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Effect of Integrated Weed Management on the Performance of Short Duration Transplanted *Aman* Rice Varieties

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Abstract:

An experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to October 2015 to study the effect of variety and integrated weed management practices on the yield performance of T. aman rice varieties. The experimental treatments comprised three varieties viz. BRRI dhan56, BRRI dhan62 and Binadhan-7; and six

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weeding treatments viz., W_0 (no weeding), W_1 (two hand weeding at 15 and 35 DAT), W_2 (application of Pyrazosulfuron ethyl), W_3 (application of Pyrazosulfuron ethyl + one hand weeding at 35 DAT), W_4 (stale seedbed) and W_5 (stale seedbed + application of Pyrazosulfuron ethyl). The experiment was laid out in a split plot design with three replications. The results showed that fifteen weed species belonging to ten families infested the experimental plots. Weed density was significantly affected by rice varieties. The maximum weed growth was noticed in variety BRRI dhan62 and minimum was in variety Binadhan-7. Stale seedbed and application of early post emergence herbicide (W5) produced the lowest weed density. BRRI dhan62 produced the highest grain yield due to highest number of grains panicle^{-1}. The highest number of each of total tillers hill^{-1}, effective tillers hill^{-1}, grain yield and 1000-seed weight was observed in stale seedbed treatment. From the interaction effects it is observed that numerically the highest grain yield was obtained from BRRI dhan62 × application of early post-emergence herbicide Pyrazosulfuron ethyl + one hand weeding at 35 DAT. From the results of the study it may be concluded that application of early post-emergence herbicide and one hand weeding at 35 DAT might be the best option for controlling weed as well as obtaining higher grain yield in transplanted aman rice.

Key words: Weed management, variety, yield and T. aman rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most extensively cultivated crop in Bangladesh and the staple food for her people. Bangladesh is an agricultural country with plenty of water and suitable climatic condition for rice production. About 80% of cropped area of Bangladesh is used for rice production, with annual production of 25.18 million tons from 10.29 million ha of land (IRRI, 2006). Rice alone contributes 18% of GDP and accounts for 55% labour employment in its production, processing and marketing and more than 94% of the population derives 76% of its daily calories and 66% of its protein needs from rice (BBS, 2012).

About 220 hectares agricultural lands are decreased per year due to urbanization, industrialization, housing and road construction purposes. Among different groups of rice Transplant *aman* rice covers about 48.67% of total rice area. Geographic and agronomic condition of Bangladesh is favorable for rice cultivation. In Bangladesh T. *aman* rice is grown during July-August to November to December. There are two major methods of *aman* rice crop establishment, namely, transplanting and direct sowing. Transplanting occupies the field for lesser time compared to the direct seeded crop and it facilitates the control of weeds. Rice cultivar has tremendous impact on the growth and infestation of weed in the rice field. Usually short stature cultivars face more weed infestation than the taller ones. So, to avoid the weed competition and to get maximum yield from rice, appropriate cultivar should be selected. In Bangladesh, transplant *aman* rice is most important that contributes a lot in total rice production. So, emphasis should be given to increase the *aman* rice yield through the adoption of proper management especially weed control and other management practices. Weeds grow in each of the crop field throughout the world. So it is often said that 'crop production' is a fight against weeds' (Mukhopadhay and Ghosh, 1981). Among the pests, weeds are considered an important biotic constraint to food production. Their competition with crops reduces agricultural output (quantity and quality), and increases external costs by spreading them across farm boundaries. It is also a major constraint to increased farmers' productivity, particularly in developing countries. Infestation of weed is one of the most important causes for low yield of rice. In Bangladesh, weed infestation reduces the grain yield by 30-40% for transplanted *aman* rice (Mamun, 1990; BRRI, 2008). The traditional method of weed control is hand weeding. The present weed control system which is done manually is laborious, time consuming and expensive and cannot be done on time due to various reasons (Ahmed *et al*., 2005). In developed countries, integrated weed management is extensively used to control weed but in Bangladesh, few studies have attempted to establish the most suitable and economic integrated weed management system in T. *aman* rice. Herbicides are effective in controlling weeds alone or in combination with hand weeding. The best weeding regime need to be found out with a view to reducing losses due to weed infestation and thus getting maximum yield. A few works on the productivity of transplant *aman* rice and weed growth due to cultivar and weeding regimes in rice have been done in our country. The present study was, therefore, undertaken with the following objectives: to see the effect of variety on weed growth and their performance, to find out the effect of integrated weed management on the performance of transplant *aman* rice and to find out the effect of interaction between variety and integrated weed management practices on the yield performance of T. *aman* rice.

