



Performance Evaluation of BRR Power Weeder for Low Land Rice (*Oryza sativa* L.) Cultivation

A.K.M. Saiful Islam^{1*}, M.T. Islam², M. Sh. Islam³, A.K.M. Lutfor Rahman⁴
and M.A. Rahman¹

¹Farm Machinery and Postharvest Technology Division, ³Agronomy Division,
Bangladesh Rice Research Institute, Gazipur; ²Post Graduate Student, Bangladesh Agricultural
University, Mymensingh; ⁴Assistant Commissioner, Office of the Deputy Commissioner, Cox's Bazar

*Corresponding author and Email: akmsaifulislam68@gmail.com

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Abstract

Mechanical intervention in crop production is increasing rapidly in Bangladesh. Researchers are finding ways to manage weeds in rice field using suitable mechanical devices instead of conventional hand weeding. A study was conducted to evaluate the field performance of BRR (Bangladesh Rice Research Institute) power weeder compared to BRR weeder and hand weeding in the farmers' field at Rashidpur in Mithapukur upazila under Rangpur district during boro season of 2014-15. Three treatments: T₁ = BRR weeder (BW), T₂ = BRR power weeder (BPW) and T₃ = Hand weeding (HW) were used in the experiment. The experiment was carried out in a randomized complete block design (RCBD) and replicated in four farmers' plots. Rice variety BRR dhan28 was selected for the experiment. The effective field capacity of BW and BPW was found to be 0.06 and 0.09 ha hr⁻¹, respectively. The weeding efficiency was the highest in HW (92%), followed by BPW (78%) and BW (73%). It was found that BW damaged the lowest number of plants (9%) compared to BPW (11%) during weeding operation, although the damaged plants recovered after a few days. BW and BPW reduced 74 and 85% of labor requirement in weeding operation compared to HW. The highest weeding cost was involved in HW (Tk. 4287 ha⁻¹) compared to BW (Tk. 1103 ha⁻¹) and BPW (Tk. 950ha⁻¹). Weed control methods exerted insignificant effect on grain yield. BRR power weeder and BRR weeder reduced weeding cost, enhanced weed control and improved the labor efficiency without sacrificing grain yield. The highest BCR was obtained in BPW (1.22) followed by BW (1.16) and HW (1.11). BRR power weeder and BRR weeder appeared to be economic, easy and also environmentally safe weed control device in low land rice cultivation.

Keywords: Weeder, field capacity, weeding efficiency, labor, yield, benefit-cost ratio.

1. Introduction

Weeding is one of the most important farm operations in crop production system. Chinnusamy *et al.* (2000) reported that maintaining a weed free period for up to 45 days after transplanting was essential to augment the

yield of medium duration rice (*Oryza sativa* L.). In rain-fed lowland rice, 30-60 days after sowing period was considered as critical period for crop weed competition to avoid grain yield losses (Moorthy and Saha, 2005). Singh *et al.* (2002) observed that maintaining weed free condition till maturity gave significantly higher grain yield

due to more panicles m^{-2} and lower density and dry weight of weeds. Crop yield losses due to weeds mainly depend upon their intensity as well as on type of weed flora. There is a linear correlation between yield loss and population of weeds. However, above a certain population limit, yield reduction becomes nearly constant due to self-competition among weed plants. Manual weeding is very effective but it is tedious, time consuming and expensive in large scale cultivation. Continuous rains in rainy season and unavailability of man power make manual weeding difficult (Puniya *et al.*, 2007). Pal *et al.* (2009) found that rice having hand weeding at 20 and 40 DAT gave the highest grain yield of $5.08 t ha^{-1}$ in the Gangetic alluvial soil, mostly because of having little scope to flourish weeds and to compete with the crop preferably at the critical stage of crop weed competition. Dutta *et al.* (2005) reported that hand weeding of rice twice at 21 and 42 DAS (days after sowing) contributed to the highest weed control efficiency and increased grain and straw yield of rice crop. The weed control cost was maximum for hand weeding (two hand weeding at 30 and 45 DAT) and the lowest for chemical weed management (Hasanuzzaman *et al.*, 2007). Uphoff (2002) reported that the mechanical hand weeder pruned some of the upper roots and encouraged deeper root growth. Randriamiharisoa (2002) noticed that the mechanical weeding using rotating hoe with small toothed wheels increased the soil pores so that roots and microbes could more easily gain access to oxygen and also significantly increase the tiller production.

