

WEED DYNAMICS AND YIELD OF TRANSPLANTED *AMAN* RICE AS INFLUENCED BY VARIETY AND INTEGRATED WEED MANAGEMENT PRACTICES

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ABSTRACT

Competitive rice cultivars can influence weed suppression. Managing weeds sustainably to achieve desirable crop yields is a major concern worldwide. When the same weed management strategies are used, such as using same herbicide year after year in a certain area, weeds become resistant to that herbicide. To study the impact of variety and integrated weed management practices on weed growth and yield of rice, an experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from June to October 2023. The experiment included three *T. aman* rice varieties viz., BRRI dhan71, BRRI dhan75 and BRRI dhan87 and five weed management practices viz., unweeded control, two hand weedings at 15 and 30 days after transplanting (DAT), application of pre-emergence herbicide followed by one hand weeding (HW) at 30 DAT, application of early post-emergence herbicide followed by one HW at 30 DAT, application of pre-emergence herbicide followed by early post emergence herbicide. The experiment was laid out in randomized complete block design with three replications. Results showed that the experimental plots were infested with seven weed species belonging to five families. The most dominant weed species in the experimental fields were Panikachu (*Monochoria vaginalis*), Shama (*Echinochloa crusgalli*) and Sabuj Nakful (*Cyperus difformis*). The highest weed density and dry weight at 15 and 30 DAT were found in BRRI dhan75 with no weeding treatment and the lowest weed density and dry weight were observed in the variety BRRI dhan87 with application of pre-emergence herbicide followed by one HW at 30 DAT. In considering yield and yield attributes, BRRI dhan87 had highest number of effective tillers hill⁻¹, longest panicle, highest number of grains panicle⁻¹ and highest grain and straw yields. Application of pre-emergence herbicide followed by one HW at 30 DAT exerted the highest number of effective tillers hill⁻¹, highest number of grains panicle⁻¹ and highest grain and straw yields. The highest grain yield (5.22 t ha⁻¹) was recorded from the interaction of variety BRRI dhan87 with application of pre-emergence herbicide followed by one HW at 30 DAT due to highest number of grains panicle⁻¹ in this treatment combination. Numerically the lowest grain and straw yields were found in the variety BRRI dhan71 with no weeding treatment combination. From the results of the study, it may be concluded that BRRI dhan87 with application of pre-emergence herbicide followed by one HW at 30 DAT may be recommended for controlling weed efficiently and maximizing grain yield of *T. aman* rice.

Key words: Early post emergence herbicide, hand weeding, pre-emergence herbicide, rice varieties, yield

INTRODUCTION

Bangladesh stands as the third-largest rice producer, benefitting from favorable climatic conditions that help year-round rice cultivation (Rahman *et al.*, 2021). As a result, the nation currently produces an impressive 39.10 million M tons of rice across 11.64 million hectares of land to meet up the nutritional needs of its vast population (BBS, 2024). Rice cultivation in Bangladesh occurs in all the three growing seasons viz., *aus* (April to July), *aman* (July to November) and *boro* (December to May). The country covers 1.06, 5.73 and 4.85 million ha for *aus*, *aman* and *boro* rice, respectively, and its production of 2.90 million M tons in *aus* season, 15.43 million M tons in *aman* season and 20.77 million M tons in

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boro seasons (BBS, 2024). Though the *aman* season covers largest area of land but total production is less than *boro* season and yield is also low. The average yield in *aman* season is 2.72 t ha⁻¹ which much lower than *boro* season (4.29 t ha⁻¹). The probable causes of low yield in *aman* season are prevailing cloudy weather, severe weed infestation, lack of appropriate cultivars and other management practices (Salam *et al.*, 2022).

Competitive rice cultivar (CV) is a component of integrated weed management (IWM) and an attractive option to suppress weed growth where there is no need to incur any additional costs (Wu *et al.*, 1999). Cultivars suppress weeds by its quick canopy coverage or cultivar may be more capable of reducing the ability of a weed species through competition for limited resources, or cultivars may produce chemical exudates that reduce the growth of weeds (Andrew *et al.*, 2015). Although rice is generally a weak competitor against weeds, the identification of superior weed competitive rice cultivars could play an important role in reducing herbicide load in the agro-ecosystem by reducing its use and enhancing the performance of herbicides (Gibson and Fischer, 2004; Zhao *et al.*, 2006; Mahajan *et al.*, 2011). Generally, taller rice varieties are more effective in suppressing weed growth compared to shorter varieties. Gogoi *et al.* (2000) reported that Akisali, a tall traditional cultivar, significantly reduced the weed dry matter accumulation compared with the other cultivars tested. Faruk *et al.* (2013) and Parvez *et al.* (2013) reported that weed population and dry weight were significantly affected by rice cultivar. They reported minimum weed growth in taller cultivar Nazirshail and maximum weed growth in dwarf cultivar BRR1 dhan41.