MATERIALS AND METHODS

Description of the Experimental Site

The experimental site is located at 240 75N' latitude and 900 50' E longitude at an elevation of 18 m above the mean sea level. 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. 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 land type was medium high with silt loam in texture. The climate of the locality is tropical in nature and is characterized by high temperature and heavy rainfall during *kharif* season (April to September)

Experimental treatment

The treatment consisted of three cultivars of transplant *aman* rice and six weeding treatments as follows: Factor A: Variety (3): BRRI dhan56, BRRI dhan62 and Binadhan-7. Factor B: Weed management practices (6): W_0 = No weeding, W_1 = Hand weeding at 15 and 35 DAT, W_2 = Application of early post emergence herbicide (Pyrazosulfuron ethyl), W_3 = Application of early post emergence herbicide + one hand weeding at 35 DAT, W_4 = Stale seedbed and W_5 = Stale seedbed + application of early post emergence herbicide.

Experimental design and layout

The experiment was laid out in a split plot design assigning variety in the main plot and integrated weed management in the sub plot. Each treatment was replicated 3 times. Treatment combinations were assigned at random to a block. Total numbers of unit plots were 3×6× 3 = 54. Each plot size was 4.0 m× 2.5 m. The distance maintained between the main plot and the replications were 0.5m and 1.0 m, respectively. Layout of the experiment was done on 12 July 2015.

Crop Husbandry

A piece of land was selected for raising seedlings. The field was opened with a power tiller and subsequently ploughed four times with country plough followed by laddering. The layout of the field was made after final land preparation. Weeds and stubbles were removed and cleaned from individual plots. The seedlings were uprooted on 16 July 2015 and they were immediately transferred to the main field at the rate of two to three seedlings hill-1, maintained row and hill distance of 25 cm and 15 cm, respectively. The land was fertilized with urea, triple superphosphate, muriate of potash and gypsum as per recommendation of BRRI and BINA for BRRI dhan56, BRRI dhan62 and Binadhan-7 respectively. Varieties BRRI dhan56, BRRI dhan62 and Binadhan-7 were fertilized with 80-60-40-10 kg ha-1, 165-50-70-45 kg ha-1 and 120-15-60-10 kg ha-1urea, triple superphosphate, muriate of potash and gypsum respectively. The entire amounts of triple superphosphate, muriate of potash and gypsum were applied at the time of final land preparation. Urea was applied in three installments at 15, 30 and 45 days after transplanting (DAT). Maturity of crops was determined when 90% of the grains became golden yellow in color. Then the harvested crops of each plot except 5 hills plot-1 was bundled separately, properly tagged and brought to threshing floor. The crops were then threshed and the fresh weights of grain and straw were recorded plot-wise. 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 collection

Weed parameters: Weed density (m-2) and Weed dry weight (m-2).Crop characters at harvest: Plant height (cm), Number of total tillers hill-1, Number of effective tillers hill-1, Number of non-effective tillers hill-1, Number of grains panicle-1, Number of sterile spikelets panicle-1, Weight of 1000 grains (g), Grain yield (t ha-1), Straw yield (t ha-1) and Harvest index (%)

Statistical analysis

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package, MSTAT. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Weed parameters

The experimental plots were infested with 15 weed species belonging to nine families (Table 1). Generally conditions favourable for growing transplanted *aman* rice also favourable for the exuberant growth of a number of weed species that compete with crop plants. Weeds found in transplanted *aman* rice field are aquatic, semi aquatic, broad leaved, grasses and a few sedges which could withstand water logging usually enough to depress crop yield very significantly if not timely controlled (Mian and Gaffer, 1960).

