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EFFECT OF WEEDING REGIME AND PLANTING DENSITY ON MORPHOLOGY AND YIELD ATTRIBUTES OF TRANSPLANT AMAN RICE CV. BRRIDHAN41

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ABSTRACT

A field experiment was carried out to investigate the effects of weeding regime and planting density on morphology and yield attributes of transplant aman rice cv. BRRI dhan41. Four weeding regimes viz., three hand weeding, two hand weeding, herbicidal control and no weeding were considered as factor A, while four different planting densities viz. two, three, four and five seedlings hill^{-1} were considered as factor B in split plot design in RCBD. Data were recorded on plant height, number of effective tillers hill^{-1}, weight of 1000 grains, grain yield plot^{-1} and straw yield plot^{-1} and some other vital yield attributing characters. Highest value was recorded from the treatment combination of three hand weeding regimes with two seedlings hill^{-1} in most of the evaluated traits. The weakest treatment combination was the no weeding with five seedlings hill^{-1}. So, three hand weeding and two seedlings hill^{-1} are recommended to be practiced for transplant aman rice cv. BRRIdhan41 at farmers' fields in Bangladesh.

Keywords: Weeding regime, planting density, transplant aman rice cv. brridhan41.

INTRODUCTION

Rice (*Oryza sativa* L.) is the dominant staple food for many countries in Asia and Pacific, South and North America as well as Africa (Mobasser *et al.*, 2007). In Asia more than 2 billion people obtain 60 to 70% of their calories from rice (Dowling *et al.*, 1998). In Bangladesh rice occupies 10.37 million hectares land (about two third of the total cultivated land) and it stands first among the cereals (BBS, 2008). Transplant aman rice covers the largest area of 5.7 million hectares (48.67%) with a production of 9.3 million tons rice grain (42.78%) and the average yield is about 1.63 t ha^{-1} in Bangladesh

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(BBS, 1994). The average yield of rice is much lower as compared to other leading rice growing countries. The crop plant growing depends largely on temperature, solar radiation, moisture and soil fertility for their growth and nutritional requirements. An unsuitable population of crop may have limitation in the maximum availability of these factors. Significant effect of planting density on the yield and yield components of rice was also found by Baloch *et al.*, (2002). Weeds compete with rice plant severely for space, nutrients, air, water and light by adversely affecting plant height, leaf architecture, tillering habit, shading ability, growth pattern and crop duration (Miah *et al.*, 1990). Weed depresses the normal yield of grains per panicle and grain weight (Bari *et al.*, 1995). Subsistence farmers of the tropics spend more time, energy and money for weed control than any other aspect of crop production (Kasasian, 1971). Poor weed control is one of the major factors for yield reduction in rice (Amarjit *et al*, 1994). Weed can be controlled by mechanical means or chemical means. Mechanical weed control is expensive and chemical method leads to environmental pollution and in many weed species have developed resistance against the herbicides. Increasing the frequency of hand weeding one or two times at 21 and 40 days after transplanting (DAT) was found to reduce the weed density and weed dry matter resulting in two fold increase in grain yield (Anonymous, 1976). Thus, the best weeding regimes need to be found out with a view to reduce yield losses due to weed infestation and getting maximum yield of transplant aman rice. Keeping the above facts in view, the present study was conducted to determine the optimum planting density for getting the maximum yield best combination of planting density and weeding regime for obtaining yield of transplant aman rice cv. BRRIdhan41.

MATERIALS AND METHODS

An experiment was carried out under field conditions to study the effects of weeding regimes and planting density on yield of Transplant aman cv. BRRIdhan41 at Patuakhali Science and Technology University, Bangladesh. The experiment was laid out in a split-plot under Randomized Complete Block Design (RCBD) with three replications. The size of each sub plot was 4.0 m x 2.5 m. There were four weeding regimes viz., W_1 = three hand weeding, at 15, 30 and 45 days after transplanting (DAT), W_2 = two hand weeding, at 15 and 30 days after transplanting, W_3 = herbicidal control and W_4 = no weeding were considered as factor A, while four different planting densities viz. D_1 = two, D_2 = three, D_3 = four and D_4 = five seedlings hill^{-1}, were considered as factor B. Previously water soaked seeds for 24 hours were sown in the nursery bed on 15 July, 2007. All recommended intercultural operations were adopted to raise a good crop.