As the time period available for weeding is limited, improved mechanical weeders are to be used to complete the weeding operation in due time at minimum cost. There is an increasing interest in the use of mechanical weeder because of concern over environmental degradation due to herbicide use and a growing demand for organic food. Agricultural sector requires non-chemical weed control methods to ensure food safety and pollution free environment. Mechanical weeder can control weeds in a way

that meets consumer and environmental demands and pollution free environment. Mechanical weed control methods ensure the safeguard against the soil and water pollution also. Most of the farmers of Bangladesh control weed in rice field by hand weeding. Mechanical weed control not only uproots the weed between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity. Recently, BRRI power weeder was developed to control the low land weed in rice culture. BRRI power weeder is equipped with three rotors to weed out three rows in single pass operation and powered by petrol engine. This machine needs thorough investigation in the farmers' field. Therefore, the present study was undertaken to evaluate the field performance of BRRI power weeder, estimate the yield performance of rice due to weed control by the weeders and compare the cost efficiency of mechanical weeding over traditional hand weeding.

2. Materials and Methods

This experiment was conducted in the farmers' field, Rashidpur, Mithapukur, Rangpur during 14 December 2014 to 02 May 2015 (seeding to harvesting). The treatments sequences were T_1 = weeding with BRRI weeder (BW) at 25 DAT; T_2 = weeding with BRRI power weeder (BPW) at 25 DAT and T_3 = weeding by hand (HW) at 25 DAT and 55 DAT. The experiment was carried out in randomized complete block design (RCBD) and replicated in four plots. Rice variety BRRI dhan28 was transplanted manually with a spacing of 20×20 cm. The field was prepared using common tillage practice, which is first plowing (primary tillage) once, followed puddling (secondary tillage) twice and leveling using two-wheel tractor under the flooding conditions. Forty-three days old seedlings were uprooted carefully from the nursery field and transplanted on 18 January, 2015. Fertilizer was applied as per recommendation set by BRRI. The human labor involved in each operation was recorded through field measurements. Irrigation water was applied time to time as when required for the crop.

2.1 Cultural practices (weeding)

Weeding was done manually by hand twice at 25 days after transplanting (DAT) and 55 DAT and machine weeding once at 25 DAT (Photo 1). After that no other weeding operation was done up to harvest. During weeding different weed species grown in the experimental plot were identified and counted species-wise.

2.2 Weed species

Data on weed density were collected from each plot at vegetative stage of the rice plants by using $0.5 \times 0.5\text{m}$ quadrat as per method described by Cruz *et al.* (1986). The quadrat was placed in three spots at random. The weeds within the quadrat were counted species-wise and converted to number m^{-2} multiplying by four.



a. BRR power weeder



b. BRR weeder



c. Hand weeding

Photo 1. Weed management options

2.3 Field capacity

It is the ratio of actual average rate of field coverage by the machine to the total time during operation (Hunt, 1995). Therefore,

$$C = \frac{A}{T} \dots\dots\dots(1)$$

Where,

C= Actual field capacity, ha hr⁻¹
 A= Total transplanted area, ha
 T= Total operating time required for transplanting, hr

2.4 Weeding efficiency

To determine the weeding efficiency in three places of each plot bamboo frame of 1m×1 m was thrown in the field randomly and the number of weeds was counted. The weeding efficiency was computed by using the following equation:

$$\text{Weeding efficiency, } \Sigma = \frac{W_1 - W_2}{W_1} \times 100 \dots\dots\dots(2)$$

Where,

W₁ = number of weeds before weeding
 W₂ = number of weeds after weeding
 Σ = weeding efficiency