Table 1: Infesting species of weed in the experimental field of transplanted *aman* rice

Serial No.	Local Name	Scientific Name	Family	Morphological Type
1.	Angta	*Paspalum scrobiculatum* L.	Poaceae	Grass
2.	Shama	*Echinochloa crusgalli* (L.) P. Beauv.	Poaceae	Grass
3.	Arial	*Leersia hexandra* Swartz	Poaceae	Grass
4.	Durba	*Cynodon dactylon* L.	Poaceae	Grass
5.	Sabuj nakful	*Cyperus difformis* L.	Cyperaceae	Sedge
6.	Mutha	*Cyperus rotundus* L.	Cyperaceae	Sedge
7.	Pani chaise	*Eleocharis atropurpurea* (Retz.) J. Presl & *C. Pres*	Cyperaceae	Sedge
8.	Joina	*Fimbristylis miliacea* L.	Cyperaceae	Sedge
9.	Pani marich	*Polygonum orientale* L.	Polygonaceae	Broad leaved
10	Keshuti	*Eclipta alba* L.	Compositae	Broad leaved
11	Pani kachu	*Monochoria vaginalis* (Burm. F.) *C. Presl*	Pontederiaceae	Broad leaved
12	Malancha	*Alternanthera philoxeroides* (Mart.)	Amaranthaceae	Broad leaved
13	Shusni sak	*Marsilea crenata C. Presl*	Marsileaceae	Broad leaved
14	Pani long	*Ludwigia hyssopifolia* (G. Don) Exell	Onagraceae	Broad leaved
15	Pani shapla	*Nymphaea nouchali* L.	Nymphaeaceae	Broad leaved

Effect of variety on weed density and weed dry weight

Weed density at 20 DAT was significantly affected by variety (Table 2). On the other hand, weed density at 40 and 60 DAT was not significantly affected by varieties. The highest weed density (72.83 m-2) was found in BRRI dhan62 and the lowest one (57.94 m-2) was found in BRRI dhan56. At 40 DAT, the highest weed density (71.11 m-2) was observed in the variety BRRI dhan62 and the lowest weed density (61.61 m-2) was found in BRRI dhan56. At 60 DAT numerically the highest weed density was (42.83 m-2) found in BRRI dhan62 and the lowest one (39.22 m-2) was found in Binadhan-7. There was no significant effect on total weed dry weight. At 20 DAT, the highest total weed dry weight was observed (5.71 g m-2) in Binadhan-7 and the lowest total weed dry weight was observed (5.11 g m-2) in BRRI dhan56 which did not significantly differ from the variety BRRI dhan62 (5.49 g m-2). At 40 DAT, the highest total weed dry weight was observed (42.94 g m-2) in BRRI dhan62 and the lowest one (39.79 g m-2) in BRRI dhan56. At 60 DAT, the highest total weed dry weight was observed (52.99 g m-2) in BRRI dhan62. It was evident that the highest weed dry weight was observed in BRRI dhan62 and the lowest dry weight was observed in the BRRI dhan56.

Table 2: Effect of variety on weed density and dry weight at 20, 40, and 60 DATs (Days after transplanting)

Variety	Weed density (no. m-2)			Weed dry weight (g m-2)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
BRRI dhan56	57.94b	61.61	39.78	5.11	39.79	45.15
BRRI dhan62	72.83a	71.11	42.83	5.49	42.94	52.99
BINA dhan7	71.78a	68.89	39.22	5.71	41.43	48.59
CV (%)	52.20	31.37	20.31	23.65	16.19	34.08
Level of significance	**	NS	NS	NS	NS	NS

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

** = Significant at 1% level of probability

NS = Not-significant

Effect of weed management on weed density and weed dry weight

Weed density was significantly influenced by weeding regimes at 20 and 60 DATs (Table 3). At 20 DAT, the highest weed density (167.1 m-2) was found in W_0 (no weeding) and the lowest one (16.44 m-2) was found in W_5 (stale seed and application of early post emergence herbicide) treatment which was significantly different from other treatments. At 40 DAT, the highest weed density (186.8 m-2) was found in W_0 (no weeding) and the lowest one (16.56 m-2) was found in W_5 (stale seed and application of early post emergence herbicide) treatment. At 60 DAT, the highest weed density (42.83 m-2) was also found in W_0 (no weeding) andthe lowest (17.78 m-2) was found in W_5 (stale seed and application of early post emergence herbicide) treatment. Rekha *et al.* (2002) reported that weed density was lower in all weeding practices compared to the unweeded control plot. There was significant effect of weeding regime treatment on total weed dry weight (g m-2) at 20, 40 and 60 DAT. At 20 DAT, the highest weed dry weight (14.25 gm-2) was observed in W_0 (no weeding) treatment. The lowest dry weight (1.81 g m-2) was observed in W_5 (stale seed and application of early post emergence herbicide) treatment. At 40 DAT, the highest weed dry weight (75.06 g m-2) was observed in W_0 (no weeding) and the lowest weed dry weight (8.27 gm-2) was observed in W_5 (stale seed and application of early post emergence herbicide) treatment. At 60 DAT, the highest weed dry weight (82.82 g m-2) was observed in W_0 (no weeding) and the lowest dry weight (15.50 g m-2) was observed in W_5 (stale seed and application of early post emergence herbicide) treatment.