Data collection of weeds

The species of weeds found growing in the experimental area were identified. To determine the relative weed density, weeds growing in the unit plots were counted by each kind. Weeds were sampled with the help of quadrat method and recorded. The relative weed density m^{-2} was recorded as under:

$$\text{Relative weed density (\%)} = \frac{\text{Density of the given species } m^{-2}}{\text{Total density of all weed species } m^{-2}} \text{ X } 100$$

Three weed samples per m^2 were collected at the time of weeding. The quadrat was placed at random in the unit plot and all the weeds within each 1 m^2 were uprooted, dried first in the sun and thereafter, for 24 hours in an electric oven maintaining a constant temperature of 70 ^{0}C. After drying weight of each sample were taken. The average weed dry weight was expressed in g m^{-2}.

Data collection of crop characters

Plant height was measured from the ground level to the tip of longest panicle. Data were collected from five hills per plot and then averaged. The panicles which had at least one grain were considered as effective tillers. Panicle length was recorded from the basal node of the rachis to the apex of each panicle. Grains lacking any food material inside were considered as unfilled grains and such grains present on the each tiller were counted. Presence of any food material in the grains was considered as filled grains and such grains presence on the each tiller was counted. Total number of grains from randomly selected five hills were counted and then averaged. One thousand clean dried grains were counted form the seed lot obtained from each plot and weighed by using an electric balance. Grains obtained from randomly selected five hills were sun dried and weighed carefully. Then it was averaged to get grain weight $hill^{-1}$. Straw obtained from randomly selected five sample hills of respective plot was dried in sun and weighed and then averaged. Grains obtained from each unit plot were sun dried and weighed carefully. The dry weights of grains from the panicle of the sample hills were added to the respective plot yield to record the grain yield $plot^{-1}$. Straw obtained from each unit plot including the straw of five sample hills of respective plot was dried in sun and weighed to record the straw yield $plot^{-1}$. The grain and straw yields per plot were subsequently converted to ha^{-1} and recorded. Data recorded for different crop parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of computer package MSTATC. The mean differences among the treatments were tested with Duncan's New Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Weed components

The data presented in Table-1 exhibit six species of weeds with their families which were identified in the experimental plot. Among the weed species *Eclipta alba* was dominant with its maximum density m^{-2} (121.00) followed by *Marsila quardifolia* (52.33), while *Monochoria hastata* was the minimum in number m^{-2} (2.67). The relative density of weed species showed that *Eclipta alba* possessed 62.72% infestation among the identified weed species, while 27.13% infestation was caused by *Marsila quardifolia* (Table-1). From the data in Table-1, it was further found that dry weight of weed m^{-2} was the highest in *Marsila quardifolia* (23.16 g), while *Eclipta olba* was the second highest (2.89 g). The minimum dry weight of only 0.1g was recorded for *Paspalum distichum* (Table-1).

Table-1. Mean number of species of weeds infesting transplant aman rice cv. BRRIdhan41 with their density, relative density and dry weight m^{-2}.

Scientific Name	Local Name	Family	Weed density m^{-2}	Relative density %	Dry weight (g m^{-2})
Marsila quardifolia	Shusni	Marseliaceae	52.33	27.13	23.16
Echinochloa colonum	Khude Shyama	Poaceae	4.33	2.25	1.33
Scirpus macronatus	Chechra	Cyperaceae	7.33	3.8	0.13
Eclipta olba	Kesoti	Compositae	121	62.72	2.89
Paspalum distichum	Gitla	Poaceae	5.25	2.72	0.10
Monochoria hastata	Nukha	Pontederiaceae	2.67	1.38	0.60

Crop parameters

Plant height

Effect of weeding regime

Plant height was significantly affected by different weeding regimes (Table-2). It was found that the tallest plants (125.37 cm) were found in three hand weeding treatment (at 15, 30 and 45 DAT) which was statistically similar (124.13 cm) to two hand weeding treatment. Whereas, shortest plant height was produced where no weeding was done (Table-2). The results revealed that more hand weeding produced highest plant height. This might be due to the availability of more nutrients from a weed free environment.

