practices: There are eight weed management treatments in this experiment to evaluate their economic performances in respect of benefit cost ratio of Nizershail, BRRI dhan62 and BRRI dhan73 as transplanted *aman* rice. It could be seen from the Table 7 application of Changer 18 WP @ 1 L ha^{-1} herbicide followed by one hand weeding at 35 DAT produced the highest BCR (1.64) IN BRRI dhan62 rice and the second highest BCR (1.52) was obtained from Application of pre-emergence herbicide followed by one hand weeding at 35 DAT in BRRI dhan73 rice and the lowest BCR (1.31) was obtained from no weeding treatment in BRRI dhan73 rice cultivar. But considering economic analysis, it is observed that the highest BCR was obtained in application of early post-emergence herbicide followed by one hand weeding at 35 DAT treatment. Based on the results of the study it may be concluded that application of early post-emergence herbicide followed by one hand weeding at 35 DAT is the best treatment for controlling weeds and highest BCR in transplanted *aman* rice.

Table 7. BCR of different rice cultivars due to different weed management practices

Weed management practices	Nizershail	BRRI dhan62	BRRI dhan73
No weeding	1.41	1.34	1.31
Application of pre-emergence herbicide Rifit	1.38	1.38	1.40
Application of early post-emergence herbicide Changer	1.39	1.45	1.34
Application of pre-emergence herbicide followed by early post-emergence herbicide	1.38	1.42	1.32
Application of pre-emergence herbicide followed by one hand weeding at 35 DAT	1.33	1.47	1.52
Application of early post-emergence herbicide followed by one hand weeding at 35 DAT	1.26	1.64	1.43
Stale seed bed technique	1.42	1.38	1.38
Stale seed bed technique followed by application of post-emergence herbicide	1.37	1.41	1.30

From the economic analysis of this study the highest net income was obtained from the application of Changer 18 WP @ 1L ha^{-1} herbicide followed by one hand weeding at 35 DAT (W_5). Application of herbicide and hand weeding were effective and economic than the other weed control treatments in controlling weeds and in producing higher grain yield. So, for the control of weeds in effective manner and in order to get the highest grain yield and economic return in transplanted *aman* rice, application of Changer 18 WP @ 1L ha^{-1} herbicide followed by one hand weeding at 35 DAT may be recommended. But for confirmation more studies are needed to conduct at different AEZs of Bangladesh.

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