



## EFFECT OF WEEDING REGIME ON THE PERFORMANCE OF DIRECT-SEEDED AUS RICE

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**Abstract:** A field experiment was conducted to find out the impact of weeding regime on the performance of three *Aus* rice. The experimental treatment consisted of three varieties of rice viz. BRRI dhan28, Bere Ratna and Kajol Lata, and four weeding regimes viz. no weeding, one hand weeding at 35 days after sowing (DAS), two hand weedings at 20 and 35 DAS and three hand weedings at 20, 35 and 50 DAS. The experiment was laid out in a factorial randomized complete block design with three replications. Eleven weed species belonging to five families infested the experimental plots; *Cyperus rotundus* L. and *Imperata cylindrica* (L.) Baeuv. were the dominant. The effect of weeding regime on weed density (except at 20 DAS) and weed dry weight was statistically significant. The results indicated that three hand weedings at 20, 35 and 50 DAS produced the highest number of effective tillers hill<sup>-1</sup>, number of filled grains panicle<sup>-1</sup>, 1000-grain weight and grain yield. Among the varieties Bere Ratna gave the highest grain yield.

**Keywords:** Weeding regime, Aus rice, BRRI dhan28, Bere Ratna, Kajol Lata

### Introduction

*Aus* rice is an important cereal crop of Bangladesh. It covers about 1.1 million hectares of land and produces 2.1 million tons of rice (ADB, 2011), thus contributes greatly to the national cereal production. Weeds are claimed to be the greatest yield constraint in rice crop and impose a serious negative effect on crop production and market value (Mamun *et al.*, 2011). The prevailing climatic and edaphic factors of Bangladesh are highly favorable for luxuriant growth of numerous species of weeds, which offer a keen competition with rice crop (Mamun, 1988). Manna (1991) reported yield reduction of 25% in transplanted rice, 32% in puddle broadcast rice and 52% in direct sown rice due to weeds. In Bangladesh, weeds reduce grain yield by 70-80% in *Aus* (early summer) rice, by 30-40% for transplanted (T) *Aman* (late summer) rice and by 22-36% in modern *Boro* (winter) rice cultivars (Mamun, 1990).

Weed free period during the critical period of competition is essential for optimum rice yield. Three to six weeks weed free period from seeding is needed for better growth and yield of *Aus* rice (BRRI, 1977). Weeds 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 (Hassan *et al.*, 2010). In Bangladesh, the traditional methods of weed control include preparatory land tillage and hand weeding. Usually two or three hand weedings are done in the growing season depending on the nature of weeds, their intensity, and the vigor of rice plants (Mamun *et al.*, 2011). Increasing the frequency of hand weeding one or two times at 21 and 40 days after transplanting was found to

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reduce the weed density and weed dry matter resulting in two fold increase in grain yield (BRRI, 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 *Aus* rice. Keeping the above facts in view, the present study was conducted to find out the effect of weeding regime on the yield and yield components of three *Aus* rice cultivars and to optimize the time of weeding for obtaining higher yield of *Aus* rice.

### Materials and methods

The experiment was conducted at the Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna during May to September, 2007. A factorial randomized complete block design with three replications was followed for the experiment. The experimental treatment included four weeding regimes *viz.*, no weeding, one hand weeding at 35 DAS, two hand weedings at 20 and 35 DAS and three hand weedings at 20, 35 and 50 DAS and three rice varieties *viz.*, BRRI dhan28, Bere Ratna and Kajol Lata. There were 36 plots in the experiment and the size of unit plot was 4.0 m × 2.5 m. The land was prepared thoroughly tilling twice with power tiller and subsequently plowing one time with country plough followed by laddering. All weeds, stubble and crop residues were removed and the field was divided into unit plot according to the design. According to the Bangladesh Rice Research Institute (BRRI), recommended rate of urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate were applied at the rate of 150, 50, 75, 35 and 5 kg ha<sup>-1</sup>. The whole amount of TSP, MOP, gypsum and zinc sulphate were applied as basal dose in the unit plot at the time of final land preparation and they were thoroughly incorporated to soil with the help of spade. Urea was top dressed in two equal splits at 25 and 45 days after sowing. Seeds were sown at the rate of 5-6 seeds hill<sup>-1</sup> maintaining a spacing of 20 cm from hill to hill and 25 cm from row to row. After germination, seedling(s) was thinned maintaining 3 seedlings hill<sup>-1</sup>. The experimental plots were irrigated as and when necessary and excess water was drained out at the time of heavy rainfall.

