Pak. J. Weed Sci. Res. 17(4):323-331, 2011

ECONOMIC WEED MANAGEMENT OPTIONS IN WINTER RICE

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ABSTRACT

Due to labor shortage chemical weed control becomes a priority by time. An experiment was carried out to find out an effective and economic herbicide to control weeds in the Agronomy Farm of Bangladesh Rice Research Institute, Gazipur, during December 2008 to June 2009 in winter season. Surjamoni and BRRI dhan-29 were used as rice cultivars. Weed control treatments were assigned using three rates of Becolor 5G (butachlor), Bouncer 10WP (pyrazosulfuron ethyl) and Becofit 500EC (Pretilachlor). Visual observation indicates that these herbicides were not toxic to rice plants. Paspalum distichum was the dominating weed species in the experimental site. Weed control efficiency ranged (WCE) from 42 to 84%. Above 80% WCE was obtained by Becolor 5G @ 30 kg ha^{-1}, Bouncer 10WP @ 150g ha^{-1} and Becofit 500EC @ 1.20 L ha^{-1}, respectively. The highest grain yield (6.96 t ha^{-1}) was obtained from Surjamoni when treated with Bouncer 10WP @ 150g ha^{-1} which was 49% higher than control. BRRI dhan29 produced also the highest grain yield when treated with same treatment which was 37% higher than control. In terms of profitability of rice production, application of Bouncer 10WP @ 150g ha^{-1} gave highest gross return and gross margin than other weed control treatments. The highest (2.77) benefit cost ratio (BCR) of Bouncer 10WP @ 150g ha^{-1} suggested that it could be an alternative weed control option for profitable rice production.

Key words: Economics, weed management, herbicides, winter rice, weed control.

INTRODUCTION

Rice is one of the most extensively cultivated cereals of the world and feeds 50% of the world's population. In Bangladesh, it is the staple food. Among different rice growing season, *boro* (winter) season covers about 43.57 of total rice area that contribute 61.33 of total rice production (BBS, 2008). Modern scientific knowledge and technologies can increase production. Weeds are claimed to be the greatest yield

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constraint in rice crop and impose a serious negative effect on crop production and market value. Al-Mamun (1990) reported that weed growth reduced the grain yield by 69-100% in direct seeded *aus* rice, 16-48% for *aman* rice and 22-36% for modern *boro* rice. Subsistence farmers of the tropics spend more time, energy and money on weed control than on any other aspects of crop production (Kassasian, 1971).

Poor weed control is one of the major factors responsible for reduction in yield including type of weed flora and their intensity (Amarjit *et al.,* 1994). Therefore, weed control with minimum cost and less adverse effect on environment is of prime importance. In Bangladesh, the traditional methods of weed control practices include preparatory land tillage, hand weeding by hoe and hand pulling. Usually two/three hand weedings are normally required for optimum yield from rice crop keeping in view the nature of weeds and their intensity. Hand weeding is very laborious, time consuming and expensive. In addition, during the peak period, the availability of labor is also becoming a serious problem by time. However, herbicides are used successfully for weed control in rice fields for rapid effect, easier to application and low cost involvement in comparison to the traditional methods of hand weeding (Mian and Al-Mamun, 1969).

The present study was undertaken to find out an effective and economical herbicide for weed control in *boro* (winter) rice cultivation.

MATERIALS AND METHODS

An experiment was conducted at Bangladesh Rice Research Institute, Gazipur, during December, 2008 to June, 2009 to find out an effective and economical herbicide for weed control in *boro* (winter) rice cultivation. The soil of the experimental site was non-calcareous dark grey flood plain (FAO, 2004) with pH around 6.2 and low in organic matter (1.2%). The experiment was laid out in a split-plot design with three replications. Weed control treatments were in the main plots and rice varieties in the sub-plots. Rice varieties were: V_1 = Surjamoni (tall variety) and V_2 = BRRI dhan29 (dwarf variety). Ten weed control treatments were included: T_0 = Weedy check, T_1 = Becolor 5G @ 20 kg ha^{-1}, T_2 = Becolor 5G @ 25 kg ha^{-1}, T_3 = Becolor 5G @ 30 kg ha^{-1}, T_4 = Bouncer 10WP @ 100g ha^{-1}, T_5 = Bouncer 10WP @ 125g ha^{-1}, T_6 = Bouncer 10WP @ 150g ha^{-1}, T_7 = Becofit 500EC @ 0.80 L ha^{-1}, T_8 = Becofit 500EC @ 1.00 L ha^{-1} and T_9 = Becofit 500EC @ 1.20 L ha^{-1}. Becolor 5G and Becofit 500EC (Pre emergence herbicide) were applied at 5 days after transplanting (DAT) but Bouncer 10WP (Post emergence herbicide) was applied at 1-2 leaf stage of weeds.