Table 3: Effect of weed management on weed density and dry weight at 20, 40, and 60 DATs (Days after transplanting)

Variety	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	67.1a	186.8a	86.78a	14.25a	75.06a	82.82a
W_1	114.8b	91.67b	50.33b	6.93b	58.05b	66.98b
W_2	50.22c	54.33c	36.67c	4.23c	42.49c	50.27c
W_3	33.78d	28.89d	28.67cd	3.13cd	36.98d	43.54d
W_4	22.78de	25.00d	23.44d	2.24de	27.47e	34.34d
W_5	16.44e	16.56d	17.78d	1.81e	8.27f	15.50e
CV (%)	20.62	19.54	27.11	21.80	11.80	21.09
Level of significance	**	**	**	**	**	**

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

** = Significant at 1% level of probability

NS = Not-significant

Interaction effect of varieties and weed management on weed density and weed dry weight

The interaction between varieties and weeding regime was found to be insignificant at 20, 40 and 60 DATs (Table 2). At 20 DAT, the highest weed density (177.3 m-2) was found in V_3W_0 (Binadhan-7× no weeding) and the lowest one (13.00 m-2) was found in V_1W_5 (BRRI dhan56× stale seed and application of early post emergence herbicide) treatment. At 40 DAT, the highest weed density (201.3 m-2) was found in V_2W_0 (BRRI dhan62 × no weeding) and the lowest one (13.6 m-2) was in V_1W_5 ((BRRI dhan56× stale seed and application of early post emergence herbicide) treatments. At 60 DAT, the highest weed density (92.33 m-2) was found in V_2W_0 (BRRI dhan62 × no weeding) and the lowest one (17.33m-2) in V_1W_5 (BRRI dhan56× stale seed and application of early post emergence herbicide) treatment. As no significant variation observed on weed dry weight at 20, 40 and 60 DAT due to interaction effect of variety and weed management. At 20 DAT, numerically the highest weed dry weight (14.59 g m-2) was observed in V_3W_0 (Binadhan-7 × no weeding) treatment and the lowest weed dry (1.66 g m-2) was observed in V_1W_5 (BRRI dhan56× stale seed and application of early post emergence herbicide) treatment. At 40 DAT, the highest weed dry weight (77.95 g m-2) was found in V_2W_0 (BRRI dhan62 × no weeding) and the lowest dry weight was observed in V_1W_5 (BRRI dhan56× stale seedbed and application of early post emergence herbicide) treatment. At 60 DAT, the highest weed dry weight was found in V_2W_0 (BRRI dhan62 × no weeding) and the lowest weed dry weight was observed in V_2W_5 (BRRI dhan62 × stale seedbed and application of early post emergence herbicide) treatment.

Table 4: Interaction effect of varieties and weed management on weed density and dry weight at 20, 40, and 60 DATs (Days after transplanting)

Interaction (variety and weed management)	weed density (no. m-2)			dry weight (g m-2)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
$V_1 W_0$	150.7	177.7	82.00	13.88	72.49	78.45
$V_1 W_1$	98.67	75.33	49.67	6.29	55.74	55.23
$V_1 W_2$	43.00	44.00	37.00	4.14	40.39	44.85
$V_1 W_3$	24.33	31.00	29.33	2.83	35.82	41.08
$V_1 W_4$	18.00	28.00	23.33	1.89	27.09	33.16
$V_1 W_5$	13.00	13.6	17.33	1.66	7.19	18.11
$V_2 W_0$	173.3	201.3	92.33	14.29	77.95	89.82
$V_2 W_1$	123.3	92.67	52.67	7.05	61.14	81.04
$V_2 W_2$	54.33	57.00	39.00	4.27	43.93	53.02
$V_2 W_3$	36.33	30.33	30.00	3.19	37.93	44.97
$V_2 W_4$	28.67	27.33	25.00	2.28	28.01	35.24
$V_2 W_5$	21.00	18.00	18.00	1.84	8.71	13.83
$V_3 W_0$	177.3	181.3	86.00	14.59	74.74	80.20
$V_3 W_1$	122.3	107.0	48.67	7.49	57.27	64.67
$V_3 W_2$	53.33	62.00	34.00	4.30	43.16	52.93
$V_3 W_3$	40.67	25.33	26.67	3.39	37.19	44.56
$V_3 W_4$	21.67	19.67	22.00	2.58	27.30	34.61
$V_3 W_5$	15.33	18.00	18.00	1.96	8.90	14.56
CV (%)	20.62	19.54	27.11	21.80	11.80	21.09
Level of significance	NS	NS	NS	NS	NS	NS

