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Effect of Variety and Herbicidal Weed Management Practices on the Performance of Transplant *Aman* Rice

Md. ABDUS SALAM
Professor
Department of Agronomy
Bangladesh Agricultural University, Mymensingh, Bangladesh
Email: salamma71@yahoo.com
SINTHIA AFSANA KHEYA
Lecturer
Department of Agronomy
Bangladesh Agricultural University, Mymensingh, Bangladesh
Email: sinthia.agron@bau.edu.bd
KAZI ASHIKA MAHMUDA ONNA
Department of Agronomy
Bangladesh Agricultural University, Mymensingh, Bangladesh
Email: onna.22120122@bau.edu.bd
Md. SHAFIQUL ISLAM[1]
Associate Professor
Department of Agronomy
Bangladesh Agricultural University, Mymensingh, Bangladesh
Email: shafiqagron@bau.edu.bd

Abstract

Weeds are one of the major biological constraints to rice production. The prevention of weed competition and provision of weed free environment at critical period of rice growth is necessary for successful rice production. So, the best weeding regime need to be found out with a view to reducing losses due to weed infestation and thus getting maximum yield of rice. In order to address the challenge a field experiment was conducted to find out the effect of variety and weed management practices on the performance of transplant aman rice. Two components made up the experimental treatment where three different rice cultivars were subjected to six different weeding regimes. The experiment was laid out in a split plot design with three replications. The cultivars were assigned to the main plot and weeding regimes were assigned to the sub plots. Results revealed that eight weed species belonging to five families (Paspalum scrobiculatum, Echinochloa crusgalli, Leersia hexandra, Oxalis europaea, Monochoria vaginalis, Ludwigia hyssopifolia, Cyperus difformis and Scirpus juncoides) infested the experimental field. Comparing BRRI dhan56 to other rice cultivars and weeding methods, it showed better competitive potential due to its lowered dry weight and weed density when cultivated on stale seed bed with one hand weeding at 35 days after transplanting. The maximum grain yield of 4.47 t ha^{-1} was obtained by the rice cultivar BRRI dhan62 when early post-emergence herbicide was used and one-hand weeding was done at 35 days after planting. This yield and its features are statistically comparable to those of BRRI dhan56 when stale seed bed technique was used and one-hand weeding was done at 35 days after planting. Therefore, since BRRI dhan56 is a long-stature cultivar and has a greater competitive capacity against weeds than BRRI dhan62 and Binadhan-7, it may be suggested for transplanting during aman season combined with stale seed bed technique and one-hand weeding at 35 DAT.

Key Words: Weed dynamics, T. *aman* rice, weed management, herbicide, stale seed bed technique

[1] Corresponding author

1. INTRODUCTION:

Rice, one of the most critical stable crops, plays a pivotal role in ensuring global food security and nourishing almost half of the world's population (Anwari *et al*., 2019; Javed *et al*., 2021). It is cultivated in diverse agro-climatic conditions across many countries covering one-third of the world's total cropped area (Jahan *et al*., 2022). The people in Bangladesh depend on rice as staple food. Being the 3rd largest rice producer of the world (38.14 million tons), Bangladesh comprises an area of 11.70 million ha for rice production (BBS, 2022). According to National Agricultural Commission to feed the increased population in 2050, 47 million tons of rice will be needed to produce. But, the average yield of rice in Bangladesh is 3.26 t ha^{-1} (BBS, 2022). This yield is much lower than that of other rice producing countries like Japan (6.8 t ha^{-1}), Korea (6.8 t ha^{-1}) and China (6.3 t ha^{-1}) (IRRI, 2005). This is due to lack of proper agronomic management practices like optimum cultivars, optimum plant population m^{-2}, weed management, water management, etc.

Among several reasons responsible for rice yield reduction, weed is the most significant biogenic factor. Weed infestation is regarded as one of the major causes of low crop yields throughout the world and can cause 50-60% reduction in grain yield under puddled conditions and 91% yield reduction in non-puddled conditions (Ali and Sankaran, 1984). Similarly, yield loss due to uncontrolled weed growth in transplanted rice has been calculated as 17-47% and 14-93% in upland rice (Rangit, 1999). Mamun (1990) pointed out that weed growth reduced the grain yield by 68 - 100% for direct seeded *aus* rice, 16 - 48% for transplant *aman* rice and 22 - 36% for modern *boro* rice in Bangladesh. This loss is, therefore, a serious threat for a densely populated country like Bangladesh. Therefore, prevention of weed competition and provision of weed free environment at critical period of rice growth is necessary for successful rice production.