2.5 Tiller damaged

After weeding operation, bamboo frame of 0.50 × 0.50 m was thrown in three places of each plot randomly and the number of damaged plant in the frame was counted (Tewari *et al.*, 1993). The percent of breakage of rice tiller was computed by using the following equation:

$$DP = \frac{Q_1}{Q_2} \times 100 \dots\dots\dots(3)$$

Where,

DP = Damaged tillers (%)
 Q₁ = Number of tillers broken in the row after weeding operation
 Q₂ = Total number of plants in the row

2.6 Yield and yield contributing characters

Grain yield was recorded from pre-selected 10 m² area and adjusted to moisture content of 14%. The plant height was measured from the base of the hill to the tip of the longest panicle. Twelve hills from each of the plots were collected randomly. The number of effective and non-

effective tillers from each hill was noted. For computing, aboveground biomass and yield contributing characters, 4 hills were collected from the outside of the selected area. The dry weight of straw was determined after oven-drying at 70°C to constant weight. Panicle number of each hill was counted to determine the panicle number m⁻². Plant samples were separated into straw and panicles. Panicles were hand-threshed and the filled spikelets were separated from unfilled spikelets. Border areas of all sides of the plot were excluded to avoid border effects.

2.7 Economic and statistical analysis

In order to estimate the production cost, the data on working speed, total time and labor inputs by the weeder, manual worker and materials inputs to complete the operations were recorded. Fixed cost and variable cost of the weeder was calculated using the method mentioned in Hunt (1995). Rental charge of the machines was also included in the cost estimation. Price of the produce was collected from the local markets to compute total production cost, gross return, gross margin and benefit-cost ratio. Data were analyzed by using statistical software Statistix 9.0. Means were compared with least significant difference (LSD) test.

3. Results and Discussion

3.1 Weed infestation

Eight different weed species belonging to three families of which 4 annual and 4 perennial were found in the experimental plot. Among eight weed species, one was sedge, one was broad leaf and six were grasses. The most predominant weed species in the experimental plots was Chesra (*Scripus maritimus*), other important weeds were Anguli (*Digitaria sanguinalis* (L.); Scop), Durba (*Cynodon dactylon* (L.) pers) and Chela ghash (*Rottboellia protensha* Hack.). The Khudeshama (*Echinochloa colonum* (L.) Beauv) was the least abundant weed species in the experimental plot. Some upland weeds observed in the fields due to dry condition of land.

3.2 Field capacity

The field capacity of BW (0.06 ha hr^{-1}) was higher than BPW (0.09 ha hr^{-1}) (Fig. 1). Operator's skill influenced the performance of weeder. At the end of each pass, operator lifted the machine, placed the machine in another new rows and started operation. This increased the turning time loss which reduced the field capacity of the BPW. Alizadeh (2011) obtained the similar field capacity of power weeder (0.08 ha hr^{-1}). Remesan *et al.* (2007) also observed that the effective field capacity of rotary weeder was 0.02 ha hr^{-1} which was lower than BW.

3.3 Labor requirement in weeding operation

Labor requirement in HW, BW and BPW were obtained 86, 22 and 13 man-hr ha^{-1} (Fig. 2). Hand weeding appeared as labor intensive works in rice production. BW and BPW reduced by 74 and 85% labor requirement in weeding operation compared to HW. Alizadeh (2011) mentioned that the labor input in mechanical weeder was obtained 36 man-hr ha^{-1} whereas 112 man-hr ha^{-1} in hand weeding which was higher than the present finding. This might be due to the variation in weed density and type of weed.