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

V_1= BRRI dhan56, V_2= BRRI dhan62 and V_3= Binadhan-7 W_0=No weeding

W_1= Hand weeding at 15 and 35 DAT (Days after transplanting), W_2=Application of early post emergence herbicide,

W_3= Application of early post emergence herbicide and one hand weeding at 35 DAT,

W_4=Stale seedbed, W_5=Stale seedbed and application of early post emergence herbicide

Effect of variety on crop characters

Variety exerted significant effect on plant height (Table 5). Results showed that V_1 (BRRI dhan56) produced the tallest plants (126.51 cm) while V3 (Binadhan-7) produced the shortest plants (104.04 cm). The variation was probably due to the genetic makeup of the varieties (Table 5). Total tillers hill^{-1} was significantly affected by variety. The variety Binadhan-7 produced the highest number of total tillers hill^{-1} (12.61) while the variety BRRI dhan56 produced the lowest number of total tillers hill^{-1} (9.68). The highest number of effective tillers hill-1 (10.68) was found in Binadhan-7. The lowest number of effective tillers hill-1 (8.16) was obtained in BRRI dhan56. Number of non-effective tillers hill-1 was not significantly influenced by variety. Panicle length was significantly influenced by variety. The longest panicle (25.71 cm) was recorded in BRRI dhan56 which was statistically similar with BRRI dhan62 and the shortest one (23.83 cm) was recorded in Binadhan-7. Number of grains panicle^{-1} was significantly influenced by different variety. The highest number of grains panicle-1 (139.50) was observed in BRRI dhan62 and the lowest one was found (84.56) in Binadhan-7. Number of sterile spikelets panicle-1 was significantly influenced by different varieties. The variety V_2 (BRRI dhan62) produced the highest number of sterile spikelets panicle-1 (21.84) while the lowest one (13.76) was attained by the variety V_1 (BRRI dhan56). 1000-grain weight was significantly influenced by different varieties of transplanted *aman* rice. The heaviest 1000-grain weight (25.04) was found in variety Binadhan-7 and the lowest 1000-grain weight was found (20.02) in variety BRRI dhan62. These variations might be due to the genetic makeup of the varieties. As the varieties differed significantly in respect of grain yield. The highest grain yield (4.47 t ha-1) was obtained in BRRI dhan62. The highest grain yield obtained from BRRI dhan62 was mainly due to the favorable effect of highest number of grains panicle-1 (139.5) and other yield attributes. The lowest grain yield (3.90 t ha-1) was obtained in BRRI dhan56. This difference was observed due to different cultivar characteristics of rice plant. Differences in number of grain yield due to varieties were also reported by Siddeque *et al.* (2002). Straw yield was not significantly influenced by the variety. Numerically, the highest straw yield (5.14 t ha^{-1}) was found in BRRI dhan62 and the lowest straw yield (4.84 t ha^{-1})

was found in BINA dhan7. Harvest index was not significantly affected by variety. Numerically, the highest harvest index (46.51%) was found in BRRI dhan62 and the lowest one (43.19%) was found in BRRI dhan56.