The field was fertilized with urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate @ 220, 100, 60, 60 and 10 kg ha^{-1}, respectively. Except urea, the whole amounts of other fertilizers were applied during final land preparation. Forty four-day old seedlings were transplanted using two seedlings per hill maintaining spacing of 25 cm x 15 cm. Urea was top dressed in three installments at 15, 30 and 45 DAT. Data on weed density and dry weight were taken from each plot on 25 and 45 DAT. The weeds were identified species-wise. Relative weed density (RWD), importance value of weed (IVM), sum dominance ratio (SDR) and weed control efficiency (WCE) of different weed control treatments were calculated with the following formulas:

$$\text{RWD (\%)} = \frac{\text{Density of individual weed species in the community x 100}}{\text{Total density of all weed species in the community}}$$

$$\text{IVW (\%)} = \frac{\text{Dry weight of a given oven dried weed species x 100}}{\text{Dry weight of all oven dried weed species}}$$

$$\text{SDR (\%)} = \frac{\text{RWD + IVW}}{2}$$

$$\text{WCE (\%)} = \frac{\text{(Dry weight of weeds in weedy check plots - Dry weight of weeds in treated plots) x 100}}{\text{Dry weight of weeds in weedy check plots}}$$

Data on plant height, effective tillers, grains/panicle, 1000-grain weight, grain and straw yield, land value, interests on it, cost of land preparation, labors, fertilizers, herbicides, seeds, irrigation, price of products and byproducts were collected. Yield attributes data were analyzed with analysis of variance using MSTAT and means were compared by DMRT. Economic performance was evaluated in terms of total variable cost, gross return, gross margin and benefit cost ratio. Gross return from *boro* rice cultivation was estimated as value of grain (Tk. ha^{-1}) + value of straw (Tk. ha^{-1}). Gross margin was calculated by the formula:

$$\text{Gross margin (Tk. ha}^{-1}\text{)} = \text{Gross return (Tk. ha}^{-1}\text{)} - \text{Total variable cost of production (Tk. ha}^{-1}\text{)}$$

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost}}$$

RESULTS AND DISCUSSION

Weed infestation and ranking of weeds

Weed competition is strong when the weed population increases and the weed growth is comparatively more exuberant and rapid than those of the desired crop plants. Three major weed species belonging to family Poaceae infested the experimental site. All were grasses and the most important weed was *Paspalum disticum* followed by *Echinochloa crusgalli* and the least was *Leersia hexandra*. Relative density of *Paspalum disticum* was highest at both 25 DAT and 45 DAT where lowest density was observed for *Leersia hexandra*. All the weed species varied considerably in their absolute density and accumulation of dry matter. Summed dominance ratio (SDR) is an important indicator of showing ranking of weeds. Here SDR of infesting weeds are showing in Figure 1. Among the infesting weed *Paspalum disticum* and *Echinochloa crusgalli* were the dominating weeds whereas *Leersia hexandra* was the least one in 25 and 45 DAT.

Weed control efficiency

The mean weed control efficiency (WCE) of various herbicidal doses was calculated for two varieties. The WCE ranged from 42% to 84% (Fig. 1). Weed control efficiency was increased with higher doses in case of all herbicides. Twenty percent higher dose of herbicides showed above 80% of WCE. Weed control efficiency of 81, 83 and 84% were obtained by Becolor 5G @ 30 kg ha^{-1}, Bouncer 10WP @ 150g ha^{-1} and Becofit 500EC @ 1.20 L ha^{-1}, respectively. Al-Mamun *et al*. (2010) found that herbicides of pyrazosulfuron ethyl and oxadiazon group control weeds above 80% using recommended dose. About 60% WCE was recorded by Becolor 5G @ 25 kg ha^{-1}, Bouncer 10WP @ 125g ha^{-1} and Becofit 500EC @ 1.00 L ha^{-1}. Becolor 5G @ 20 kg ha^{-1}, Bouncer 10WP @ 100g ha^{-1} and Becofit 500EC @ 0.80 L ha^{-1} gave less than 60% WCE. Bari (2010) reported that herbicides of pretilachlor group @ 1 L ha^{-1} control weeds by 86% in boro (winter) season.