Rice cultivar has 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. Weed free during the critical period of competition is essential for optimum rice yield.

In rice, the conventional method of weed control i.e. hand weeding is very laborious, expensive and inefficient. Due to the labor shortage during the peak season, these procedures have currently become a challenging task and ultimately minimize significant amount of yield (Hasanuzzaman *et al.,* 2009). Herbicidal weed control methods offer an advantage to save labour and money, as a result, regarded as cost effective method of weed control (Ahmed *et al.,* 2000). Though chemical herbicides offer an effective and practical solution for weed management, their widespread use raises sustainability concerns such as herbicide-resistant weed development and changes in weed flora (Duary, 2008). Otherwise, herbicides may provide the main means of control, these alone are unlikely to be successful unless combined with good land preparation and, in the lowland systems, good water control. An alternative weed management practice is the stale seedbed technique. It is a weed management practice in which weed seeds just below the soil surface are allowed to germinate and then killed prior to planting the crop while minimizing soil disturbances. The stale seedbed technique is based on the premise that weeds which germinate and emerge before the crop is planted are easier to manage. Though the stale seedbed technique can be effective, like any weed management tactic there are some drawbacks. Weeds with lengthy

emergence periods may not be managed as well with this technique. Soil conditions such as moisture and temperature affect weed emergence and these factors cannot be controlled. Actually, no one weed control method is likely to control all weeds, and in the long term this can lead to a build-up of certain species. The combination of direct weed control methods, such as herbicides or hand weeding, with indirect methods such as land preparation, stale seed bed, flooding and a competitive crop, may help to prevent this situation.

So, 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 has been done in our country. Addressing all of the above issues, this experiment was carried out to evaluate the weed control efficiency of different weeding regimes and to see their effects on yield and yield components of transplant *aman* rice.

2. MATERIALS AND METHODS

2.1 Features of the experimental location

The experiment was carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from July to October 2023 to study the effect of cultivar and weeding regime on the performance of short duration transplant *aman* rice. In terms of location, the site is located at latitude 24°42′55″N, longitude 90°25′47″E, and elevation 19 m above sea level. The test site is in the Old Brahmaputra Floodplain (AEZ-9) having subtropical monsoon climate with a humid environment. 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 silty loam in texture.

2.2 Experimental treatments and design

Two components made up the experimental treatment where three rice cultivars viz. BRRI dhan56 (V_1), BRRI dhan62 (V_2) and Binadhan-7 (V_3) were subjected to six different weeding regimes viz., W_0 = No weeding, W_1 = Two hand weedings at 15 and 35 DATs, W_2 = Application of early post emergence herbicide (Pyrazosufuron ethyl), W_3 = Application of early post emergence herbicide (Pyrazosufuron ethyl) followed by one hand weeding at 35 DAT, W_4 = Stale seedbed, W_5 = Stale seedbed followed by one hand weeding at 35 DAT. The experiment was laid out in a split plot design with three replications. The cultivars were assigned to the main plot and weeding regimes were assigned to the sub plots. Total numbers of unit plots were 3×6×3= 54 and each plot size was 4.0 m × 2.5 m. The distance maintained between the individual unit plots was 0.5 m and that between the replications was 1.0 m.

Table 1: **Description of the treatments**

Treatments	Description
V_1	The rice variety BRRI dhan56 was developed by Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh and released in 2011. Average plant height is 115 cm and 1000-grain weight is 23.6 g. Duration of life cycle is 105-110 days in *aman* season. Average yield is 4.5-5 t ha^{-1}. Medium salt and drought tolerant.
V_2	The rice variety BRRI dhan62 was developed by Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh and released in 2013. Average plant height is 98 cm and 1000-grain weight is 24 g. Duration of life cycle is 100 days. Average yield is 3.5-4.5 t ha^{-1}. Drought tolerant.
V_3	The variety Binadhan-7 was developed by the Bangladesh Institute of Nuclear Agriculture (BINA) in 2007. Duration is 110-120 days from seed to seed in *aman* season. Plants are medium with 95 cm height. Average yield is 4.8 t $ha^{-1.}$
W_0	No weeding was done from transplanting to harvesting the crop.
W_1	Weeds were allowed to grow with the crop for the first 14 DAT. At 15 DAT days one hand weeding was done. Thereafter weeds were allowed to grow with the crop till 34 DAT and at 35 DAT, another hand weeding was given and afterwards no weeding was done till harvesting.
W_2	Early post emergence herbicide Manage 10WP @ 225 g ha^{-1} was applied at 9 DAT in 4-5 cm standing water mixing with small amount of urea fertilizer in the plots and thereafter no weeding was done till harvesting.
W_3	Manage 10 WP @ 225 g ha^{-1} was applied at 9 DAT in 4-5 cm standing water mixing with small amount of urea fertilizer in the plots. Weeds in the plots after herbicide application were allowed to grow with the crop for the first 34 DAT. At 35 days one hand weeding was done and afterwards no weeding was done till harvesting.
W_4	After ten days the germinated weed seedling were destroyed by spading. Then rice seedlings were transplanted.
W_5	After ten days the germinated weed seedling were destroyed by spading. Then rice seedlings were transplanted. After applying stale seed bed technique weeds were allowed to grow with the crop for the first 34 DAT. At 35 days one hand weeding was done and thereafter no weeding was done till harvesting.