Effect of weed management on crop characters

Plant height was not significantly influenced by different weed management practices (Table 6). The tallest plant (116.5 cm) was found in W_2 (application of early post emergence herbicide) treatment which was statistically identical with W1 (hand weeding at 15 and 35 DATs), and W3 (post-emergence herbicide and hand weeding at 35 DAT), W4 (stale seedbed) and W5 (stale seed and application of early post emergence herbicide) treatments. The shortest plant (105.7 cm) was found in W0 (no weeding) treatment. Number of total tillers hill^{-1} was not significantly influenced by different weed management treatment. However, numerically the highest number of total tiller hill^{-1} (12.09) was observed from W_4 (stale seedbed) treatment. The lowest number of total tillers hill^{-1} (10.80) was obtained from W_0 (no weeding) treatment. The result reveals that effective weed management enhanced effective tillers production. Number of effective tillers hill-1 was significantly influenced by variety. The highest number of effective tillers hill-1 (10.68) was found in Binadhan-7. The lowest number of effective tillers hill-1 **(**8.16) was obtained in BRRI dhan56. Number of non-effective tillers hill-1 was not significantly influenced by different weed management practices. Panicle length was significantly affected by different weed management. The longest panicle (25.78 cm) was observed in W5 (stale seed and application of early post emergence herbicide) which was statistically similar with W_2 (application of early post emergence herbicide), W3 (post-emergence herbicide and hand weeding at 35 DAT) and W4 (Stale seedbed) treatment. The shortest panicle (23.78 cm) was observed in W0 (no weeding) treatment. Number of grains panicle-1 was significantly influenced by different weed management practices. The highest number of grains panicle-1 (129.50) was produced by W3 (post-emergence herbicide and hand weeding at 35 DAT) treatment and the lowest number of grains panicle-1 (95.36) was produced by W0 (no weeding) treatment. Number of grains panicle-1 was significantly influenced by different weed management practices. The highest number of grains panicle-1 (129.50) was produced by W3 (post-emergence herbicide and hand weeding at 35 DAT) treatment and the lowest number of grains panicle-1 (95.36) was produced by W0 (no weeding) treatment. Number of sterile spikelets panicle-1 was significantly influenced by different weed management practices. The highest number of sterile spikelets panicle-1 (17.78) was produced by W0 (No weeding) treatment, while the lowest one (16.43) was produced by W4 (stale seedbed) treatment. 1000-grain weight was not significantly affected by weed management practices. Numerically the heaviest 1000-grain weight (23.03 g) was observed in W_2 (Application of early post emergence herbicide), W3 (post-emergence herbicide and hand weeding at 35 DAT), W4 (stale seedbed) and W5 (stale seed and application of early post emergence herbicide) treatments and the lowest 1000-grain weight was (22.93 g) observed in W0 (no weeding) treatment. Grain yield was significantly influenced by different weed management practices. The highest grain yield (4.56 t ha-1) was produced by W4 (stale seedbed) treatment which was statistically identical with W3 (post- emergence herbicide and hand weeding at 35 DAT) treatment, while the lowest grain yield (3.05 t ha-1) was produced by W0 (no weeding) treatment. Treatment W_1 (hand weeding at 15 and 35 DAT) and W5 (stale seed and application of early post emergence herbicide) treatment were statistically identical. Control treatment (no weeding) produced the lowest grain yield (3.05 t ha^{-1}). Different weed management practices had significant effect on straw yield. The highest straw yield (5.43 t ha^{-1}) was observed in W0 (no weeding) treatment and the lowest straw yield (4.61 t ha^{-1}) was observed in W5 (stale seed and application of early post emergence herbicide) treatment. Harvest index was significantly influenced by different weed management. The highest harvest index (47.94%) was observed in W_3 (application of early post emergence herbicide and one hand weeding at 35 DAT) treatment. The lowest harvest index (35.96%) was observed in W_0 (no weeding) treatment.

Interaction effect of variety and weed management

Plant height was significantly affected by interaction between varieties and weed management (Table 7). The tallest plant height (133.5 cm) was obtained from the variety V_1 (BRRI dhan56) with W2 (early post-emergence herbicide) treatment and the shortest one from the variety V_3 (Binadhan-7) with W_0 (no weeding) treatment. There was no significant variation in total tillers $hill^{-1}$ due to interaction between variety and weeding treatment. Significant variation was found in number of effective tillers hill-1 due to interaction between variety and weed management. The highest number of effective tillers hill-1 (12.67) was produced by Binadhan-7 in W3 (post- emergence herbicide and hand weeding at 35 DAT) treatment which was statistically identical with Binadhan-7 × stale seedbed + application of early post emergence herbicide Pyrazosulfuron ethyl. The lowest number of effective tillers hill-1 (6.77) was produced by Binadhan-7 variety in W0 (No weeding) treatment. Number of non-effective tillers $hill^{-1}$ was not significantly influenced by the interaction between variety and weed management. Panicle length was not significantly affected by variety and weed management. Numerically, the longest panicle length (26.59 cm) was found in BRRI dhan56 with W4 (stale seedbed) treatment and the shortest panicle (22.55 cm) was found in Binadhan-7 with W0 (No weeding) treatment.