After counting the weed density m<sup>-2</sup>, the collected weeds were dried in an electronic oven for 72 hours at a temperature of 70°C. Weed dry weight was calculated as g m<sup>-2</sup>. For data collection the following parameters were considered:

- i) Number of total tillers hill<sup>-1</sup>
- ii) Effective tillers hill<sup>-1</sup>
- iii) Panicle length (cm)
- iv) Number of filled grains panicle<sup>-1</sup>
- v) Unfilled grains panicle<sup>-1</sup>
- vi) Thousand-grain weight (g)
- vii) Grain yield (t ha<sup>-1</sup>)
- viii) Straw yield (t ha<sup>-1</sup>)
- ix) Biological yield (t ha<sup>-1</sup>) and
- x) Harvest index (%).

Data were statistically analyzed using the “Analysis of Variance” technique with the help of statistical computer package MSTAT-C. The mean differences were compared by Duncan’s New Multiple Range Test (Gomez and Gomez, 1984).

### Results

**Weed species:** Weeds found in *Aus* rice field were sedges, grasses and semi-aquatic which can withstand waterlogging and usually enough to suppress crop yield very significantly if not controlled timely. The experimental plots were infested with eleven weed species belonging to five families (Table 1). Four weed species were of the family Gramineae, three of the family

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Cyperaceae, two of the family Euphorbiaceae and one each of the family Scrophulariaceae and Tiliaceae. The most important weed infesting species were Holde mutha (*Cyperus rotundus* L.), Ulu (*Imperata cylindrica* (L.) Baeuv.), Durba {*Cynodon dactylon* (L.) Pers.}, Khude shama {*Echinochloa colonum* (L.) Link.}, Joina {*Fimbristylis miliacea* (L.) Vahl} and Dadkuri (*Paspalum conjugatum* Berg.).

Table 1: Weed species recorded from the experimental field of Aus rice

Sl. no.	Local name	Botanical name	Family
1	Durba	<i>Cynodon dactylon</i> (L.) Pers.	Gramineae
2	Khude shama	<i>Echinochloa colonum</i> (L.) Link.	Gramineae
3	Joina	<i>Fimbristylis miliacea</i> (L.) Vahl	Cyperaceae
4	Holde mutha	<i>Cyperus rotundus</i> L.	Cyperaceae
5	Boro chucha	<i>Cyperus iria</i> L.	Cyperaceae
6	Ulu	<i>Imperata cylindrica</i> (L.) Baeuv.	Gramineae
7	Bon morich	<i>Croton sparsiflorus</i>	Euphorbiaceae
8	Chhoto dudhia	<i>Euphorbia parviflora</i> L.	Euphorbiaceae
9	Sada panighas	<i>Lindernia ciliata</i> (Colsm.) Pennell	Scrophulariaceae
10	Dadkuri	<i>Paspalum conjugatum</i> Berg.	Gramineae
11	Bonpat	<i>Corchorus acutangulus</i> Lam.	Tiliaceae

Table 2: Effect of weeding regime on weed density and weed dry weight of Aus rice

Weeding regime	Weed density (number m <sup>-2</sup> ) at			Weed dry weight (g m <sup>-2</sup> ) at		
	20 DAS	35 DAS	50 DAS	20 DAS	35 DAS	50 DAS
W <sub>1</sub>	152.61	84.28a	80.56a	28.54a	15.99a	8.72a
W <sub>2</sub>	147.06	80.39a	68.89b	27.90a	15.14a	4.95b
W <sub>3</sub>	145.28	65.44b	57.17c	26.72b	12.13b	3.88c
W <sub>4</sub>	149.94	62.78b	53.00d	26.01b	11.33b	3.58c
Level of significance	NS	**	**	**	**	**
CV (%)	8.60	4.17	3.49	2.21	4.45	6.84