Effect of planting density

Plant height was statistically significant for the planting density (Table-2). It was found that planting two seedlings $hill^{-1}$ at a spacing of

20 cm × 15 cm produced tallest plant height (126.89 cm), while lowest (116.51 cm) plant height was from five seedlings hill^{-1} when planted at similar spacing (Table-2). Mobasser *et al.* (2007) showed that plant height was decreased significantly with increase of planting density, which supports the present results.

Interaction effect of weeding regime and planting density

Plant height was significantly influenced by the interaction effect between weeding regime and planting density (Table-3). The tallest plants (128.80 cm) were obtained in the interaction between three hand weeding (at 15, 30 and 45 DAT) and two seedlings hill^{-1} which was statistically similar (128.27 cm) to the interaction between two hand weeding and two seedlings hill^{-1}. The shortest plants (110.63 cm) were observed in the interaction between no weeding and five seedlings hill^{-1}. This result was similar to the findings of Mobasser *et al.* (2007) who found that plant height was decreased significantly with increase of planting density.

Number of effective tillers hill^{-1}

Effect of weeding regime

Statistical results showed that the number of effective tillers hill^{-1} were significant due to different weeding regimes (Table-2). The highest number of effective tillers hill^{-1} (9.25) were found in three hand weeding (at 15, 30 and 45 DAT), whereas lowest one (5.04) were observed in no weeding treatment. The results revealed that more hand weeding produced highest effective tillers hill^{-1}. This might be due to more light and nutrient reception of crop from a weed free environment.

Effect of planting density

There was significant variation on the number of effective tillers hill^{-1} due to various plant populations (Table-2). The highest number of effective tillers hill^{-1} (10.39) was obtained in two seedlings hill^{-1} when planted at a spacing of 20 cm × 15 cm. However, the lowest effective tillers hill^{-1} (5.86) was found from five seedlings hill^{-1} (Table-2). The higher number of effective tillers hill^{-1} from lower seedlings hill^{-1} might be due to lesser nutrient competition among the lower number of plants per unit area and the availability of more space to rice plants.

Interaction effect of weeding regime and planting density

The interaction effect of weeding regime and planting density showed significant variation in respect of number of effective tillers hill^{-1} (Fig. 1). A decreasing trend was found with the increase of number of seedlings hill^{-1} from the two seedlings hill^{-1} (Fig. 1). However, the maximum number of effective tillers hill^{-1} (12.33) were obtained from the treatment combination of W_1D_1 (three hand weeding and two seedlings hill^{-1}), while the minimum number (3.30) was found from no weeding with five seedlings hill^{-1} treatment combination (Fig. 1). Mobasser *et al.* (2007)

found that effective tillers were decreased significantly with increase of planting density which was similar with the present study.

Panicle length

Effect of weeding regime

The results on main effects of weeding regime showed that different weeding regime had significant effect on panicle length (Table-2). The three hand weeding at 15, 30 and 45 DAT gave the maximum panicle length (22.44 cm) and no weeding or control condition gave the minimum (18.95 cm). The maximum panicle length from higher hand weeding might be due to reception of more light and better supply of nutrient crop from a weed free environment.

Effect of planting density

The length of panicle was also significantly influenced by different planting density (Table-2). The D_1 treatment (two seedlings hill^{-1} planted at 20 cm × 15 cm spacing) gave the largest panicle length (24.06 cm). On the other hand five seedlings hill^{-1} gave the shortest (18.10 cm) panicle length.

Interaction effect of weeding regime and planting density

The interaction effect of weeding regime and planting density had significant influence on the panicle length (Fig. 2). The highest length of panicle (25.23 cm) was obtained from the treatment combination of W_1D_1 (three hand weeding with two seedlings hill^{-1}), though it was similar (24.93 cm) to the treatment W_3D_1 (herbicidal control with two seedlings hill^{-1}) and the lowest (17.00 cm) panicle length was obtained from the treatment W_4D_4 (no weeding with five seedlings hill^{-1}). There was a decreasing trend of panicle length with the increasing plant population (Fig. 2). Almost similar results were also represented by Hasan and Sarker (2002).