2.3 Crop husbandry

A piece of land was selected for raising seedlings. The land was puddled well with country plough followed by leveling with a ladder. The sprouted seeds were sown in the nursery bed on 21 July 2023. The seedlings were uprooted on 16 July 2023 without causing much mechanical injury to the roots and they were immediately transferred to the main field. The field was opened with a power tiller and subsequently ploughed four times with country plough followed by laddering. The land was fertilized with urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate as per recommendation of BRRI for all the varieties (BRRI, 2022). The fertilizer rate was 170-70-100-60-10 kg ha^{-1} urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate, respectively. The entire amounts of triple superphosphate, muriate of potash, gypsum and zinc sulphate were applied at the time of final land preparation. Urea was applied in three installments at 7, 22 and 37 days after transplanting (DAT).

2.4 Data collection

Data on weed density were collected from each plot at 15 DAT and 35 DAT of the rice plants by using 0.5 m × 0.5 m quadrate as per method described by Cruz *et al.* (1986). The quadrate was placed in three spots at random. The weeds within the quadrate were

counted and converted to number m^{-2} multiplying by four. After counting the weed density, the weeds inside each quadrate were uprooted, cleaned, separated species-wise and dried first in the sun and then in an electrical oven for 72 hours at a temperature of 80°C. The dry weight of each species was taken by an electrical balance and expressed in g m^{-2}.

At maturity (90% ripened grain), the entire plant was cut with a sickle at the ground level. The rice cultivars Binadhan-7 and BRRI dhan62 were harvested on 20 October and BRRI dhan56 was harvested on 25 October 2023. Each pot's harvested crop was packed and carefully marked separately. Following sun drying of the plant materials, separate records of grain and straw yields and yield-contributing parameters were made. From randomly chosen sample plants from each plot, data of growth, yield and yield-contributing characteristics were recorded.

2.5 Statistical analysis of data

Data recorded for various parameters were properly collated, tabulated and statistically analyzed. Utilizing the MSTAT-C software tool, the analysis of variance was carried out. Duncan's Multiple Range Test was used to adjudge the mean differences among the treatments.

3. RESULTS AND DISCUSSION

3.1 Infested weed species in the experimental field

Eight weed species belonging to five families infested the experimental field. Among the eight species of weeds three were grasses, three were broad leaves and two were sedges. Local name, scientific name, family and life cycle of the weed in the experimental plot have been presented in Table 1. The important weeds of the experimental plots were *Paspalum scrobiculatum*, *Echinochloa crusgalli*, *Leersia hexandra*, *Oxalis europaea*, *Monochoria vaginalis*, *Ludwigia hyssopifolia*, *Cyperus difformis* and *Scirpus juncoides*. Bari *et al*. (1995*)* in the experiment at BAU reported that the three important weeds of transplanted *aman* 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 important species of weeds in transplant *aman* rice field. The values of present results varied a little bit from those reports and those might be due to seasonal variations.