NS: p>0.05, \*\* p<0.01; W<sub>1</sub>: No weeding; W<sub>2</sub>: One hand weeding at 35 DAS  
W<sub>3</sub>: Two hand weedings at 20 and 35 DAS; W<sub>4</sub>: Three hand weedings at 20, 35 and 50 DAS  
DAS: Days after seeding

**Weed density:** Weed density was significantly influenced by weeding regime except at 20 DAS (Table 2). Weeds emerged profusely up to 20 DAS, so that peak weed densities were recorded in all weeding regimes during this period. After 20 DAS, a sharp decline in weed density was noticed. At 35 DAS, the maximum weed density (84.28) was obtained in W<sub>1</sub> treatment which was statistically similar to W<sub>2</sub> treatment. At 50 DAS, the highest weed density (80.56) was produced by W<sub>1</sub> treatment which was statistically different from the weed density obtained from other weeding regime; the minimum weed density was found from plots receiving three hand weedings at 20, 35 and 50 DAS.

**Weed dry weight (g):** Weed dry weight was significantly affected by weeding regime (Table 2). At 20 DAS, the highest weed dry weight (28.54 g) was obtained in W<sub>1</sub> treatment which was statistically identical to W<sub>2</sub> treatment. At 35 DAS, the maximum weed dry weight (15.99 g) was obtained in W<sub>1</sub> treatment which was statistically at par with W<sub>2</sub> treatment. At 50 DAS, the highest

weed dry weight (8.72 g) was produced by W<sub>1</sub> treatment and the lowest (3.58 g) was produced by W<sub>4</sub> treatment which was statistically similar to W<sub>3</sub> treatment.

### Yield and yield attributes

**Total tillers hill<sup>-1</sup>:** Total tillers hill<sup>-1</sup> increased markedly as the number of weeding increased. Results showed that tillers produced at W<sub>2</sub> and W<sub>3</sub> treatments were statistically similar. More number of tillers hill<sup>-1</sup> (13.53) was obtained from W<sub>4</sub> treatment which was statistically different from other weeding regimes (Table 3). Results revealed that effective weed management enhanced tiller production. From the study it was found that the varietal differences on number of tillers hill<sup>-1</sup> were significant. Number of tillers hill<sup>-1</sup> in BRRI dhan28 (10.33) was lower than those of Bere Ratna (11.13) and Kajol Lata (11.05) (Table 3). These differences might be due to genetic make up of the variety. Number of tillers hill<sup>-1</sup> was significantly affected by the interaction between variety and weeding regime. The more number of tillers hill<sup>-1</sup> (13.73) was found in the combination of V<sub>2</sub>×W<sub>4</sub> which was statistically different from other combinations (Table 4).

**Effective tillers hill<sup>-1</sup>:** The number of effective tillers hill<sup>-1</sup> was significantly affected by weeding regime. The highest number of effective tillers hill<sup>-1</sup> (12.53) was obtained from W<sub>4</sub> treatment and the lowest (3.76) was in W<sub>1</sub> treatment (Table 3). In respect of producing effective tillers hill<sup>-1</sup>, no weeding was significantly inferior to rest of the treatments. The varietal differences in number of effective tillers hill<sup>-1</sup> were significant. The number of effective tillers hill<sup>-1</sup> in Kajol lata (9.55) was higher than that of other varieties (Table 3). The combined effect of variety and weeding regime was significant for number of effective tillers hill<sup>-1</sup>. The highest (12.67) and lowest (3.47) number of effective tillers hill<sup>-1</sup> were found in V<sub>2</sub>×W<sub>4</sub> and V<sub>1</sub>×W<sub>1</sub> treatments, respectively (Table 4).

Table 3: Effect of weeding regime and varietal differences in the yield and yield components of Aus rice