Number of grains tiller^{-1}

Effect of weeding regime

Present study showed that the number of grains tiller^{-1} significantly differed among the different weeding regimes (Table-2). The highest number of grains tiller^{-1} (105.95) were found in three hand weeding (at 15, 30 and 45 DAT) which was followed by herbicidal control weeding regime (98.92), while the minimum number of grains (79.70) were recorded from no weeding treatment.

Effect of planting density

Planting density significantly contributed to the number of grains tiller^{-1} (Table-2). The highest number of total grains tiller^{-1} (108.75) were obtained from two seedlings hill^{-1} and the lowest grain numbers tiller^{-1} (80.80) were from five seedlings hill^{-1} (Table-2). Sarker *et al.* (2002) also endorsed similar results.

Interaction effect of weeding regime and planting density

Effect of interaction between weeding regime and planting density was found significant in respect of number of grains tiller^{-1} (Table-3). The maximum number of grains tiller^{-1} (124.00) were obtained from the treatment combination of W_1D_1 (three hand weeding with two seedlings hill^{-1}). The minimum number of grains tiller^{-1} (70.20) were found with no weeding and five seedlings hill^{-1}, which was statistically similar to no weeding (71.92) with four seedlings hill^{-1} (W_4D_4) treatment combination (Table-4). Sarker *et al.* (2002) reported from a field trial that 15 day old single seedling hill^{-1} with 30 cm × 30 cm spacing the highest number of seeds panicle^{-1} (131.4) were obtained out of 178.45 spikelets panicle^{-1} as compared to the conventional practices at 40 day old 4 seedlings with spacing of 20 cm × 15 cm.

Weight of 1000 grains (g)

Effect of weeding regime

The effects of weeding regimes were found statistically significant in respect of 1000 grains weight (Table-2). The highest (22.90 g) and lowest (21.09 g) weight of 1000 grains were found from the weeding regime of three hand weeding and no weeding, respectively. The highest 1000 grains weight from highest hand weeding might be due to less nutrient competition between crop and weed.

Effect of planting density

Different number of seedlings hill^{-1} had also significant effect on 1000 grains weight (Table-2). The maximum 1000 grain weight (23.56 g) was obtained from the treatment D_1 (two seedlings hill^{-1}) and the lowest weight (20.61 g) was found from maximum number of seedlings hill^{-1} when planted at a spacing of 20 cm × 15 cm. Baloch *et al.* (2002) found maximum 1000 grain weight from comparatively lower population and higher planting density.

Interaction effect of weeding regime and planting density

The interaction effect was also significant in case of 1000 grain weight (Table-3). The highest (24.01 g) and lowest (19.88 g) weight of 1000 grain were recorded from the treatment combination of W_1D_1 (three hand weeding regime with two seedlings hill^{-1}) and W_4D_4 (no weeding regime with five seedlings hill^{-1}), respectively. Muhammad *et al.* (1997) reported that 1000 grain weight decreased with increasing plant density.

Grain yield plot^{-1} (kg)

Effect of weeding regime

Weeding regime markedly influenced the grain yield plot^{-1} (Fig. 3). The maximum (3.40 kg) and minimum (2.12 kg) grain yield plot^{-1} were recorded from three hand weeding and no weeding regime, respectively. Haque *et al.* (2003) reported that the highest grain yield (3.95 t ha^{-1}) was from three hand weeding regime, which was almost similar to the finding of this study.

Effect of planting density

The results on different planting densities revealed that grain yield was significantly influenced by planting density (Fig. 4). A gradual decrease of grain yield was recorded with the increase of seedling population hill^{-1}. However, two seedlings hill^{-1} produced the maximum grain yield plot^{-1} (4.02 kg), while five seedlings produced the minimum grain yield plot^{-1} (1.83 kg). Mobasser *et al.* (2007) also found increased grain yield with the decreasing plant population.

Interaction effect of weeding regime and planting density

The analysis of variance indicated that interaction between weeding regime and planting density was significant for grain yield plot^{-1} (Table-3). Three hand weeding regime with two seedlings hill^{-1} gave maximum grain yield plot^{-1}, while no weeding regime with four seedlings hill^{-1} gave minimum yield plot^{-1}. Findings of Mobasser *et al.* (2007) agreed with the result of this study.