Severe weed infestation constitutes one of the important reasons for low yield of rice in Bangladesh (Mamun, 1988). The weather conditions during the *aman* season in Bangladesh are highly conducive to the rapid growth of weeds (Ahmed *et al.*, 2015). Consequently, yield loss due to weed competition in transplanted *aman* (*T. aman*) rice is around 40% in Bangladesh (BRR1, 2008). Manual weeding is the most common weeding practice in Bangladesh. But weed control is often imperfect or delayed due to unavailability of labor during the peak period and the high cost of labor (Ghosh, 2014). Moreover, the current manual weed management system is labor-intensive, time-consuming, expensive and often cannot be carried out on schedule due to various reasons (Ahmed *et al.*, 2005). Over the past few decades, herbicides have significantly revolutionized in agriculture. In large-scale rice farming, herbicide-based weed management has emerged as the most efficient and practical solution to address the scarcity and high expenses associated with labor (Singh *et al.*, 2006; Anwar *et al.*, 2012). But, intensive use of herbicide can lead to environmental contamination and the development of herbicide resistance weed (Fischer *et al.*, 1993; Labrada, 2003; Zhao *et al.*, 2006). Therefore, attention has shifted to integrate methods of weed control into the current farming systems to reduce herbicide use (McDonald, 2003), such as the development of competitive rice cultivars which provide a safe and environmentally benign tool for IWM (Fischer *et al.*, 1993). Differences between rice cultivars in response to weed competition have been recognized (Suzuki *et al.*, 2002; Estorninos *et al.*, 2005; Zhao *et al.*, 2007). Besides these, application of herbicide with hand weeding resulted better weed management and maximized grain yield and benefit cost ratio (BCR) (Salam *et al.*, 2020). Keeping the above points in views, the present study was, therefore, undertaken to find out the effect of variety and IWM practices on weed dynamics and yield performance of *T. aman* rice.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh from June to October 2023 to study the effect of variety and IWM practices on weed dynamics and yield performance of *T. aman* rice. The experimental site belongs to the Sonatala series of Old Brahmaputra Floodplain Agro-ecological Zone (AEZ-9) having non-calcareous dark grey floodplain soils with pH 6.5 (FAO, 2009). The experimental site's climate is classified as sub-tropical and is distinguished by high temperature, high levels of humidity and a lot of precipitation with periodic

gusty winds during the *Kharif* (April to September) season and little precipitation with a moderately low temperature and abundant sunshine during the Rabi season. Two experimental factors were included in the experiment. These were - Factor A: Variety: BRRI dhan71 (V_1), BRRI dhan75 (V_2) and BRRI dhan87 (V_3), Factor B: IWM practices : Unweeded control (W_0), two hand weeding (HW) at 15 and 30 days after transplanting (DAT) (W_1), application of pre-emergence herbicide Superhit 500 EC (Pretilachlor) @ 2 L ha⁻¹ followed by one HW at 30 DAT (W_2), Application of early post-emergence herbicide Changer 18WP (Acetachlor 14% + Bensulfuron methyl 4%) @ 1 kg ha⁻¹ followed by one HW at 30 DAT (W_3) and application of pre-emergence herbicide followed by early post-emergence herbicide (W_4). The experiment was laid out in a randomized complete block design (RCBD) with three replications.