Treatments	Total tillers hill <sup>-1</sup>	Effective tillers hill <sup>-1</sup>	Panicle length (cm)	Filled grains panicle <sup>-1</sup>	Weight of 1000 grains (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Harvest index (%)
Weeding regime									
W <sub>1</sub>	5.42c	3.76d	16.33c	45.23c	20.34d	1.05c	1.08c	2.13c	49.22b
W <sub>2</sub>	12.00b	9.80c	19.43b	65.67b	20.99c	2.60b	2.58b	5.18b	50.10b
W <sub>3</sub>	12.40b	11.53b	21.85a	92.66a	21.39b	4.26a	3.10a	7.36a	57.95a
W <sub>4</sub>	13.53a	12.53a	21.72a	94.67a	21.69a	4.38a	3.15a	7.53a	58.20a
Level of significance	**	**	**	**	**	**	**	**	**
CV (%)	2.98	3.04	1.63	2.63	0.51	2.68	3.88	2.29	1.89
Variety									
BRRI dhan28	10.33b	9.20	20.69a	80.65a	22.61b	3.06b	2.46b	5.52b	54.12ab
Bere Ratna	11.13a	9.47	18.69c	67.79c	23.23a	3.20a	2.73a	5.93a	52.51b
Kajol Lata	11.05a	9.55	20.12b	75.24b	17.47c	2.94b	2.26b	5.20c	54.98a
Level of significance	**	*	**	**	**	**	**	**	**
CV (%)	2.98	3.04	1.63	2.63	0.51	2.68	3.88	2.29	1.89

\*\* p<0.01, \* p<0.05, W<sub>1</sub>: No weeding, W<sub>2</sub>: One hand weeding at 35 DAS

W<sub>3</sub>: Two hand weeding at 20 and 35 DAS, W<sub>4</sub>: Three hand weeding at 20, 35 and 50 DAS

**Panicle length:** The panicle length was significantly influenced due to weeding regime. Results indicated that panicle length obtained from W<sub>3</sub> and W<sub>4</sub> treatments were statistically similar. The shortest panicle (16.33 cm) was obtained from W<sub>1</sub> treatment which was statistically different from other weeding regime (Table 3). Significant differences in panicle length were found among the varieties. The panicles were longer in BRRi dhan28 (20.69 cm) than Bere Ratna (18.69 cm) and Kajol Lata (20.12 cm) (Table 3). Interaction effect of variety and weeding regime was significant on panicle length. However, the longest panicle (23.37 cm) was obtained from V<sub>1</sub>×W<sub>4</sub> treatment which was significantly different from the panicle length obtained from other combinations (Table 4).

**Filled grains panicle<sup>-1</sup>:** From the study it was found that the effect of weeding regime on number of filled grains panicle<sup>-1</sup> was significant. Results showed that grains produced at W<sub>3</sub> and W<sub>4</sub> treatments were statistically identical. The highest number of filled grains panicle<sup>-1</sup> (94.67) was found from W<sub>4</sub> treatment and the lowest number (45.23) in W<sub>1</sub> treatment (Table 3). The varietal differences on number of filled grains panicle<sup>-1</sup> was found significant. The number of filled grains panicle<sup>-1</sup> in BRRi dhan28 (80.65) was higher than that of Bere Ratna (67.79) and Kajol Lata (75.24) (Table 3). Number of filled grains panicle<sup>-1</sup> was significantly affected by interaction between variety and weeding regime. The highest number of filled grains panicle<sup>-1</sup> (105.20) was found in the combination of V<sub>1</sub>×W<sub>4</sub> and the lowest number (44.84) in V<sub>1</sub>×W<sub>1</sub> (Table 4).

**Thousand-grain weight:** Thousand-grain weight was significantly affected by weeding regime. The heaviest grain (21.69 g) was found from W<sub>4</sub> treatment which was statistically different from the grain weight obtained at other weeding regime. The lowest grain weight (20.34 g) was found in W<sub>1</sub> treatment (Table 3). Significant differences in thousand-grain weight were found among the varieties. Thousand-grain weight in Bere Ratna (23.23 g) was more than that of other two varieties (Table 3). Interaction effect between variety and weeding regime was significant on thousand-grain weight. The heaviest grain (23.71 g) was found from V<sub>2</sub>×W<sub>4</sub> treatment combination which was statistically different from the grain weight obtained at other treatment combinations (Table 4).