Table 2: Infesting weed species found growing in the experimental plots in T. *aman* rice

Sl. No.	Local name	Scientific name	Family	Life cycle
1	Angta	*Paspalum scrobiculatum* L.	Poaceae	Perennial
2	Shama	*Echinochloa crusgalli* (L.) P. Beauv.	Poaceae	Annual
3	Arail	*Leersia hexandra* Swartz	Poaceae	Perennial
4	Amrul shak	*Oxalis europaea* L.	Oxaledaceae	Annual
5	Panikachu	*Monochoria vaginalis* (Burm. F.) C. Presl	Pontederiaceae	Perennial
6	Panilong	*Ludwigia hyssopifolia* (G. Don) Exell	Onagraceae	Annual
7	Sabuj Nakphul	*Cyperus difformis* L.	Cyperaceae	Annual
8	Chechra	*Scirpus juncoides* Roxb.	Cyperaceae	Perennial

3.2 Weed density and weed dry weight

Effect of cultivar

Weed density at 15 and 35 DATs was significantly affected by cultivars. The highest weed density was observed in BRRI dhan62 which was statistically similar with Binadhan-7. The lowest weed density was observed in the cultivar BRRI dhan56. Though weed dry weight was not significantly affected by cultivars but the cultivar BRRI dhan56 produced the lowest weed dry weight at 15 and 35 DATs. The cultivars with lower weed densities were able to limit weeds because they were better capable of competing with weeds for resources. Crop species, even variants of the same species, have different capacities for engaging in resource competition. The cultivars with the lowest weed density were able to suppress the weeds because they were more potent to compete for resources than weeds. Salma *et al.* (2017) also reported that weed population was significantly influenced by variety. On the other hand, this result indicates that higher weed density was observed in the plots of dwarf statured rice cultivar Binadhan-7 and the lowest weed density was found in the plots of tall statured rice cultivar BRRI dhan56. This observation was in agreement with the findings of Sarker (1979) who reported that tall cultivar produced lower weed population than the dwarf cultivar.

3.3 Effect of weeding regime

Weed density and weed dry weight were significantly influenced by weeding regimes at 15 and 35 DATs (Table 3). At 15 DAT, the highest weed density (167.11 m^{-2}) and weed dry weight (14.25 g m^{-2}) were found in W_0 (No weeding) and the lowest (16.4 m^{-2} and 1.82 g m^{-2}) were found in W_5 (Stale seedbed + one hand weeding at 35 DAT) treatment which was significantly different from other treatments. Rekha *et al.* (2002) reported that weed density was lower in all weeding practices compared to the unweeded control plot. At 35 DAT, the highest weed density (186.80 m^{-2}) and weed dry weight (75.06 g m^{-2}) were found in W_0 (No weeding). But among the weed management practices, Stale seedbed + one hand weeding at 35 DAT performed superiorly because of lowest weed density (25.00 m^{-2}) and dry weight (8.27 gm^{-2}) at this treatment. The stale seedbed technique works by depleting shallow "germinable" weed seeds that would normally develop and compete with a crop after it is planted. This technique works especially well if these shallow weed seeds germinate just prior to crop planting or during the early period of the crop cycle while germinable weed seeds at deeper depths remain undisturbed. Although weed emergence stimulated by irrigation and other production practices is often thought to complicate weed management efforts but the combination of Stale seedbed and one hand weeding at 35 DAT made this treatment more effective.

3.4 Effect of interaction of cultivar and weeding regime

The interaction of cultivar and weeding regime was found to be significant at 15 and 35 DATs (Table 4). At 15 DAT, the highest weed density (177.33 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 bed + one hand weeding at 35 DAT) treatment (Table 4). At 35 DAT, the highest weed density (201.3 m^{-2}) was found in V_2W_0 (BRRI dhan62 × no weeding) and the lowest one (13.67 m^{-2}) was found in V_1W_5 (BRRI dhan56 × Stale seed bed + one hand weeding at 35 DAT) treatment. In case of weed dry weight at 15 and 35 DATs, the highest weed dry weight (14.59 g m^{-2} and 90.15 g m^{-2}) was observed in V_3W_0 (Binadhan-7 × no weeding) and V_2W_0 (BRRI dhan62× no weeding). The lowest weed dry

weight at 15 DAT (1.66 g m^{-2}) and 35 DAT (15.67 g m^{-2}) were observed in V_1W_5 (BRRI dhan56 × Stale seed bed + one hand weeding at 35 DAT) at all the sampling dates (Table 4). The competitiveness of BRRI dhan56 and also stale seed bed + one hand weeding at 35 DAT made this treatment combination more effective against weed.