Healthy and vigorous seeds of BRRI dhan71, BRRI dhan75 and BRRI dhan87 were collected from Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur. Selected seeds were soaked in water for 24 hours and then kept in gunny bags. Seeds started sprouting after 48 hours and almost all seeds were sprouted after 72 hours. Sprouted seeds were sown in the wet nursery bed on 18 June 2023. Proper care was taken to raise the seedlings in the nursery bed. Thirty-four-day old seedlings were uprooted carefully early in the morning on 21 July 2023 without causing injury to roots and seedlings. The uprooted seedlings were kept on soft mud in shade until they were transplanted in the main field. About ten days before transplanting the experimental land was prepared by a power tiller. It was then ploughed and cross ploughed four times followed by laddering to obtain a desirable tilth and to make the soil ready for transplanting. Weeds and stubbles were removed and the field was cleaned. The experimental field was then divided into unit plots according to the layout of the experimental design. The uprooted seedlings were transplanted carefully on 21 July 2023 in the main field at the rate of 2-3 seedlings hill⁻¹ with 20 × 15 cm row and hill spacing, respectively. Nitrogen (in the form of urea) was applied at the rate of 150 kg urea ha⁻¹ in three equal splits at 7, 22 and 35 DATs. At the time of final land preparation full dose of triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate were applied at the rate of 60, 85, 60 and 10 kg ha⁻¹, respectively, in all plots. For ensuring vigorous growth and development of crop intensive care was taken during growth period of the crop. Damaged seedlings were replaced with healthy seedlings after one week of transplantation from the same source to maintain optimum plant population. No weeding was performed in nine control plots and two times manual weeding were done at 15 and 30 DATs in another nine plots as per experimental treatments. Experimental plots were irrigated as and when necessary. Excess water was drained out from the plots before 15 days of harvest to enhance maturity of the crop. Superhit 500 EC (Pretilachlor) @ 1 L ha⁻¹ and Changer 18 WP (Acetachlor 14% + Bensulfuron methyl 4%) herbicide @ 1 kg ha⁻¹ was applied as per experimental treatment. There was no remarkable infestation by insect pest or diseases during the crop growth period. Therefore, no plant protection measures were taken. The experimental field was observed regularly and the field was looked nice with normal green leaves. For recording data, three hills were randomly selected from each plot (outside the area selected for final harvest). The crops were harvested at full maturity when 90% of the seeds became golden yellow in color. One square meter area from each plot was selected from the central portion and cut manually from the ground level to take grain and straw yields. The rice varieties were harvested on 23 October 2023. The harvested crop was separately bundled, properly tagged and then brought to the concrete threshing floor. The crops were threshed with a pedal thresher and the fresh weights of grain and straw were recorded and converted to t ha⁻¹. The grains were cleaned and dried to a moisture content of 14%. Straws were sun dried to record straw yield per square meter. Grain and straw yield recorded from one square meter finally converted to t ha⁻¹.

Weed density was calculated at 15 and 30 DAT with the help of a quadrat of size 1 m². The quadrat was placed randomly in three spots of each plot and the weeds inside the quadrat was counted as per method described by Cruz *et al.* (1986) and then converted to number m⁻². After counting the weed number, the weeds inside each quadrat were uprooted and cleaned. To determine dry matter the

sample weeds were first air dried for 6-8 hours. Then the weed samples were packed in labeled brown paper bag and dried in the oven at 80°C for 72 hours until constant weight was reached. The samples were weighed carefully after oven drying to measure the dry weight of weed and finally the weight was converted to g m⁻². Data recorded for weed parameters and yield and yield contributing characters were recorded, compiled and tabulated in proper form for statistical analysis. The collected data were statistically analyzed using “Analysis of Variance” technique with the help of computer package program, MSTAT-C. The significance of mean difference among the treatments was adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984), where needed.

RESULTS AND DISCUSSION

Infested weed species in the experimental plots

The experimental plots were infested with seven weed species belonging to five families (Table 1). Among the weeds, two weed species were from Poaceae, two from Cyperaceae family and one each from the family Pontederiaceae, Marsileaceae and Oxalidaceae. The most dominant weed species in the experimental fields were Panikachu (*Monochoria vaginalis*), Shama (*Echinochloa crusgalli*) and Sabuj nakphul (*Cyperus difformis*). Other infesting species of weeds were Angta (*Paspalum scrobiculatum*), Chaich (*Fimbristylis dichotoma*), Shushnishak (*Marsilea quadrifolia*) and Amrul (*Oxalis corniculata*) (Table 1). Ali *et al.* (2022) conducted research on the same experimental site and reported that *Echinochloa crusgalli* and *Monochoria vaginalis* were the most dominant weeds in the T. aman rice cultivation. Similar results were also observed by Sultana *et al.* (2023) in Agronomy Field Laboratory, BAU where the most important weeds were *Echinochloa crusgalli* and *Monochoria vaginalis*. But Islam *et al.* (2018), Afroz *et al.* (2019) and Monira *et al.* (2020) reported that *Echinochloa crusgalli* was the most dominant weed species in the aman rice field at the same location. The environmental conditions that promote the successful cultivation of T. aman rice also encouraged the vigorous growth and development of various weed species that contended with the growth of crop plants (BRRI, 2017). This explains the presence of broad spectrum weed species in T. aman rice field.