**Grain yield:** From the study it was found that grain yield was significantly influenced by weeding regime. The highest grain yield (4.38 t ha<sup>-1</sup>) was obtained from W<sub>4</sub> treatment, which was statistically identical to W<sub>3</sub> treatment. The lowest grain yield (1.05 t ha<sup>-1</sup>) was found in W<sub>1</sub> treatment (Table 3). Significant differences in grain yield were found among the varieties. However, the grain yield in Bere Ratna (3.20 t ha<sup>-1</sup>) was higher than that of other two varieties (Table 3). Grain yield was significantly influenced by interaction between variety and weeding regime. The highest (4.58 t ha<sup>-1</sup>) and lowest (1.03 t ha<sup>-1</sup>) grain yield was found in V<sub>2</sub>×W<sub>4</sub> and V<sub>2</sub>×W<sub>3</sub> treatment combinations, respectively (Table 4).

**Straw yield:** In the present study it was observed that straw yield was markedly influenced by different weeding regimes (Table 3). The highest straw yield (3.15 t ha<sup>-1</sup>) was obtained from W<sub>4</sub> treatment, which was statistically at par with W<sub>3</sub> treatment (3.10 t ha<sup>-1</sup>). The lowest grain yield (1.08 t ha<sup>-1</sup>) was found in W<sub>1</sub> treatment. Striking differences in straw yield were also found among the varieties. The straw yield of Bere Ratna (5.93 t ha<sup>-1</sup>) was higher than that of other two varieties (Table 3). Straw yield was significantly influenced by interaction between variety and weeding regime. The highest (3.51 t ha<sup>-1</sup>) and lowest (1.02 t ha<sup>-1</sup>) straw yield was found in V<sub>2</sub>×W<sub>4</sub> and V<sub>3</sub>×W<sub>1</sub> treatment combinations, respectively (Table 4).

**Biological yield:** The effect of weeding regime on biological yield was significant. The highest biological yield (7.53 t ha<sup>-1</sup>) was obtained from W<sub>4</sub> treatment and the lowest (2.13 t ha<sup>-1</sup>) was found in W<sub>1</sub> treatment (Table 3). Significant differences in biological yield were found among the varieties. However, the biological yield in Bere

Table 4: Interaction effect of variety and weeding regime on yield and yield components of *Aus* rice

Variety × weeding regime	Total tillers hill <sup>-1</sup>	Effective tillers hill <sup>-1</sup>	Panicle length (cm)	Filled grains panicle <sup>-1</sup>	Weight of 1000 grains (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Harvest index (%)
V <sub>1</sub> xW <sub>1</sub>	5.27g	3.47f	15.40h	44.84h	21.96f	1.05f	1.05f	2.10g	49.81
V <sub>1</sub> xW <sub>2</sub>	10.40e	9.07e	20.99c	73.92f	22.53e	2.70d	2.59d	5.29e	50.91
V <sub>1</sub> xW <sub>3</sub>	12.47cd	11.67c	22.99a	98.66b	22.84d	4.18bc	3.06b	7.24bc	57.77
V <sub>1</sub> xW <sub>4</sub>	13.20ab	12.60a	23.37a	105.20a	23.09c	4.32b	3.10b	7.44b	57.98
V <sub>2</sub> xW <sub>1</sub>	5.87f	3.87f	16.11g	44.87h	22.75d	1.06f	1.18f	2.24g	47.59
V <sub>2</sub> xW <sub>2</sub>	12.13d	9.40e	17.99f	60.39g	23.04c	2.67d	2.72cd	5.39e	49.49
V <sub>2</sub> xW <sub>3</sub>	12.80bc	11.93bc	20.54cd	85.29d	23.43b	4.50a	3.48a	7.98a	56.33
V <sub>2</sub> xW <sub>4</sub>	13.73a	12.67a	20.13d	80.63e	23.71a	4.58a	3.51a	8.09a	56.63
V <sub>3</sub> xW <sub>1</sub>	5.13g	3.93f	17.48f	45.99h	16.31j	1.03f	1.02f	2.05g	50.25
V <sub>3</sub> xW <sub>2</sub>	13.47a	10.93d	19.32e	62.71g	17.40i	2.42e	2.43e	4.85f	49.91
V <sub>3</sub> xW <sub>3</sub>	11.93d	11.00d	22.02b	94.03c	17.91h	4.09c	2.76c	6.85d	59.76
V <sub>3</sub> xW <sub>4</sub>	13.67a	12.33ab	21.66b	98.23b	18.28g	4.23bc	2.82c	7.05cd	60.00
Level of significance	**	**	**	**	**	**	**	**	NS
CV (%)	2.98	3.04	1.63	2.63	0.51	2.68	3.88	2.29	1.89