Table 3: Weed density and dry weight at 15 and 35 DATs as influenced by cultivars

Rice cultivar	Weed density (no. m^{-2})		Weed dry weight (g m^{-2})	
	15 DAT	35 DAT	15 DAT	35 DAT
BRRI dhan56	57.94b*	39.79b	5.11	39.79
BRRI dhan62	72.83a	42.94a	5.48	42.94
Binadhan-7	71.78a	41.43a	5.72	41.43
CV (%)	20.62	11.80	21.80	11.80
Level of significance	0.05	0.01	NS	NS

*In a column, values having similar letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT.

Table 4: Weed density and dry weight as influenced by weed management practices at 15 and 35 DAT

Weed management practices	Weed density (no. m^{-2})		Weed dry weight (g m^{-2})	
	15 DAT	35 DAT	15 DAT	35 DAT
W_0	167.11a	186.8a	14.25a	75.06a
W_1	114.78b	91.67b	6.939b	58.05b
W_2	50.22c	54.33c	4.239c	42.49c
W_3	33.78d	28.89d	3.132cd	36.98d
W_4	22.78d	25.00d	2.243de	27.47e
W_5	16.44d	16.56d	1.82e	8.271f
CV (%)	20.62	11.80	21.80	11.80
Level of significance	0.01	0.01	0.01	0.01

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

W_0= No weeding, W_1 = Weeding at 15 and 35 DAT, W_2 = Application of early post emergence herbicide Pyrazosulfuron ethyl, W_3 = Application of early post emergence herbicide Pyrazosulfuron ethyl followed by one hand weeding at 35 DAT, W_4 = Stale seed bed, W_5 = Stale seed bed followed by One hand weeding at 35 DAT

Table 5: Weed density and total dry weight at 15 and 35 DAT in T. *aman* rice as influenced by interaction of cultivar and weeding regime

Method of planting × weeding	Weed no. (m^{-2})		Weed dry weight (g m^{-2})	
	15 DAT	35DAT	15 DAT	35DAT
V_1W_0	150.7b*	177.7b	13.88a	80.08ab
V_1W_1	98.67d	75.33de	6.28b	60.45b
V_1W_2	43.00ef	44.00fg	4.15cd	44.40cd
V_1W_3	24.33fgh	31.00gh	2.83cde	33.00d
V_1W_4	18.00fgh	28.00gh	1.88de	29.70d
V_1W_5	13.00h	13.67h	1.66e	15.67e
V_2W_0	173.3ab	201.3a	14.29a	90.15a
V_2W_1	123.3c	92.67cd	7.05b	64.25b
V_2W_2	54.33e	57.00ef	4.27c	51.00c
V_2W_3	36.33e-h	30.33gh	3.18cde	39.33cd
V_2W_4	28.67e-h	27.33gh	2.27cde	27.33d
V_2W_5	21.00fgh	18.00h	1.84e	18.00de
V_3W_0	177.33a	181.3ab	14.59a	88.35a
V_3W_1	53.33e	107.0c	7.48b	66.00b
V_3W_2	122.3c	62.00ef	4.30c	60.00b
V_3W_3	40.67efg	25.33gh	3.38cde	25.33d
V_3W_4	21.67fgh	19.67gh	2.57cde	19.67de
V_3W_5	15.33gh	18.00h	1.96de	18.00de
CV (%)	20.62	16.56	21.80	11.80
Level of significance	0.05	0.05	0.05	0.05

*In a column, values having similar letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT, **= Significant at 1% level of probability, CV= Coefficient of variation, V_1= BRRI dhan56, V_2 = BRRI dhan62, V_3= BINA dhan7, W_0= No weeding, W_1 = Weeding at 15 and 35 DAT, W_2 = Application of early

post emergence herbicide Pyrazosulfuron ethyl, W_3 = Application of early post emergence herbicide Pyrazosulfuron ethyl +One hand weeding at 35 DAT, W_4 = Stale seed bed, W_5 = Stale seed bed + One hand weeding at 35 DAT