Table 1. Infesting species of weed in the experimental plots of short duration drought tolerant T. aman rice

Sl. no.	Local name	Scientific name	Family	Morphology type
1	Pani kachu	<i>Eichhornia crassipes</i> (Burm. F.) C. Presl.	Pontederiaceae	Broad leaved
2	Shama	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	Poaceae	Grass
3	Angta	<i>Paspalum scrobiculatum</i> L.	Poaceae	Grass
4	Sabuj Nakphul	<i>Cyperus difformis</i> L.	Cyperaceae	Sedge
5	Cheich	<i>Fimbristylis dichotoma</i> (L.) Vahl	Cyperaceae	Sedge
6	Shusni shak	<i>Marsilea quadrifolia</i> C. Presl.	Marsileaceae	Broad leaved
7	Amrul shak	<i>Oxalis corniculata</i> L.	Oxalidaceae	Broad leaved

Effect of variety on weed density and dry weight

Weed density and dry weight were significantly influenced by variety at 15 and 30 DAT at 1% level of probability (Table 2). At both the sampling dates, the highest weed density (8.16 m⁻² and 7.03 m⁻²) and dry weight (3.37 g m⁻² and 5.31 g m⁻²) were observed in V₂ which was followed by the rice variety V₁. The lowest weed density (5.71 m⁻² and 7.03 m⁻²) and dry weight (2.53 g m⁻² and 3.56 g m⁻²) were recorded in the rice variety BRRI dhan87. This observation is in agreement with the findings of Faruk *et al.* (2013) who reported that the taller cultivar produced lower weed population than that of dwarf cultivar. Moe *et al.* (2017) also reported that dwarf plant with its erect leaf habit promoted more weed growth than that of tall cultivar.

Table 2. Effect variety on weed density and weed dry weight at 15 and 30 DATs

Variety	Weed density		Weed dry weight at	
	15 DAT	30 DAT	15 DAT	30 DAT
V ₁	6.13 ab*	5.173 b	2.77 ab	4.10 b
V ₂	8.16 a	7.03 a	3.37 a	5.31 a
V ₃	5.71 b	4.73 b	2.53 b	3.56 c
LS	0.01	0.01	0.05	0.01
CV (%)	17.11	19.96	20.56	14.29

*In a column figures having common letter(s) do not differ significantly as per DMRT. V₁ = BRRI dhan71, V₂ = BRRI dhan75, V₃ = BRRI dhan87

Effect of weed management practices on weed density and weed dry weight

Weed density and dry weight were significantly affected by integrated weed management practices at 15 and 30 DAT at 1% level of probability (Table 3). At both the sampling dates, the highest weed density (9.89 m⁻² and 7.56 m⁻²) and dry weight (4.23 g m⁻² and 5.97 g m⁻²) was found in W₀ (unweeded control) treatment. This was due to the fact that in no weeding condition weed-crop competition was higher and hence weed density and dry weight was the highest. Singh and Kumar (1999) also reported that the maximum weed dry weight was recorded in the unweeded control condition which was significantly higher compared to other weed control practices. At both the sampling dates the lowest weed density (4.96 m⁻² and 4.87 m⁻²) and dry weight (2.17 g m⁻² and 3.47 g m⁻²) were recorded in application of pre-emergence herbicide followed by one HW at 30 DAT (W₂) treatment which was statistically identical to other weed management treatments at both the sampling dates (Table 3).

Table 3. Effect integrated weed management on weed density and weed dry weight at 15 and 30 DATs

Integrated weed management	Weed density		Weed dry weight (g m ⁻²)	
	15 DAT	30 DAT	15 DAT	30 DAT
W ₀	9.89 a*	7.56 a	4.23 a	5.97 a
W ₁	6.56 b	5.50 b	2.63 b	3.97 bc
W ₂	4.96 b	4.878 b	2.17 b	3.47 c
W ₃	5.83 b	5.23 b	2.65 b	4.19 b
W ₄	6.10 b	5.04 b	2.78 b	4.03 bc
LS	0.01	0.01	0.01	0.01
CV (%)	17.11	19.96	20.56	14.29

*In a column figures having common letter(s) do not differ significantly as per DMRT. W₀=Control (no weeding), W₁=Two hand weeding at 15 and 30 DATs, W₂ = Application of pre-emergence herbicide followed by one HW at 30 DAT, W₃ = Application of early post emergence herbicide followed by one HW at 30 DAT, W₄ = Application of pre-emergence herbicide followed by Application of early post emergence herbicide.

Faruk *et al* (2013) also reported the lowest weed density and dry weight in application of pre-emergence herbicide Pretilaclor followed by one HW at 25 DAT. Weed density and dry weight at earlier stage of crop growth are more critical than later stage, generally, the weeds that emerge simultaneously with the crop. Therefore, the treatments that can control weed more effectively at earlier stage of crop growth can reduce yield losses. Similar research finding was also reported by Salam *et al.* (2020). Rekha *et al.* (2002) opined that weed density was lower in all weeding practices compared to the unweeded control plot.