\*\* p<0.01, NS: p>0.05, V<sub>1</sub>: BRRI dhan28, V<sub>2</sub>: Bere Ratna, V<sub>3</sub>: Kajol Lata, W<sub>1</sub>: No weeding  
W<sub>2</sub>: One hand weeding at 35 DAS, W<sub>3</sub>: Two hand weeding at 20 and 35 DAS, W<sub>4</sub>: Three hand weeding at 20, 35 and 50 DAS

Ratna (5.93 t ha<sup>-1</sup>) was higher than that of other two varieties (Table 3). The interaction effect of variety and weeding regime on biological yield was significant. The highest biological yield (8.09 t ha<sup>-1</sup>) was obtained from V<sub>2</sub>xW<sub>4</sub> treatment and the lowest (2.05 t ha<sup>-1</sup>) in V<sub>3</sub>xW<sub>1</sub> (Table 4).

**Harvest index:** Harvest index was significantly influenced by weeding regime. The results of the present study showed that W<sub>3</sub> and W<sub>4</sub> treatments were statistically similar in respect of harvest index. However, the maximum harvest index (58.20%) was recorded from W<sub>4</sub> treatment and the minimum (49.22%) in W<sub>1</sub> treatment (Table 3). The varietal differences on harvest index were also found significant. Harvest index in Kajol Lata (54.98%) was higher than those of other varieties (Table 3). The interaction effect between variety and weeding regime on harvest index was not significant. However, numerically the maximum harvest index (60.00%) was recorded from V<sub>3</sub>xW<sub>4</sub> treatment whereas the minimum harvest index (47.49%) was found in V<sub>2</sub>xW<sub>1</sub> treatment (Table 4).

**Discussion**

Direct seeding of rice seems a viable alternative in rescuing farmers (Farooq *et al.*, 2011). Sustainability of dry direct-seeded rice is however adversely affected by weeds. It is estimated that direct-seeded rice yield is reduced by 60% and even 100% due to huge weed infestation (Rao *et al.*, 2007). Proper time and method of weed control are also a complex phenomenon as the weeds and rice emerge simultaneously. There is a relationship between the timing of weed emergence and the pressure exerted to the crop through competition and resultant losses in crop yield (Khaliq and Matloob, 2011). In the present study, peak weed density was counted at 20 DAS. After 20 DAS, weed density declined sharply for all the weeding regimes (Table 2). This

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drop in weed density (even in no weeding condition) could be in part due to inter and intra-specific competition (Khaliq and Matloob, 2011).

Rice is a poor competitor with weeds (Saito, 2010). Weed competitive ability of a particular rice cultivar can be assessed in terms of weed number and biomass under weedy conditions (Zhao *et al.*, 2006). The outcome of competition between rice and weeds is the differential acquisition of resources and this acquisition is density dependent provided the two species can co-exist (Rao *et al.*, 2007). Such outcomes tend to be influenced by composition of weed stand and type of rice cultivar (Chauhan and Johnson, 2010). The local climate and hydrology of experimental site was conducive to luxurious weed growth and diverse composition. The variation in weed pressure encountered in terms of density and dry biomass and also in relative proportion of different weed types can be in part due to morphological difference in rice cultivars, different rates of canopy closure and tillering capacity, and partially owing to inherent weed flora of the site. However, contrary to our results, Rodenburg *et al.* (2009) found a significant effect of cultivar on weed biomass only at harvest after season long competition.