Number of grains panicle-1 was not significantly influenced by different varieties and weed management. Numerically, the highest number of grains panicle-1 (176.7) was produced by BRRI dhan62 with W3 (post-emergence herbicide and hand weeding at 35 DAT) treatment and the lowest one (77.80) was produced by Binadhan-7 with W0 (no weeding) treatment. The interaction between variety and weed management had significant effect on number of sterile spikelet's panicle-1. The highest number (22.49) of sterile spikelets panicle-1 was obtained from BRRI dhan62 with W3 (post- emergence herbicide and hand weeding at 35 DAT) treatment and the lowest number (11.88) of sterile spikelet's panicle-1 was found from BRRI dhan56 with W5 (stale seed and application of early post emergence herbicide) treatment which was statistically identical with V_1W_4 (BRRI dhan56 × stale seedbed). V_3W_0, V_3W_1, V_3W_2, V_3W_3, V_3W_4 and V_3W_5 were statistically identical with each other. 1000-grain weight was not significantly affected by varieties and weed management. Grain yield was not significantly influenced by different varieties and weed management. Numerically, the highest grain yield (4.94 t ha^{-1}) was produced by V2W3 (BRRI dhan62 × post-emergence herbicide and hand weeding at 35 DAT) treatment. Similar results were also observed by Ferdous *et al.* (2016). The lowest grain yield (2.95) was obtained in BRRI dhan56 × no weeding practice might be due to the poor performance of yield contributing characters like number of tillers $hill^{-1}$ and grains panicle-1 because severe weed infestation occurred in the plots due to competition for moisture, nutrients between weed and rice plants. Similar results were also observed by Gogoi *et al.* (2000). Straw yield was not significantly influenced by variety and weed management. Harvest index was significantly influenced by different weed management. The highest harvest index (47.94%) was observed in W_3 (application of early post emergence herbicide and one hand weeding at 35 DAT) treatment. The lowest harvest index (35.96%) was observed in W_0 (no weeding) treatment.

Table 5: Effect of variety on the performance of transplanted *aman* rice

Variety	Plant height (cm)	Total tiller hill^{-1} (no.)	Effective tiller hill^{-1} (no.)	Non-effective tiller hill^{-1} (no.)	Panicle length (cm)	Grain panicle-1 (no.)	Sterile spikelets panicle-1	1000-grain weight	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index
BRRI dhan56	126.51a	9.68c	8.161c	1.53	25.71a	119.0b	13.76c	23.99b	3.90b	5.13	43.19
BRRI dhan62	108.73b	11.54b	9.344b	1.83	25.68a	139.5a	21.84a	20.02c	4.47a	5.14	46.51
BINA dhan7	104.04c	12.61a	10.68a	2.45	23.83b	84.56c	15.53b	25.04a	3.94b	4.84	44.88
CV (%)	4.29	26.21	13.89	88.9	3.09	12.03	8.93	0.53	10.24	7.80	3.38
Level of significance		**	**	NS	**	**	**	**	**	NS	NS

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

** = Significant at 1% level of probability NS = Not-significant

Table 6: Effect of integrated weed management practices on the performance of transplanted *aman* rice

Weed management practices	Plant height (cm)	Total tiller hill^{-1} (no.)	Effective tiller hill^{-1} (no.)	Non-effective tiller hill^{-1} (no.)	Panicle length (cm)	Grain panicle-1 (no.)	Sterile spikelets panicle-1	1000-grain weight	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index
W_0	105.7c	10.80	7.100c*	1.644	23.78d	95.36b	17.78a	22.93	3.05b	5.43a	35.96a
W_1	115.4ab	10.84	8.689b	1.822	24.69c	118.9a	16.75ab	23.00	4.06a	4.96ab	45.01a
W_2	116.5a	11.36	9.844a	1.822	25.11b	114.3a	17.46ab	23.03	4.37a	5.26ab	45.38a
W_3	115.1ab	11.51	10.07a	1.756	25.31b	129.5a	17.28ab	23.03	4.54a	4.93ab	47.94a
W_4	113.4ab	12.09	10.42a	3.111	25.77a	117.4a	16.43b	23.03	4.56a	5.04ab	46.87a
W_5	112.4b	11.07	10.24a	1.489	25.78a	110.7ab	16.55b	23.03	4.07a	4.61b	46.89b
CV (%)	3.00	10.61	8.07	79.65	1.70	15.43	6.39	0.59	11.66	12.93	2.90
Level of significance	NS	NS	**	NS	**	**	**	NS	**	**	**