Straw yield plot^{-1} (kg)

Effect of weeding regime

Data showed that there was a significant effect on the straw yield plot^{-1} for weeding regimes (Table-2). The highest straw yield plot^{-1} (5.46 kg) was found in three hand weeding regime (at 15, 30 and 45 DAT), but the lowest (3.65 kg) was observed in control treatment.

Effect of planting density

Significant variation on the straw yield plot^{-1} was observed due to various planting densities (Table-2). The highest straw yield plot^{-1} (6.22 kg) was obtained in two seedlings hill^{-1} when planted at a spacing of 20 cm × 15 cm (D_1). However, the lowest straw yield plot^{-1} (3.33 kg) was from five seedlings hill^{-1} treatment.

Interaction effect of weeding regime and planting density

The interaction effect of weeding regime and planting density showed significant variation in respect of straw yield plot^{-1} (Table-3). However, the maximum straw yield plot^{-1} (7.00 kg) was obtained from the treatment combination W_1D_1 (three hand weeding and two seedlings hill^{-1}), while the minimum grain weight hill^{-1} (2.67 kg) was found from no weeding with four seedlings hill^{-1} treatment combination which was statistically identical (2.99 kg) to the treatment combination of no weeding regime with five seedlings hill^{-1}.

Based on the above results, it can be summarized that almost all of the yield and yield contributing characters of transplant aman rice cv. BRRIdhan 41 were performed best under three hand weeding regime (at 15, 30 and 45 DAT) and two seedlings hill^{-1} when transplanted at a spacing of 20 cm × 15 cm. So, from the maximum yield point of view the above treatment combination would be the best under the Ganges Tidal Flood Plain (AEZ 13) in Bangladesh.

Table-2. Effects of weeding regime and planting density on yield and yield components of BRRIdhan41.

Treatments		Plant height (cm)	Number of effective tillers hill^{-1}	Panicle length (cm)	Number of grains tiller^{-1}	Weight of 1000 grains (g)	Straw yield plot^{-1}
Weeding regime	W_1 3 hand weedings	125.37a	9.25a	22.44a	105.95a	22.90a	5.46a
	W_2 2 hand weedings	124.13ab	8.38b	21.42b	95.18c	22.35b	5.05b
	W_3 herbicide control	123.20b	8.41b	21.72b	98.92b	22.45b	5.05b
	W_4 weedy check	117.42c	5.04c	18.95c	79.70d	21.09c	3.65c
	Level of significance	*	*	*	**	*	*
	% CV	1.66	11.90	2.93	4.27	1.81	9.24
	LSD value at 0.05	1.70	0.77	0.52	3.38	0.34	0.37
Planting density	D_1 2 seedlings hill^{-1}	126.89a	10.39a	24.06a	108.75a	23.56a	6.22a
	D_2 3 seedlings hill^{-1}	124.85b	8.14b	22.35b	99.04b	22.88b	5.37b
	D_3 4 seedlings hill^{-1}	121.87c	6.69c	20.04c	91.15c	21.80c	4.29c
	D_4 5 seedlings hill^{-1}	116.51d	5.86d	18.10d	80.80d	20.61d	3.33d
	Level of significance	*	*	*	**	*	*
	% CV	1.66	11.90	2.93	4.27	1.81	9.24
	LSD value at 0.05	1.70	0.27	0.54	3.38	0.34	0.37

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly by per DMRT at 5% level of probability.

*Significant at 5% level of probability, **Significant at 1% level of probability

Table-3. Interaction effects of weeding regime and planting density on the growth and yield of BRRIdhan41.