Rice yield and its components were positively influenced by increasing number of weedings (Table 3 and Table 4). Statistically significant ( $p < 0.01$ ) interactions between rice cultivars and weeding regimes were observed for all the yield related traits. These findings were similar to that of Naseem *et al.* (1995). They found that grain yield increased with the increment of weeding regime. The weeds competed with the crop for growth factors thus reducing yield. This might be due to the fact that the weeding kept the land clean and soil was well aerated which facilitated the crop for better absorption of nutrients, moisture and solar radiation for higher yield. Effective weed management enhanced number of effective tillers  $\text{hill}^{-1}$ , number of filled grains  $\text{panicle}^{-1}$  and 1000-grain weight which ultimately increased grain yield of rice. On the other hand, reduction of effective tillers  $\text{hill}^{-1}$ , filled grains  $\text{panicle}^{-1}$  and 1000-grain weight due to severe weed competition in the control treatment caused a reduction in the grain yield of rice. Yield continued to decline as the duration of weed competition increased. Weed competition for 35 DAS caused drastic reduction in the number of panicles  $\text{m}^{-2}$  and grain yield that accounted for lower rice yield (Table 3). Chauhan and Johnson (2011) recorded a grain yield loss of 24% when weeds were allowed to grow for 28 DAS. Sultana (2000) observed that weed infestation of 100-200 weeds  $\text{m}^{-2}$  reduced rice yield by 51-64% compared with weed-free conditions. Rice plots without such competition recorded higher number of productive tillers over control because of the greater space capture by rice plants. The period within 20 to 50 DAS appeared to be an important factor in crop weed competition in dry direct-seeded rice.

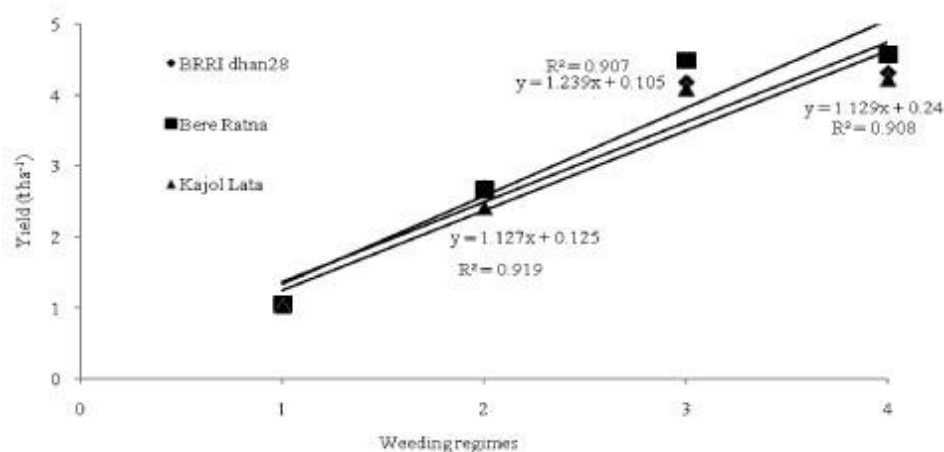


Fig. 1: Functional relationship between weeding regimes and grain yield ( $\text{t ha}^{-1}$ ) in rice varieties. 0 : No weeding, 1 : One hand weeding at 35 DAS, 2 : Two hand weedings at 20 and 35 DAS, 3 : Three hand weedings at 20, 35 and 50 DAS.

Simple linear regressions showed that grain yield was highly dependent on weeding regime in all the three rice varieties. Results indicated that yield of rice varieties increased with increment of weeding regime (Fig. 1). The present findings are corroborated with the previous work of Hassan *et al.* (2010) and Khaliq and Matloob (2011) who opined that yield increase was proportional to increasing duration of weed-free period achieved through increased number of weeding. The regression equations obtained are -

Grain yield (BRRI dhan28) =  $0.240 + 1.129 \times \text{weeding regime}$  ( $R^2 = 0.908$ )

Grain yield (Bera Ratna) =  $0.105 + 1.239 \times \text{weeding regime}$  ( $R^2 = 0.907$ )

Grain yield (Kajol Lata) =  $0.125 + 1.127 \times \text{weeding regime}$  ( $R^2 = 0.919$ )

### Conclusion

Results suggest that different weeding regimes greatly affected the weed growth, yield contributing characters and grain yield of *Aus* rice varieties. Weeding regime and variety had significant effect on yield and yield contributing characters of *Aus* rice. From the present study it might be concluded that i) three hand weedings at 20, 35 and 50 DAS produce the highest number of effective tillers  $\text{hill}^{-1}$ , number of filled grains panicle $^{-1}$ , 1000-grain weight and grain yield in *Aus* rice varieties. ii) Bera Ratna is better than others regarding yield. iii) Direct seeded *Aus* rice must be kept weed free till 35 DAS to obtain better yield.

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