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

Weed density was significantly influenced by interaction of variety and integrated weed management at 5% level of probability (Table 4) but non-significant at 30 DAT. The highest weed density (11.67 m⁻²) was found in combination of V₂W₀ (BRRI dhan75 × no weeding) treatment at 15 DAT. Faruk *et*

al. (2013) also found similar finding in their research who observed the highest weed density and dry weight using dwarf rice cultivar with no weeding treatment than tall cultivar with weeding treatment. The lowest weed density (4.07 m^{-2}) was found in the treatment combination of V_3W_2 (BRRi dhan87 \times Application of pre-emergence herbicide followed by one HW at 30 DAT). Conversely, the interaction of variety and integrated weed management on weed dry weight was statistically insignificant at 15 DAT and 35 DATs. At 15 DAT, numerically the highest weed dry weight (5.00 g m^{-2} and 7.00 g m^{-2}) was found in the treatment combination of V_2W_0 (BRRi dhan75 \times no weeding at 15 and 30 DATs) and the lowest weed dry weight (0.38 g m^{-2}) was observed in the treatment combination of V_3W_2 (BRRi dhan87 \times application of pre-emergence herbicide followed by one HW at 30 DAT (Table 4). The probable causes of effective weed control in this treatment might be due to reason that BRRi dhan87 exhibited strong weed suppression capabilities compared to other rice cultivars and pre-emergence herbicide was applied before the weeds emerge, preventing them from germinating or establishing. This helped to reduce the initial weed population. Similar observation was also reported by Faruk *et al.* (2013) who found the lowest weed density and dry weight in taller cultivar Nizershail with application of Prechlor herbicide.

Table 4. Interaction effect of variety and integrated weed management on weed density and weed dry weight at 15 and 30 DATs

Variety \times Integrated weed management	Weed density (no. m^{-2})		Weed dry weight (g m^{-2})	
	15 DAT	30 DAT	15 DAT	30 DAT
$V_1 \times W_0$	9.33 ab*	7.00	4.40	6.07
$V_1 \times W_1$	5.33 de	4.90	2.23	3.70
$V_1 \times W_2$	4.333 e	4.33	2.06	3.11
$V_1 \times W_3$	5.667 c-e	4.63	2.41	3.87
$V_1 \times W_4$	6.000 b-e	5.00	2.77	3.76
$V_2 \times W_0$	11.67 a	9.33	5.00	7.00
$V_2 \times W_1$	9.00 a-c	7.00	3.35	5.17
$V_2 \times W_2$	6.47 b-e	6.30	2.59	4.03
$V_2 \times W_3$	6.67 b-e	6.67	3.08	5.10
$V_2 \times W_4$	7.00 b-e	5.83	2.85	5.27
$V_3 \times W_0$	8.67 a-d	6.33	3.30	4.83
$V_3 \times W_1$	5.33 de	4.60	2.30	3.04
$V_3 \times W_2$	4.07 e	4.00	1.86	3.26
$V_3 \times W_3$	5.17 de	4.40	2.48	3.59
$V_3 \times W_4$	5.30 de	4.30	2.72	3.07
LS	0.05	NS	NS	NS
CV (%)	17.11	19.96	20.56	14.29

*In a column figures having common letter(s) do not differ significantly as per DMRT. V_1 =BRRi dhan71, V_2 =BRRi dhan75, V_3 = BRRi dhan87; W_0 =Control (no weeding), W_1 =Two hand weeding at 15 and 30 DATs, W_2 = Application of pre-emergence herbicide followed by one HW at 30 DAT, W_3 = Application of early post emergence herbicide followed by one HW at 30 DAT, W_4 = Application of pre-emergence herbicide followed by Application of early post emergence herbicide