3.5 Yield and yield attributes

Effect of cultivar

All the growth, yield and yield contributing characters except straw yield and harvest index were significantly influenced by varietal effect. Plant height of rice, a genetic character, varies from cultivar to cultivar. The plant height varied significantly among the cultivars (Table 5). The tallest plant (126.51 cm) was observed in BRRI dhan56 and the shortest plant (104.04 cm) was observed in Binadhan-7. Variation in plant height might be due to the differences in the genetic makeup of the varieties. This result is consistent with the findings of Alam *et al.* (2012) who also reported a variable plant height existed among the varieties. The number of total and effective tillers hill^{-1} varied from 9.68 to 12.61 and 8.16 to 10.68, respectively. The highest values were found in Binadhan-7 and the lowest ones were documented in BRRI dhan56. Tillering is an important trait for rice production (Badshah *et al.,* 2014). The number of total tillers hill^{-1} varied among the varieties was also reported by Karak *et al.* (2005). Differences in number of effective tillers hill^{-1} among the varieties was also reported by Tyeb *et al.* (2013) and Chamely *et al.* (2015). The reasons for differences in producing effective tillers hill^{-1} might be due to the variation in genetic make-up of the variety that might be influenced by heredity. Conversely, the longest panicle (25.71 cm) was observed in cultivar BRRI dhan56 and the shortest one (23.83 cm) was recorded in Binadhan-7. Differences in panicle length among genotypes were also stated by Kabir *et al.* (2004). On the other hand, BRRI dhan62 had the highest number of grains panicle^{-1} (139.5) and also the maximum sterile spikelets panicle^{-1} (21.84) but the lowest grains (84.56) and sterile spikelet (13.76) panicle^{-1} were found in Binadhan-7 and BRRI dhan56, respectively. Though Binadhan-7 produced minimum grains panicle^{-1} but in case of grain weight it had the highest 1000-grain weight (25.04 g) and similarly BRRI dhan62 had the minimum 1000-grain weight (20.02 g) with higher grains panicle^{-1}. Mou *et al.* (2017), Afroz *et al.* (2019) and Salam *et al.* (2020) also found variation in 1000cgrain weight among the cultivars used. They opined that the variation in 1000-grain weight among the cultivars might be due to the genetic constituents of the cultivars. In case of grain yield about 3.90- 4.47 t ha^{-1} variations was observed among the varieties where BRRI dhan62 produced the highest value and BRRI dhan56 produced the lowest. Variation in grain yield was also reported by Akando (2007) and Gawali *et al.* (2015) and this was might be due to genetic heredity of the cultivars.

3.6 Effect of weed management practices

Weed management practices had significant effect on most of the parameters except total tillers hill^{-1}, sterile spikelet panicle$^{-1,}$ straw yield and harvest index (Table 6). The tallest plant (116.50 cm) was found in W_2 (Application of early post emergence herbicide Pyrazosulfuron ethyl) treatment and the shortest plant (105.7 cm) was observed in no weeding treatment. Number of effective tillers hill^{-1} fluctuated from 7.10- 10.42 where the highest number of effective tillers hill^{-1} (10.42) was produced by W_5 (Stale seed bed technique + One hand weeding at 35 DAT treatment which was statistically identical to other treatments except on weeding and two hand weeding at 15 and 35 DATs. The lowest number of effective tillers hill^{-1} was produced by W_0 (No weeding) treatment. The longest panicle (25.78 cm) was observed in W_5 (Stale seed be + One hand weeding at 35

DAT) treatment which was statistically identical (25.77 cm) to that of W_4 (Stale seed bed) treatment. The shortest panicle (23.78 cm) was observed in W_0 (no weeding). The highest number of grains panicle^{-1} (129.5) was produced by W_3 (application of early post emergence herbicide pyrazosulfuron ethyl (Manage) + one hand weeding at 35 DAT which was statistically identical to W_1, W_4 and W_5 treatments. The lowest number of grains panicle^{-1} (95.36) was produced in W_0 (no weeding) treatment. The highest grain yield (4.07 t ha^{-1}) was produced by W_4 (Stale seed bed) treatment which was statistically identical to W_3, W_2, W_5 and W_1 treatments. The lowest grain yield (3.05 t ha^{-1}) was produced by W_0 (no weeding) treatment. The weeds compete with the crop for nutrient, water, air, sunlight and space. The increased yield was contributed in weed management treatments by higher number of effective tiller hill^{-1}, higher number of grains panicle^{-1} over no weeding treatment. These might be due to the fact that the different weed management treatments kept the rice field weed free 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.