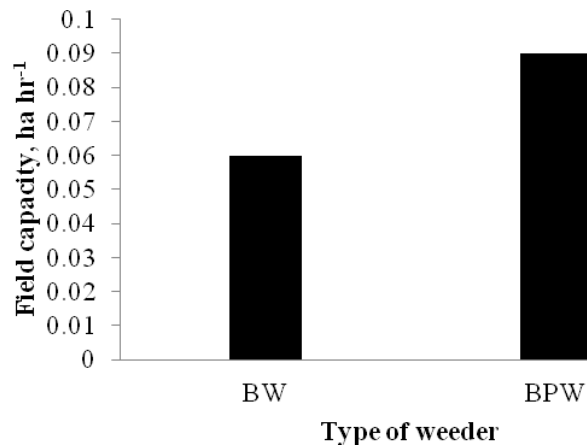


Figure 1. Field capacity of weeders

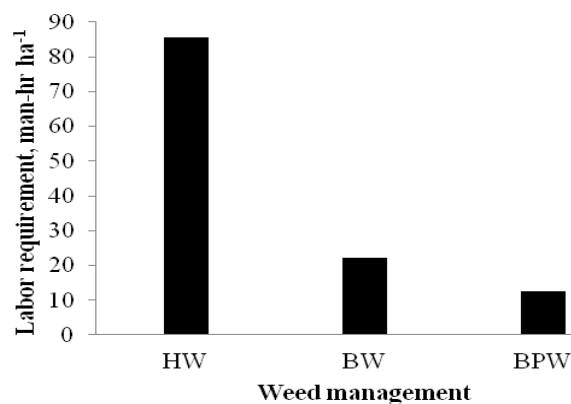


Figure 2. Labor requirement in different weed managements

3.4 Weeding efficiency

Means comparison for weeding efficiency in the experimental treatments is demonstrated in Table 1. BW and BPW worked in the top 2-3 cm layer where most weeds were grown. The highest weeding efficiency was obtained in HW (92%) followed by BPW (78%) and BW (73%). Dutta *et al.* (2005) reported that hand weeding twice at 21 and 42 DAS recorded the highest weeding efficiency. The results showed that for each type of weeding method, the weeding efficiency in BPW was more than BW. This could be attributed to utilized active rotors mechanism in the power weeder. It means the engine would provide the required power for rotor caused better blades grips with soil, resulting in higher weeding efficiency of the weeder. Generally, weeding efficiency depends on the weeder type, weed species and the weeding time. If weeding is delayed, the weeding efficiency will be decreased for excessive growth of weeds in soil and improper involvement of machine blades in soil depth. Alizadeh (2011) tested the weeding efficiency of two types of weeder in low land rice cultivation in Iran and found that weed efficiency of power weeder (84%) was higher than the rotary weeder (73%). Ramesan *et al.* (2007) reported that the weeding efficiency of rotary weeder was around to be 72%, respectively. Subudhi (2004) reported that the efficiency of different types of hand operated weeder is between 76 to 91%. These findings are

consistent to the results of the present experiment.

3.5 Tiller damaged

Figure 3 showed the means comparison for damaged plants in the experimental treatments. Results indicated that the least percentage of damaged plants (9%) obtained in BW. The BPW caused higher damaged plant (11%), although it had high efficiency rather than BW. The movements of weeder machines encounters difficulties in BPW plot because of the distribution pattern and shading of plant over spaces between the rows and percentage of damaged plant will be consequently occurred. Moreover, the weeder moved swiftly between the rows caused more damages of plants through weeding. Alizadeh (2011) observed the lowest damage of plants in rotary (4.26%) and power weeded (4.03%) plot which may be due to erect behavior of the hybrid rice variety than that of inbred BRRI dhan28 and weeder moves easily between the rows caused fewer damages of plants through weeding.

3.6 Yield and yield contributing character

Data on yield and yield contributing character were statistically analyzed and presented in Table 2. Weed management had significant effect on other parameters whereas, no effect on grain yield and yield contributing characters.

Table 1. Effect of weed management on weed population and weeding efficiency

Treatment	Weed population				
	Weeds before weeding, no. m ⁻²	Weeds after weeding, no. m ⁻²	Weeding efficiency, %	Weeds after 3 days of weeding, no. m ⁻²	Weeds after 10 days of weeding, no. m ⁻²
HW	308	25	92	149	165
BW	334	75	76	122	109
BPW	217	75	78	98	107