Effect of variety on the yield attributes and yield of *T. aman* rice

Variety exerted significant effect on plant height (Table 5). The tallest plant (120 cm), the highest number of total tillers hill⁻¹ (11.63), the higher number of effective tillers hill⁻¹ (10.80), the highest number of grains panicle⁻¹ (99.23) the highest grain yield (4.49 t ha^{-1}) and straw yield (5.43 t ha^{-1}) were observed in the variety V_3 . The genetic variation results in differences in plant height among different varieties of the same species. Similar research findings were also reported by Masum *et al.* (2008), Faruk *et al.* (2013) and Mou *et al.* (2017) who found variation of plant height among the varieties used in their studies. The variation of tiller production might be due to the fact that this variety had better nutrient uptake efficiency, particularly nitrogen, which promoted early and more tiller

development (Song *et al.*, 2023). 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. Similar research finding was also reported by Salam *et al.* (2022) who observed variation in tiller production due to variety. The variation in producing grains panicle⁻¹ might be due to the fact that variety V₃ is efficient in absorbing and translocation of more nutrients and photosynthates, especially during the reproductive stage, which supports more grain formation (Jiang *et al.*, 1988). The lowest number of grains panicle⁻¹ (89.40) was observed in BRR1 dhan71 (Table 5). Similar result was also recorded by Aktar *et al.* (2022). Variety V₂ (BRR1 dhan75) produced the highest number of sterile spikelets panicle⁻¹ (17.84) and the lowest number of sterile spikelets panicle⁻¹ (8.83) was observed in the variety V₃ which was statistically identical (16.14) to V₁ (Table 5). The heaviest 1000-grain weight (23.25 g) was observed in V₁ and the lightest one (21.53 g) was observed in V₃ (Table 5). Roy *et al.* (2014) found differences in 1000-grain weight due to morphological and varietal variations. Mondal *et al.* (2005) stated that 1000-grain weight differed significantly among *aman* rice varieties. Mou *et al.* (2017), Afroz *et al.* (2019) and Salam *et al.* (2020) also found variation in 1000-grain weight among the varieties used. They opined that the variation in 1000-grain weight among the varieties might be due to the genetic constituents of the varieties. This highest grain yield in V₃ might be due to its genetic makeup that led to highest number of effective tillers hill⁻¹, longest panicle, highest number of grains panicle⁻¹ and lowest number of sterile spikelets panicle⁻¹, ultimately better grain yield. Similar result was also obtained by Mou *et al.* (2017) and Salam *et al.* (2022) who opined that variation in grain yield might be due varietal differences and due to differences in inherent genetic traits. Variation in straw yield was also reported by Akando (2007), Gawali *et al.* (2015) and Salam *et al.* (2022). This variation might be due to genetic heredity of the varieties.

Table 5. Effect variety on the yield and yield contributing characters of T. aman 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)
BRR1 dhan71	119.11 a*	11.02	9.78 b	23.42 b	89.40 b	16.14 b	23.25 a	3.89 b	4.66 b
BRR1 dhan75	97.89 b	11.19	10.13 b	22.81 b	95.73 a	17.84 a	19.99 c	4.15 ab	4.46 b
BRR1 dhan87	120.00 a	11.63	10.80 a	25.32 a	99.23 a	15.42 b	21.53 b	4.49 a	5.43 a
LS	0.01	NS	0.01	0.01	0.05	0.01	0.01	0.05	0.01
CV (%)	3.30	7.79	8.87	3.74	8.79	11.79	0.92	13.49	11.24

*In a column figures having common letter(s) do not differ significantly as per DMRT.; V₁ = BRR1 dhan71, V₂ = BRR1 dhan75, V₃ = BRR1 dhan87

Effect of integrated weed management on the yield attributes and yield of rice

Integrated weed management practices did not exert any significant effect on plant height (Table 6). Similar research finding was also reported by Faruk *et al.* (2013), Mou *et al.* (2017) and Tasmin *et al.* (2019). This might be due the reason that plant height is a genetic trait which is controlled by genetic inheritance (Khatakk *et al.*, 2002). The highest number of total tillers hill⁻¹ (12.64) was observed in W₂ treatment. Weed was controlled effectively in this weed management treatment; hence plant growth was vigorous and produced a greater number of tillers (Mou *et al.*, 2017). The lowest number of total tillers hill⁻¹ (9.66) was observed in no weeding (W₀) treatment. The effect of weed management on effective tillers hill⁻¹ was statistically significant (Table 6). The highest number of effective tillers hill⁻¹ (11.49) was observed in W₂ treatment. Application of pre-emergence herbicide followed by one HW at 30 DAT controlled weed effectively and plant growth was vigorous in this treatment. As a result, produced a greater number of tillers. These results corroborate the finding of Mou *et al.* (2017). The lowest number of effective tillers hill⁻¹ (8.59) was found in W₀ (no weeding) treatment (Table 6). Different weeding regimes enhanced effective tiller production hill⁻¹ by reducing the growth of weed. Similar result was found by Salam *et al.* (2020) who reported that the application of integrated weed