3.7 Effect of interaction between cultivar and weeding regime

Except for panicle length, straw yield and harvest index, interaction of cultivar and weed management practices had significant effect on all the studied parameters (Table 7). The tallest plant (133.50 cm) was obtained from BRRI dhan56 with the application of early post emergence herbicide Pyrazosulfuron ethyl and the shortest plant (99.00 cm) was obtained from the variety Binadhan-7 and no weeding treatment. Binadhan-7 produced the maximum number (14.40) of total tillers hill^{-1} in stale seed bed technique treatment, while the lowest number of total tillers hill^{-1} (9.00) was produced by cultivar BRRI dhan56 with no weeding treatment. On the other hand, the highest number of (12.67) effective tillers hill^{-1} was produced by Binadhan-7 with the application of early post emergence herbicide followed by one hand weeding at 35 DAT treatment which was statistical identical to Binadhan-7 with stale seed bed technique and Binadhan-7 with stale seed bed technique with one hand weeding at 35 DAT. As usual the lowest number (7.20) of effective tillers hill^{-1} was produced by BRRI dhan56 with no weeding treatment. The highest number (176.7) of grains panicle^{-1} was produced by BRRI dhan62 with the application of early post emergence herbicide followed by one hand weeding at 35 DAT while the lowest number of grains panicle^{-1} (52.11) was produced by Binadhan-7 with no weeding treatment. Sterile spikelets panicle^{-1} was found maximum in BRRI dhan62 with stale seed bed + One hand weeding at 35 DAT which was statistically identical with BRRI dhan62 with other weed management practices. The lowest sterile spikelets panicle^{-1} (11.88) was observed in V_1W_5 (BRRI dhan56 × Stale seed bed + One hand weeding at 35 DAT) treatment. 1000-grain weight was found highest in Binadhan-7 with all weeding treatments but BRRI dhan62 produced the lowest 1000-grain weight with all weeding treatments. The highest grain yield (4.94 t ha^{-1}) was produced by BRRI dhan62 with the application of early post emergence herbicide Pyrazosulfuron ethyl followed by one hand weeding at 35 DAT treatment, which was statistically identical to BRRI dhan62 with Stale seed bed and application of early post emergence herbicide Pyrazosulfuron ethyl treatment and BRRI dhan56 with Stale seed bed technique technique. The lowest grain yield (2.95 t ha^{-1}) was produced by BRRI dhan56 with 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 tillers hill^{-1} and grain panicle^{-1}. Because severe weed infestation was occurred in the plots due to competition for moisture, nutrients between weed and rice plants.

Table 6. Effect of variety on the performance of short duration transplanted a*man* rice

Variety	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})	Harvest index (%)
BRRI dhan56	126.51a	9.68c	8.161c	25.71a	119.0b	13.76c	23.99b	3.90b	5.13	43.19
BRRI dhan62	108.73b	11.54b	9.344b	25.68a	139.5a	21.84a	20.02c	4.47a	5.14	46.51
BINA dhan7	104.04c	12.61a	10.68a	23.83b	84.56c	15.53b	25.04a	3.94b	4.84	44.88
CV (%)	3.00	10.61	8.07	1.70	15.43	6.39	0.59	11.66	12.93	4.05
Level of Significance	0.01	0.05	0.01	0.01	0.01	0.01	0.05	0.01	NS	NS

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

Table 7. Effect of integrated weed management practices on the performance of short duration transplanted a*man* rice

Weed Management practices	Plant height (no.)	Total tillers hill^{-1} (no.)	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 (%)
W_0	105.7c*	10.80	7.100c	23.78d	95.36b	17.78	22.93	3.05b	5.43	35.96
W_1	115.4ab	10.84	8.689b	24.69c	118.9a	16.75	23.03	4.06a	4.96	45.01
W_2	116.5a	11.36	9.844a	25.11b	114.3a	17.46	23.03	4.37a	5.26	45.37
W_3	115.1ab	11.51	10.07a	25.31b	129.5a	17.28	23.03	4.54a	4.93	47.94
W_4	113.4ab	12.09	10.24a	25.77a	117.4a	16.43	23.03	4.56a	5.04	47.5
W_5	112.4b	11.07	10.42a	25.78a	110.7ab	16.55	23.0a	4.07a	4.61	46.89
CV (%)	3.00	10.61	8.07	1.70	15.43	6.39	0.59	11.66	12.93	4.05
Level of Significance	0.01	NS	0.01	0.01	0.01	NS	NS	0.01	NS	NS

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

W_0=No weeding, W_1= Hand weeding at 15 & 35 DAT (Days After Transplanting), W_2= Application of early post emergence herbicide, W_3= Application of early post emergence herbicide & one hand weeding at 35 DAT, W_4=Stale seed bed, W_5=Stale seed and One hand weeding at 35 DAT

Table 8. Interaction effect of variety and weed management practices on the performance of short duration transplanted a*man* rice