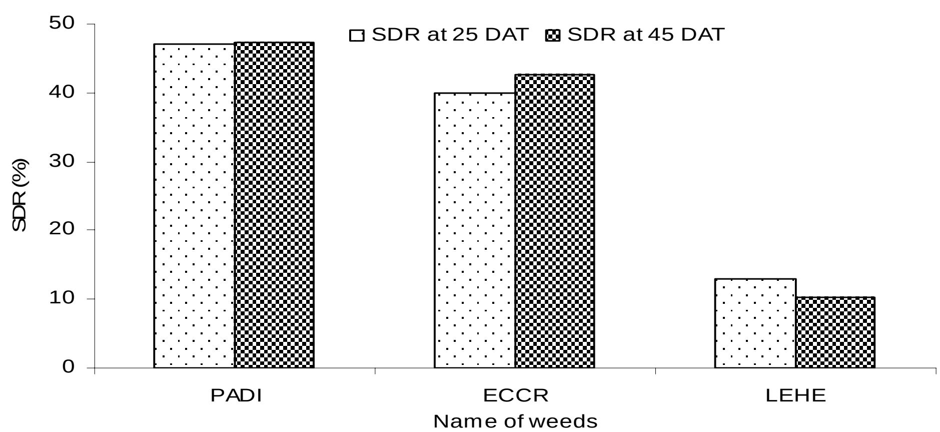

Figure 1. Some dominance ratio (SDR) of infesting weeds.

(PADI = *Paspalum distichum*, ECCR = *Echinochloa crusgalli* and LEHE = *Leersia hexandra*)

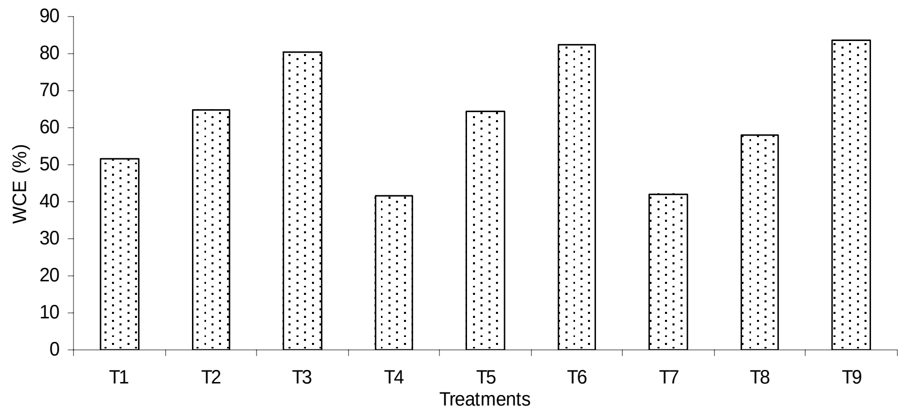

Figure 2. Weed control efficiency (WCE) of different weed treatments.

T_1 = Becolor 5G @ 20 kg, T_2 = Becolor 5G @ 25 kg, T_3 = Becolor 5G @ 30 kg, T_4 = Bouncer 10WP @ 100 g, T_5 = Bouncer 10WP @ 125 g, T_6 = Bouncer 10WP @ 150 g, T_7 = Becofit 500EC @ 0.8 L, T_8 = Becofit 500EC @ 1 L and T_9 = Becofit 500EC @ 1.2 L ha^{-1}

Yield and yield contributing characters

Yield and yield contributing characters such as grains/panicle, grain yield and harvest index were significantly influenced by the interaction between variety and weed control treatments (Table-1). But the interaction effects of variety and weed control treatments on number of effective tillers/ hill and 1000 grain weight were not significant.

Result of this study showed that control treatment failed to produce more tiller due to severe infestation of weeds in the field. Hasanuzzaman *et al.* (2009) reported similar results. Maximum number of tillers/hill were recorded in BRRI dhan29 with Becolor 5G @ 20 kg ha^{-1} (T_1), Bouncer 10WP @ 100g ha^{-1} (T_4), Bouncer 10WP @ 125g ha^{-1} (T_5) and Becofit 500EC @ 0.80 L ha^{-1}(T_7). Weedy check (T_0) produced minimum number of tillers/hill in both varieties.