management practices increased the number of effective tillers per hill by reducing weed competition and allowing better resource availability for the crop. The highest number of grains panicle⁻¹ (101.40) was observed in W₂ treatment. Application of pre-emergence herbicide followed by one HW at 30 DAT resulted the highest number of grains per panicle due to reduced early weed competition and improved crop growth during the critical establishment phase (Bista *et al.*, 2023). The lowest number of grains panicle⁻¹ (77.09) was found in control treatment where no weeding was done. The integrated weed management exerted significant effect on sterile spikelets panicle⁻¹ (Table 6). The highest number of sterile spikelets panicle⁻¹ (17.74) was observed in W₀ treatment and the lowest number of sterile spikelets panicle⁻¹ (15.49) was found in W₂ treatment (Table 5). The effect of integrated weed management on 1000-grain weight was statistically insignificant. Grain yield was significantly influenced by weed management at harvest at 1% level of probability. The highest grain yield (4.89 t ha⁻¹) was observed in W₂ (two HW at 15 and 35 DATs) treatment and the lowest grain yield (4.43 t ha⁻¹) was found in W₀ (no weeding) treatment (Table 6). Weed management practices reduced weed effectively which provided competitive advantage to the crop and ultimately grain yield was increased compared to unweeded control treatment. Similar results were also found by Sarkar *et al.* (2016), Islam *et al.* (2018) and Salam *et al.* (2020). The highest straw yield (5.09 t ha⁻¹) was observed in W₂ treatment which was statistically identical to W₃ and W₄ treatments. The lowest straw yield (4.30 t ha⁻¹) was found in W₀ treatment (Table 4). Similar result was also reported by Afroz *et al.* (2019) where the authors observed the lowest grain yield in W₀ treatment.

Table 6. Effect integrated weed management on the yield and yield contributing characters of *T. aman* rice

Weed management	Plant height (cm)	Total tillers hill ⁻¹ (no.)	Effective tillers hill ⁻¹ (no.)	Panicle length (cm)	Grains panicle ⁻¹ (no.)	Sterile spikelets panicle ⁻¹ (no.)	1000-grain weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)
W ₀	111.00 b*	9.66 c	8.59 c	23.82	77.09 b	17.74 a	21.58	3.05 b	4.30 b
W ₁	111.00 b	11.73 b	10.63 b	23.65	99.96 a	16.52 ab	21.56	4.44 a	4.82 ab
W ₂	113.41 ab	12.64 a	11.49 a	24.08	101.4 a	15.49 b	21.70	4.80 a	5.09 a
W ₃	115.22 a	11.38 b	10.44 b	24.06	98.64 a	16.24 b	21.60	4.36 a	5.04 a
W ₄	111.00 b	10.99 b	10.04 b	23.64	96.83 a	16.34 ab	21.50	4.23 a	5.00 a
LS	0.05	0.01	0.01	NS	0.01	0.05	NS	0.01	0.05
CV (%)	3.30	7.79	8.87	3.74	8.79	11.79	0.92	13.49	11.24

*In a column figures having common letter(s) do not differ significantly as per DMRT. W₀ = Control (no weeding), W₁ = Two hand weedings at 15 and 30 DATs, W₂ = Application of pre-emergence herbicide followed by one HW at 30 DAT, W₃ = Application of early post emergence herbicide followed by one HW at 30 DAT, W₄ = Application of pre-emergence herbicide followed by Application of early post emergence herbicide

Interaction effect of variety and weed management on the yield attributes and yield of rice

The interaction effect of variety and weed management on plant height exerted significant influence (Table 7). The highest plant height (125.70 cm) was observed in the treatment combination of V₃W₃ (BRR1 dhan87 × application of early post-emergence herbicide followed by one HW at 30 DAT) and the lowest one (108.44 cm) was observed in combination the treatment combination of V₂W₁ (BRR1 dhan75 × two HW at 15 and 30 DAT (Table 7). Numerically, the highest number of total tillers hill⁻¹ and effective tillers hill⁻¹ (13.25 and 12.29) was observed in the treatment combination of V₃W₂ (BRR1 dhan87 × Application pre-emergence herbicide followed by one HW at 30 DAT) and the lowest ones (9.37 and 8.41) was observed in the treatment combination of V₂W₀ (BRR1 dhan75 × no weeding) treatment (Table 7). The interaction effect of variety and weed management on grains panicle⁻¹ was statistically significant (Table 7). The highest number of grains panicle⁻¹ (107.0) was observed in the treatment combination of V₃W₂ (BRR1 dhan87 × Application of pre-emergence herbicide followed by one HW at 30DAT) and the lowest number of grains panicle⁻¹ (74.95) was observed in the treatment combination of V₁W₀ (BRR1 dhan71) treatment (Table 7). Sterile spikelets panicle⁻¹ was not