Weeding regime × Planting density	Plant height (cm)	Number of grains tiller^{-1}	Weight of 1000 grains (g)	Grain yield t ha^{-1}	Straw yield t ha^{-1}
W_1D_1	128.80a	124.00a	24.01a	4.66a	7.00a
W_1D_2	126.27bc	108.77c	23.41cd	3.74c	6.05cd
W_1D_3	124.80cd	102.67d	23.02ef	3.08e	5.12f
W_1D_4	121.60e	88.35gh	21.15i	2.10h	3.67h
W_2D_1	128.27a	106.00cd	23.58bc	4.19b	6.65ab
W_2D_2	126.13bc	98.05e	23.12def	3.37d	5.76de
W_2D_3	124.07d	98.33e	21.85g	2.73f	4.40g
W_2D_4	118.05f	78.34j	20.85ij	1.77ij	3.41hi
W_3D_1	127.17ab	112.33b	23.86ab	4.24b	6.40bc
W_3D_2	125.20cd	105.34cd	23.23cde	3.55cd	5.56e
W_3D_3	124.67cd	91.67fg	22.17g	2.87ef	4.98f
W_3D_4	115.76g	86.33hi	20.55j	1.91hi	3.25ij
W_4D_1	123.33de	92.66f	22.79f	3.00e	4.84f
W_4D_2	121.80e	84.00i	21.51h	2.37g	4.11g
W_4D_3	113.92h	71.92k	20.17k	1.60jk	2.67k
W_4D_4	110.63i	70.20k	19.88k	1.52k	2.99jk
Level of significance	*	**	*	**	*
% CV	1.66	4.27	1.81	9.24	9.24
LSD value at 0.05	1.70	3.38	0.34	0.22	0.37

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) at 5% level.

W_1 = Three hand weeding at 15, 30, 45 (DAT)	D_1 = Two seedlings hill^{-1}	* Significant at 5% level of probability
W_2 = Two hand weeding at 15, 30 (DAT)	D_2 = Three seedlings hill^{-1}	** Significant at 1% level of probability
W_3 = Herbicidal control	D_3 = Four seedlings hill^{-1}	
W_4 = No weeding	D_4 = Five seedlings hill^{-1}	