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

** = Significant at 1% level of probability, NS = Not-significant W_0=No weeding

W_1= Hand weeding at 15 and 35 DAT (Days after taransplanting),

W_2= Application of early post emergence herbicide

W_3= Application of early post emergence herbicide and one hand weeding at 35 DAT

W_4=Stale seed bed and

W_5=Stale seed and application of early post emergence herbicide

Table 7: Interaction effect of variety and weed management on the performance transplanted *aman* rice

Interaction (Variety and Weed management)	Plant height (cm)	Total tillers hill (no.)	Effective tillers hill-1 (no.)	Non-effective tillers hill-1 (no.)	Panicle length (cm)	Grains panicle (no.)	Sterile spikelets panicle-1 (no.)	1000-grain weight (g)	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index (%)
$V_1 W_0$	115.1c	9.600	7.20gh	1.733	24.25	98.96	16.67b	23.70	2.95	5.86	33.49
$V_1 W_1$	131.7a	9.533	8.26defg	1.267	24.98	125.0	14.03cd	24.05	3.66	5.13	41.63
$V_1 W_2$	133.5a	9.867	8.63defg	1.333	25.99	124.3	14.61bcd	24.04	3.87	5.14	42.96
$V_1 W_3$	130.8a	9.533	7.93efgh	1.600	26.13	125.1	13.45de	24.05	4.32	4.83	47.21
$V_1 W_4$	124.1b	10.27	8.20defg	2.067	26.59	124.9	11.89e	24.05	4.59	5.25	46.65
$V_1 W_5$	123.9b	9.27	8.73cdef	1.200	26.34	115.6	11.88e	24.04	4.06	4.60	50.00
$V_2 W_0$	103.0ef	11.06	7.33fgh	1.600	24.54	109.3	21.59a	20.05	3.17	5.36	37.17
$V_2 W_1$	108.4de	11.67	8.47defg	2.200	25.58	148.5	21.07a	20.01	4.38	4.96	46.00
$V_2 W_2$	111.0cd	12.27	10.33b	2.267	25.59	135.9	21.79a	20.01	4.60	5. 40	48.62
$V_2 W_3$	111.0cd	11.67	9.60bcd	2.067	25.73	176.7	22.49a	20.01	4.94	5.22	48.62
$V_2 W_4$	110.7cd	11.60	10.07bc	1.467	26.29	139.2	21.99a	20.01	4.89	5.35	47.76
$V_2 W_5$	108.3de	11.00	10.27b	1.400	26.36	127.2	22.13a	20.01	4.87	4.55	51.69
$V_3 W_0$	99.00f	11.00	6.77h	1.600	22.55	77.8	15.10bcd	25.05	3.05	5.07	37.56
$V_3 W_1$	106.0de	11.33	9.33bcde	2.000	23.51	83.12	15.16bcd	25.04	4.14	4.78	46.41
$V_3 W_2$	105.1def	11.93	10.57b	1.867	23.74	82.59	15.97bc	25.04	4.63	5.24	46.91
$V_3 W_3$	103.5ef	13.33	12.67a	1.600	24.07	86.53	15.91bc	25.03	4.37	4.74	47.96
$V_3 W_4$	105.6de	14.40	12.47a	5.800	24.43	88.04	15.41bcd	25.04	4.19	4.53	48.05
$V_3 W_5$	105.1def	12.93	12.27a	1.867	24.64	89.23	15.64bc	25.03	3.28	4.70	41.10
CV (%)	3.00	10.61	8.07	79.65	1.70	15.43	6.39	0.59	11.66	12.93	2.90
Level of significance	**	NS	**	NS	NS	NS	**	NS	NS	NS	NS

*In a column figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. ** = Significant at 1% level of probability, NS = Not-significant

V_1= BRRI dhan56, V_2= BRRI dhan62 and V_3= Binadhan-7; W_0=No weeding, W_1= Hand weeding at 15 and 35 DAT (Days after transplanting), W_2= Application of early post emergence herbicide, W_3= Application of early post emergence herbicide and one hand weeding at 35 DAT, W_4=Stale seedbed and W_5=Stale seedbed and application of early post emergence herbicide.

CONCLUSIONS

From the result of the study, it could be concluded that, for the control of weeds in effective manner and in order to get considerable amount of grain yield in transplant *aman* rice, application of early post emergence herbicide Pyrazosulfuron ethyl @ 1 L ha-1 with one hand weeding at 35 DAT might be recommended. However, further studies at different locations are needed to draw a concrete conclusion.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper

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