significantly influenced by the interaction of variety and integrated weed management. However, numerically the highest number of sterile spikelets panicle⁻¹ (19.23) was observed in the treatment combination of V₂W₀ (BRRI dhan75 × No weeding) and the lowest number of sterile spikelets panicle⁻¹ (13.99) was observed in the treatment combination of V₁W₀ (BRRI dhan87 × application of pre-emergence herbicide followed by one HW at 30 DAT) (Table 7). Also, numerically the highest 1000-grain weight (23.53 g) was observed in the treatment combination of V₁W₂ (BRRI dhan71 × application of pre-emergence herbicide followed by one HW at 30 DAT). The lowest 1000-grain weight (20.08 g) was observed in the treatment combination of V₂W₀ (BRRI dhan75 × no weeding) treatment (Table 5). Grain yield did not vary significantly due to interaction of variety and weed management. However, apparently the highest grain yield (5.22 t ha⁻¹) was observed in the treatment combination of V₃W₂ (BRRI dhan87 × application of pre-emergence herbicide followed by one HW at 30 DAT) treatment and the lowest grain yield (2.98 t ha⁻¹) was observed in treatment combination of V₁W₀ (BRRI dhan71 × no weeding) (Table 7). The interaction of variety and weed management had no significant effect on straw yield.

Table 7. Interaction effect of variety and integrated weed management on yield attributes and yield of *T. aman* rice

Interaction (Variety × Integrated Weed management)	Plant height (cm)	Total tillers hill ⁻¹ (no.)	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)
V ₁ × W ₀	113.3 c*	9.89	8.44	23.21	74.95 d	17.09	23.19	2.98	4.32
V ₁ × W ₁	118.2 bc	11.78	10.11	23.33	95.24 ab	16.89	23.18	4.05	4.71
V ₁ × W ₂	121.8 ab	12.11	10.94	23.55	94.88 ab	15.54	23.53	4.37	4.81
V ₁ × W ₃	120.7 ab	10.86	9.89	23.92	91.81 abc	15.30	23.19	4.14	4.64
V ₁ × W ₄	121.6 ab	10.45	9.53	23.11	90.14 bc	15.88	23.14	3.92	4.82
V ₂ × W ₀	100.3 d	9.37	8.41	22.89	76.76 cd	19.23	20.00	3.02	4.04
V ₂ × W ₁	96.33 d	11.00	10.15	22.74	100.1 ab	17.68	20.08	4.47	4.55
V ₂ × W ₂	97.11 d	12.56	11.23	22.67	102.4 ab	16.93	19.97	4.80	4.94
V ₂ × W ₃	99.33 d	11.73	10.44	22.93	101.8 ab	17.56	19.96	4.27	4.74
V ₂ × W ₄	96.33 d	11.30	10.40	22.82	97.59 ab	17.78	19.95	4.16	4.36
V ₃ × W ₀	119.2 abc	9.72	8.92	25.37	79.56 cd	16.90	21.53	3.14	4.54
V ₃ × W ₁	118.4 bc	12.40	11.62	24.89	104.6 ab	15.01	21.43	4.81	5.54
V ₃ × W ₂	121.3 ab	13.25	12.29	26.02	107.0 a	13.99	21.61	5.22	5.51
V ₃ × W ₃	125.7 a	11.53	10.99	25.33	102.3 ab	15.86	21.64	4.68	5.73
V ₃ × W ₄	115.1 bc	11.22	10.18	25.00	102.8 ab	15.36	21.41	4.60	5.84
LS	0.05	NS	NS	NS	0.05	NS	NS	NS	NS
CV (%)	3.30	7.79	8.87	3.74	8.79	11.79	0.92	13.49	11.24

*In a column, figures with same letter(s) or without letters do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT). V₁ = BRRI dhan71, V₂ = BRRI dhan75, V₃ = BRRI dhan87; W₀ = Control (no weeding), W₁ = Two hand weedings at 15 and 30 DATs, W₂ = Application of pre-emergence herbicide followed by one HW at 30 DAT, W₃ = Application of early post emergence herbicide followed by one HW at 30 DAT, W₄ = Application of pre-emergence herbicide followed by Application of early post emergence herbicide

CONCLUSION

From the results of the study, it may be concluded that BRRI dhan87 with application of pre-emergence herbicide followed by one HW at 30 DAT may be recommended for controlling weed efficiently and maximizing grain yield of *T. aman* rice. But further studies are needed at different AEZs to arrive a definite conclusion.

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