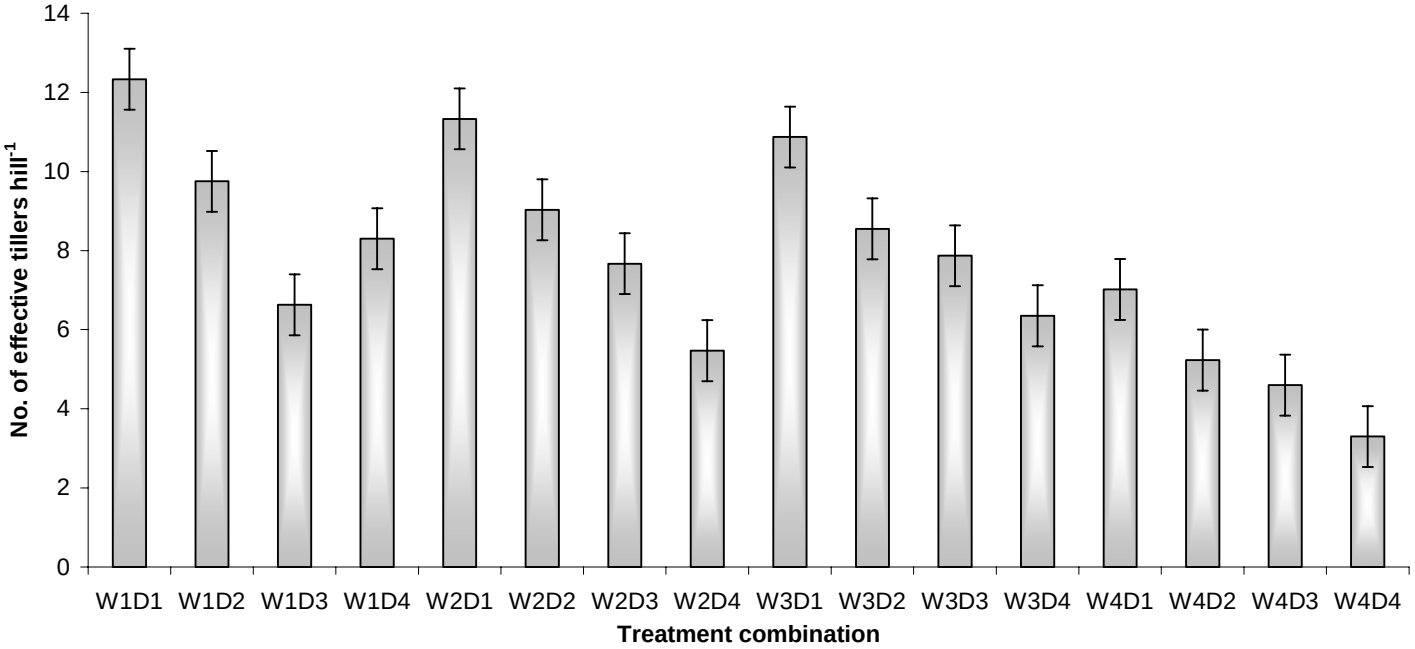

Fig. 1. Interaction effect of weeding regime and planting density on number of effective tillers hill^{-1} of transplant aman rice cv. BRRIdhan41. The vertical bar represents LSD at 0.05 probability level.

W_1 = Three hand weeding at 15, 30, 45 (DAT)
W_2 = Two hand weeding at 15, 30 (DAT)
W_3 = Herbicidal control
W_4 = No weeding

D_1 = Two seedlings per hill
D_2 = Three seedlings per hill
D_3 = Four seedlings per hill
D_4 = Five seedlings per hill

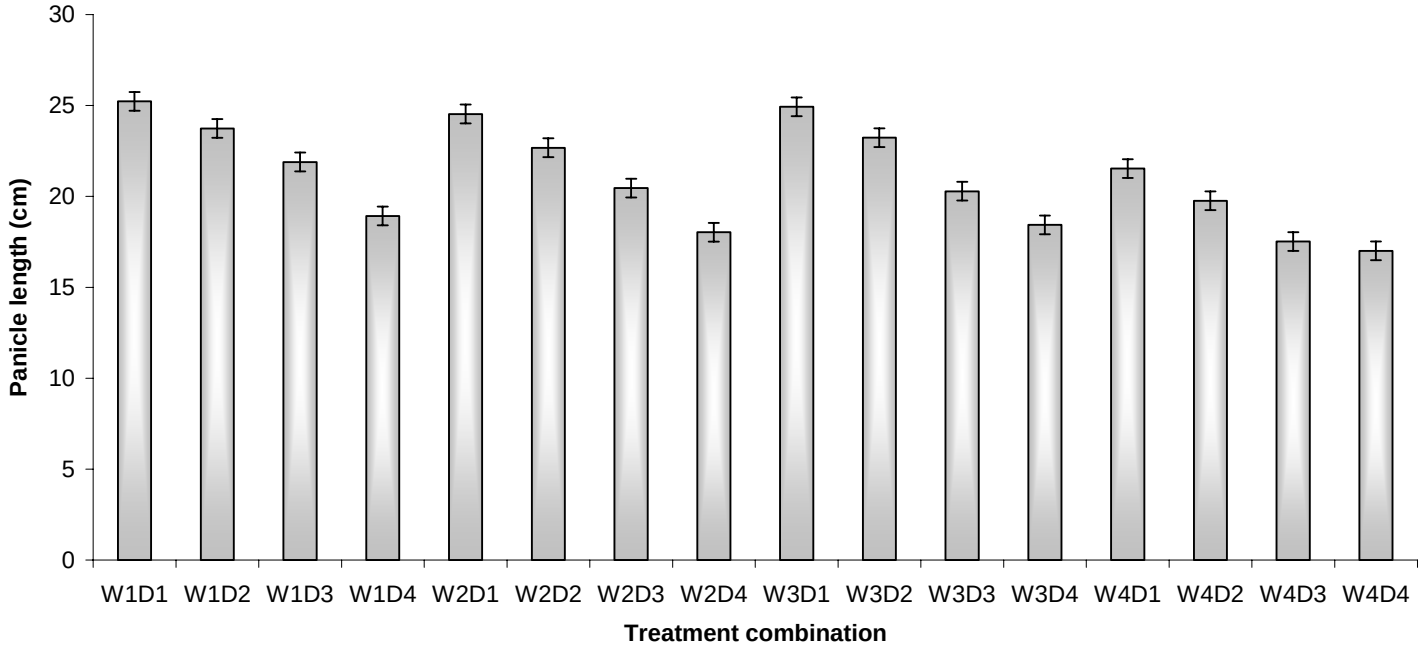

Fig. 2. Interaction effect of weeding regime and planting density on panicle length (cm) of transplant aman rice cv. BRRIdhan41. The vertical bar represents LSD at 0.05 probability level.