The minimum number of plant/hill in the control plot was the result of higher competition for nutrient, air space, light and water between crop plants and weeds. Ghobrial (1983) and Patil *et al.* (1986) observed that increased weed competition in control plots reduced the plant population. The significant highest number of grains/panicle (143) was produced by Becofit 500EC @ 0.80 L ha^{-1} (T_7) in the variety Surjamoni.

Table-1. Effect of weed control treatments on yield and yield contributing characters.

Treatments	Tillers /hill	Grains /panicle	1000-grain weight (g)	Grain yield (t/ha)	HI (%)
			Sunjamoni		
T_0	5	100bc	24.62	3.54c	41d
T_1	8	120ab	24.75	6.25a	48c
T_2	8	122ab	24.76	6.30a	48c
T_3	7	121ab	24.44	6.34a	48c
T_4	7	133ab	25.10	6.42a	51c
T_5	7	117ab	25.42	6.95a	53bc
T_6	7	134ab	25.23	6.96a	56b
T_7	8	143a	25.06	6.20a	53bc
T_8	8	127ab	22.22	6.40a	55b
T_9	8	117ab	22.68	6.11a	56b
			BRRI dhan29		
T_0	6	79e	22.73	3.70c	49c
T_1	10	91c	22.49	5.06ab	51bc
T_2	9	68ef	24.97	5.05ab	52bc
T_3	9	91c	25.10	5.48ab	54b
T_4	10	99bc	25.21	5.31ab	49c
T_5	10	84d	24.97	5.30ab	57b
T_6	9	119ab	25.34	5.84ab	52bc
T_7	10	98bc	25.78	5.15ab	57b
T_8	9	98bc	25.50	5.56ab	49c
T_9	9	107b	25.64	5.70ab	61a
CV (%)	17.06	18.47	4.53	16.07	8.81

T_0 = Weedy check, T_1 = Becolor 5G @ 20 kg, T_2 = Becolor 5G @ 25 kg, T_3 = Becolor 5G @ 30 kg, T_4 = Bouncer 10WP @ 100 g, T_5 = Bouncer 10WP @ 125 g, T_6 = Bouncer 10WP @ 150 g, T_7 = Becofit 500EC @ 0.80 L, T_8 = Becofit 500EC @ 1 L and T_9 = Becofit 500EC @ 1.2 L ha^{-1}.

The lowest number of grains $panicle^{-1}$ (79) were found in weedy check (T_0) in the variety BRRI dhan29. The highest 1000-grain weight (25.78) were produced by Becofit 500EC @ 0.80 L ha^{-1} (T_7) in the variety BRRI dhan29. The lowest 1000-grain weight (22.22) was found due to Becofit 500EC @ 1.00 L ha^{-1} (T_8) in the variety Surjamoni. When the combination of variety and weed control treatments were considered the highest grain yield (above 6.00 t ha^{-1}) was observed in all the treated plots using the rice variety Surjamoni. BRRI dhan29 produced above 5.00 t ha^{-1} with all the treatments. Grain yield increased with the increases of doses irrespective of herbicides. It may be due to maximum control of weeds and minimum competition between weed and crop. The lowest grain yield (3.17 t ha^{-1}) was obtained in weedy check with both verities. This happened due to severe infestation of weeds in the BRRI dhan29 and lead to reduction of all yield components and finally the grain yield. BRRI (2004) reported the similar effects of weed competition on the reduction of yield components of rice. The highest harvest index was recorded from Becofit 500EC @ 1.20 L ha^{-1}(T_9) and lowest one from weedy check. Herbicide treatments contributed to higher yield performance compared to control in all the growing seasons (Bari, 2010). These findings are further supported with the work of Bhuiyan and Ahmad (2010), who realized better yields in rice with herbicide use.

Toxicity of herbicides on rice crop

Although no scoring was done in the study but visual observation indicates that all the herbicides were not toxic to rice plants. Initially the rice plants looked yellowing slightly but recovered within five days of application.

Economic performance

The economic performance of weed control treatments were evaluated in terms of cost and return (Table-2) and (Fig. 3). The cost of production and return of unit plot of *boro* rice were converted into cost per hectare. When the means of two varieties were considered it was noticed that the highest gross margin ($ 730 ha^{-1}) and benefit-cost ratio (BCR) (2.77) were in the treatment of Bouncer 10WP @ 150g ha^{-1} (T_6) and the lowest was obtained from control plot ($ 283 ha^{-1}) and BCR (1.72).