Interaction (variety and weed management)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill (no.)	Panicle length	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*	9.60def	7.20gh	24.25	98.96def	16.67b	23.70c	2.95f	5.86	33.48
$V_1 W_1$	131.7a	9.53ef	8.26defg	24.98	125.0bcd	14.03cd	24.05b	3.66c-f	5.13	41.63
$V_1 W_2$	133.5a	9.87def	8.63defg	25.99	124.3bcd	14.61bcd	24.04b	3.87b-e	5.14	42.95
$V_1 W_3$	130.8a	9.53ef	7.93efgh	26.13	125.1bcd	13.45de	24.05b	4.32abc	4.83	47.21
$V_1 W_4$	124.1b	10.27c-f	8.20defg	26.59	124.9bcd	11.89e	24.05b	4.59ab	5.25	46.64
$V_1 W_5$	123.9b	9.27f	8.73cdef	26.34	115.6b-e	11.88e	24.04b	4.06a-d	4.60	46.87
$V_2 W_0$	103.0ef	11.06b-f	7.33fgh	24.54	109.3c-f	21.59a	20.05d	3.17ef	5.36	37.16
$V_2 W_1$	108.4de	11.67b-e	8.47defg	25.58	148.5ab	21.07a	20.01d	4.38abc	4.96	46.89
$V_2 W_2$	111.0cd	12.27abc	10.33b	25.59	135.9bc	21.79a	20.01d	4.60ab	5. 40	46.00
$V_2 W_3$	111.0cd	11.67b-e	9.60bcd	25.73	176.7a	22.49a	20.01d	4.94a	5.22	48.62
$V_2 W_4$	110.7cd	11.60b-e	10.07bc	26.29	139.2bc	21.99a	20.01d	4.89a	5.35	47.76
$V_2 W_5$	108.3de	11.00b-f	10.27b	26.36	127.2bcd	22.13a	20.01d	4.87a	4.55	51.69
$V_3 W_0$	99.00f	11.0b-e	6.77h	22.55	77.8f	15.10bcd	25.05a	3.05ef	5.07	37.56
$V_3 W_1$	106.0de	11.33b-f	9.33b-e	23.51	83.12ef	15.16bcd	25.04a	4.14a-d	4.78	46.41
$V_3 W_2$	105.1def	11.93bcd	10.57b	23.74	82.59ef	15.97bc	25.04a	4.63ab	5.24	46.90
$V_3 W_3$	103.5ef	13.33ab	12.67a	24.07	86.53ef	15.91bc	25.03a	4.37abc	4.74	47.97
$V_3 W_4$	105.6de	14.40a	12.47a	24.43	88.04ef	15.41bcd	25.04a	4.19abc	4.53	48.05
$V_3 W_5$	105.1def	12.93ab	12.27a	24.64	89.23ef	15.64bc	25.03a	3.28def	4.70	41.10
CV (%)	3.00	10.61	8.07	1.70	15.43	6.39	0.59	11.66	12.93	4.05
Level of significance	0.05	0.05	0.01	NS	0.05	0.01	0.05	0.05	NS	NS

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

V1 = BRRI dhan56, V_2 = BRRI dhan62, V_3 = BINA dhan7

W_0=No weeding, W_1= Hand weeding at 15 & 35 DAT (Days After Transplanting), W_2= Application of early post emergence herbicide, W_3= Application of early post emergence herbicide followed by one hand weeding at 35 DAT, W_4=Stale seed bed & W_5=Stale seed and One hand weeding at 35 DAT

CONCLUSION

In transplant *aman* season, when BRRI dhan56 cultivated in Stale seed bed with one hand weeding at 35 DAT showed more competitive ability than other rice cultivars and weeding treatments as this combination had lowest weed density and dry weight. In considering yield and yield attributes, rice cultivar BRRI dhan62 with Application of early post emergence herbicide followed by one hand weeding at 35 DAT produced the highest grain yield which was statistically similar with BRRI dhan56 and Stale seed bed with one hand weeding at 35 DAT. So, rice cultivar BRRI dhan56 with stale seed bed with one hand weeding at 35 DAT can be recommended for transplant *aman* season since this is a long stature cultivar and this cultivar had higher competitive ability against weed than BRRI dhan62 and Binadhan-7.

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Authors' contribution
Md. Abdus Salam designed, supervised the experiment, Sinthia Afsana Kheya wrote the manuscript, Kazi Ashika Mahmuda Onna reviewed the manuscript and Md Shafiqul Islam overviewed the manuscript. All authors have read and approved the final manuscript.

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