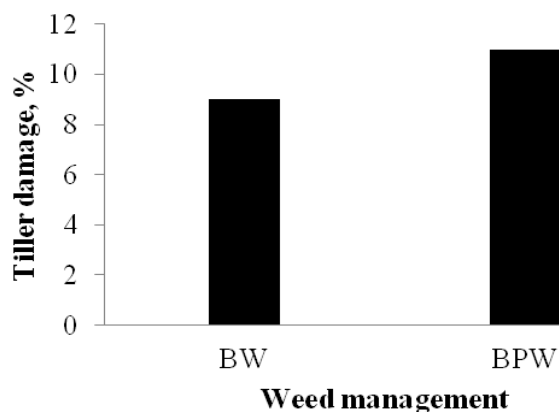


Figure 3. Tiller damage during weeding operation

Table 2. Yield and yield contribution characters as influenced by different weed management options, boro 2015-16

Treatments	Panicle (no. m ⁻²)	1000-grain wt.(g)	Grain yield (t ha ⁻¹)	Sterility (%)
BW	264	21.04	5.33	26.35
BPW	240	19.28	5.71	24.28
HW	233	20.51	5.29	31.72
CV (%)	18.76	7.41	6.39	31.35
LSD _(0.05)	NS	NS	NS	NS

3.7 Weeding cost

Weeding costs of different weeding methods are shown in Fig. 4. In BPW and BW, the cost of machine operation was the sum of fixed and variable costs. In HW, the cost of operation is just related to the labor cost. Weeding cost of HW, BW and BPW was obtained Tk. 4287, 1103 and 950 per hectare. BW and BPW reduced 74 and 78% weeding cost compared to HW. Other researchers also reported that weeding cost decreased in the mechanized methods over hand weeding (Alizadeh, 2011; Goel *et al.*, 2008 and Remesan *et al.*, 2007).

3.8 Effect of weed control methods on total cost, gross return and net return

Total production cost including all the costs shown in Table 3. The gross return was calculated based on the existing market price of paddy and straw. Production cost per hectare showed the highest in HW. The gross returns and net return was obtained the highest in BPW followed by BW and HW, respectively. The BPW showed the highest BCR (1.22) followed by BW (1.16) and HW (1.11) due to less labor requirement in weeding operation.

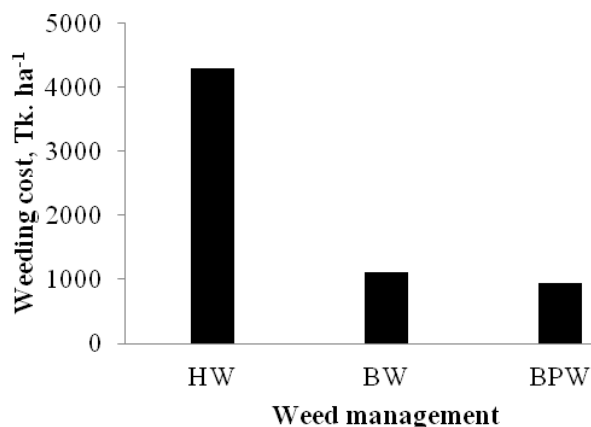


Figure 4. Weeding cost in different weed management

Table 3. Gross return, net return and benefit cost ratio (BCR) as calculated for weed management with BRR I weeder, BRR I power weeder and by hand weeding

Treatments	Input cost (Tk.ha ⁻¹)	Return from grain (Tk. ha ⁻¹)	Return from straw (Tk. ha ⁻¹)	Gross return (Tk. ha ⁻¹)	Net return (Tk. ha ⁻¹)	Benefit Cost Ratio (BCR)
	A	B	C	D=B+C	E	F
BW	84,686	86,450	11,970	98,420	13,734	1.16
BPW	86,789	92,788	12,840	1,05,636	18,847	1.22
HW	88,961	85,963	11,895	97,866	9,905	1.11

4. Conclusions

BRR I power weeder was found to have the highest effective field capacity. The labor requirement for weed management with BRR I weeder and BRR I power weeder was reduced by 74 and 85%, respectively compared to hand weeding method. Weeding cost in BRR I weeder and BRR I power weeder was decreased by 74 and 78%, respectively compared to hand weeding method. Therefore, BRR I power weeder was more effective and economic in weed management under low land rice cultivation though it created some tiller damage. However, the performance of the power weeder should be compared with weed management by the application of herbicides.

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