Table-2. Economic performance of different weed control treatments, 2008.

Treatment	Cost of production ($ ha^{-1})			Yield (t ha^{-1})		Gross return ($ ha^{-1})			Gross margin ($ ha^{-1})
	Fixed cost	Herbicide cost	Total cost	Grain	Straw	Grain	Straw	Total	
T_0	395	0.00	395	3.62	4.25	579	99	678	283
T_1	395	19.33	414	5.66	4.5	905	105	1010	595
T_2	395	23.87	419	5.68	5.75	908	134	1042	623
T_3	395	28.67	424	5.91	5.71	946	133	1079	655
T_4	395	12.67	408	5.87	5.75	938	134	1073	665
T_5	395	15.33	410	6.13	5.88	980	137	1117	707
T_6	395	18.00	413	6.40	5.08	1024	119	1143	730
T_7	395	12.53	408	5.68	5.46	908	127	1035	628
T_8	395	15.33	410	5.98	4.67	957	109	1066	655
T_9	395	17.87	413	5.91	5.58	945	130	1075	662

Price of un-husked rice $ 0.16 kg^{-1}, and straw $ 0.25 kg^{-1}

T_0 = Weedy check, T_1 = Becolor 5G @ 20 kg, T_2 = Becolor 5G @ 25 kg, T_3 = Becolor 5G @ 30 kg, T_4 = Bouncer 10WP @ 100 g, T_5 = Bouncer 10WP @ 125 g, T_6 = Bouncer 10WP @ 150 g, T_7 = Becofit 500EC @ 0.80 L, T_8 = Becofit 500EC @ 1 L and T_9 = Becofit 500EC @ 1.2 L ha^{-1}

The treatment Bouncer 10WP @ 150g ha^{-1} (T_6) provided with the maximum net profit which was 61.23% higher over control. The highest gross return ($ 1143 ha^{-1}) was obtained from Bouncer 10WP @ 150g ha^{-1} (T_6) and the lowest ($ 678 ha^{-1}) from control plot (T_0). It was revealed that the application of Bouncer 10WP @ 150g ha^{-1} (T_6) maximized the net profit in comparison to other treatments.

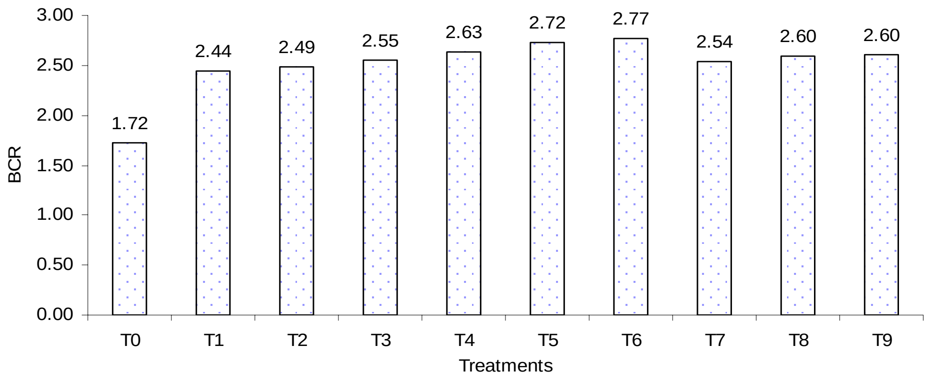

Figure 3. Economic performance of different weed control treatments.

T_0 = Weedy check, T_1 = Becolor 5G @ 20 kg, T_2 = Becolor 5G @ 25 kg, T_3 = Becolor 5G @ 30 kg, T_4 = Bouncer 10WP @ 100 g, T_5 = Bouncer 10WP @ 125 g, T_6 = Bouncer 10WP @ 150 g, T_7 = Becofit 500EC @ 0.80 L, T_8 = Becofit 500EC @ 1 L and T_9 = Becofit 500EC @ 1.2 L ha^{-1}

CONCLUSION

It can be concluded that use of herbicide could be an alternative cost effective weed control approach. Bouncer 10WP @ 150g ha^{-1} could be applied to increase weed control efficiency and profitable rice production in winter season.

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