W_1 = Three hand weeding at 15, 30, 45 (DAT)
W_2 = Two hand weeding at 15, 30 (DAT)
W_3 = Herbicidal control
W_4 = No weeding

D_1 = Two seedlings per hill
D_2 = Three seedlings per hill
D_3 = Four seedlings per hill
D_4 = Five seedlings per hill

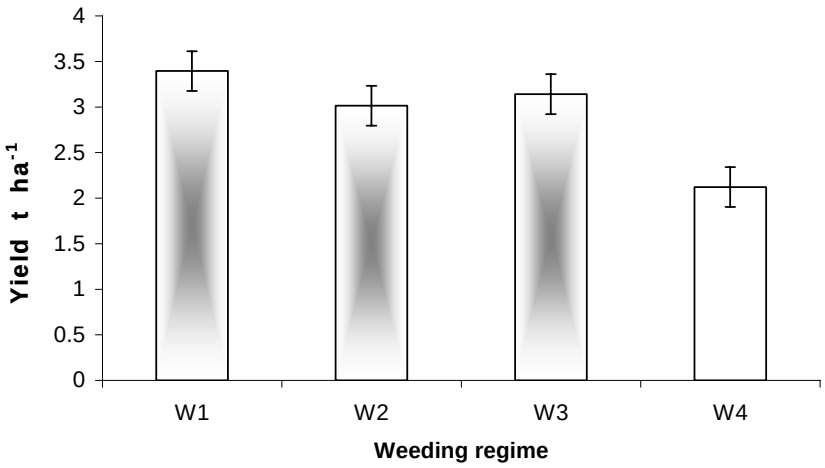

Fig. 3. Effect of weeding regime on grain yield (t ha^{-1}) of transplant aman rice cv. BRRIdhan41. The vertical bars represent LSD at 0.05 probability level.

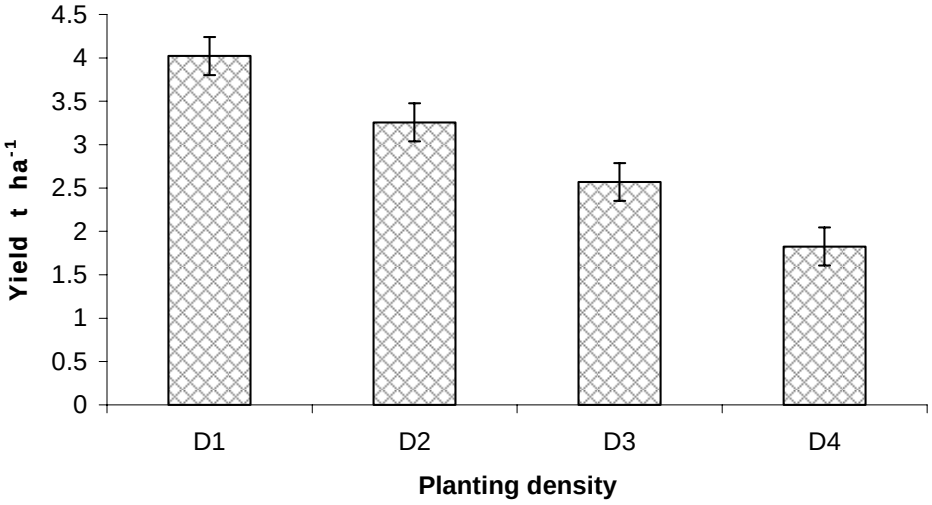

Fig. 4. Effect of planting density on grain yield (t ha^{-1}) of transplant aman rice cv. BRRIdhan41. The vertical bars represent LSD at 0.05 probability level.

W_1 = Three hand weeding at 15, 30, 45 (DAT)
W_2 = Two hand weeding at 15, 30 (DAT)
W_3 = Herbicidal control
W_4 = No weeding

D_1 = Two seedlings per hill
D_2 = Three seedlings per hill
D_3 = Four seedlings per hill
D_4 = Five seedlings per hill

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