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SOUND WEED MANAGEMENT OPTIONS FOR SUSTAINABLE CROP PRODUCTION

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ABSTRACT

An investigation was carried out to evaluate the performance of different weed management options regarding effective weed control, yield and yield contributing characters of three popular BRRI (Bangladesh Rice Research Institute) released aman varieties (BRRI dhan39, BRRI dhan49 and BR11) having different growth duration in the year of 2008 and 2009 at Bangladesh Rice Research Institute, regional station, Rajshahi. Weed management options were pre (Pretilachlor) and post emergence (Pyrozosulfuran-ethyl) herbicide, BRRI weeder, hand weeding (three times), pre and post emergence herbicide along with one supplement hand weeding and control (no weeding). Weed dry matter was significantly highest in control plot (78.67 g m^{-2}) followed by BRRI weeder (45.03 g m^{-2}) and lowest in hand weeding (20.17 g m^{-2}) and pyrozosulfuron-ethyl with one supplement hand weeding (22.2 g m^{-2}. Weed population showed significant effect on panicles m^{-2}. Highest panicle m^{-2} was obtained in hand weeding treated plot and lowest in pyrozosulfuron-ethyl with one supplement hand weeding treated plot. Among the varieties, BR11 produced significantly higher yield (5.02 t ha^{-1}) while lowest yield was recorded in BRRI dhan39 (3.58 t ha^{-1}). Irrespective of weed management options, hand weeding and post emergence herbicide with one supplement hand weeding produced significantly higher yield 4.89 and 4.80 t ha^{-1}, respectively while lowest yield was recorded in control plots (3.29 t ha^{-1}).

Keywords: Herbicide, rice, weed, management, yield.

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INTRODUCTION

Oryza sativa L. is the most important food crop of the world (Mikkelsen *et al*., 1995). More than half of the world's population depends on rice for food calories and proteins, especially in the developing countries. More than 90% of rice is grown and consumed in Asia (Blake, 1992). Rice is grown on 140 million hectare (ha) of arable land, which constitutes 10% of the arable land worldwide (IRRI, 1993). Rice cultivation in the Asian countries has been sustained for over it thousands of years and it is increasing by 1.8% per year where as an additional 50-60 percent of the current rice supply will be required for the Asian people during the period of 1990-2025 (Pingali *et al*., 1997). It is grown in a wide range of locations under various climatic conditions (Choi, 2001). In Bangladesh, rice production has to be increased by the year 2020 (Bhuiyan and Karim, 1999). But there is little evidence that the rice area will be increased further, meaning, this additional rice production must be come from existing or diminishing land resources (Swaminathan, 1993 and Sheehy *et al*., 1998). Thus, with shrinking land resources, rice production will be under even more pressure in the coming decades. The major strategy for overcoming the impending food crisis is to increase the production per unit area.

This production per unit area may be increased through improved cultural management practices especially crop establishment, efficient management of crop and weed control. Weed is a serious pest of rice reducing yield directly by competing with rice plants for sunlight, moisture and nutrients. The annual crop loss due to uncontrolled weed growth in Asia is 11.8% and the corresponding figure for the world is 9.5% (IRRI, 1991). Traditionally, in Bangladesh, weeds are controlled in rice field by hand. But it is laborious, time consuming and costly. De-Datta (1988) reported that three times more labour was needed for hand weeding in direct-seeded rice fields than that in transplanted rice fields. Therefore, controlling weeds by using herbicide is one of the most effective means by which farmers can reduce labour costs in rice areas. In Bangladesh, in the near future, herbicide either alone or in combination with practice of hand weeding will be effective method of weed control due to shifting of agricultural labours to industries and for other purposes. Therefore, this study was carried out to find out better weed management options for sustainable crop production.

MATERIALS AND METHODS

The experiment was conducted at the Bangladesh Rice Research Institute, regional station, Rajshahi during July – November,

2008 and 2009. The experimental field was in High Gangetic River floodplain under AEZ 11 having silty loam soil with pH 7.7, organic matter content 1.3%, total nitrogen 0.07%, Olsen phosphorus 15.1 mg g^{-1} soil, exchangeable potassium 0.26 me 100 g^{-1} soil, sulphur 25.1 mg g^{-1} soil and zinc 2.12 mg g^{-1} soil. The treatments were consisted of three variety (short duration variety, BRRI dhan39; medium duration, BRRI dhan49 and long duration BR11) along with seven weed management options such as pre emergence herbicide (Pretilachlor), post emergence herbicide (Pyrozosulfuran-ethyl), BRRI weeder operated at 20 DAT (Days after Transplanting) (mechanical), three hand weeding at 15,30 & 45 DAT just after urea top dressing, pre emergence herbicide with one hand weeding (at 30 DAT, just after 2^{nd} urea top dressed), post emergence herbicide with one hand weeding (at 30 DAT, just after 2^{nd} urea top dressed) and control (no weeding). The experiment was laid out in split plot design with three replications, where varieties were assigned in main plots and weed management options were in sub plots. Seeds were sown in 17 June, 2008 and 2009 and transplanted in 12 July, 2008 and 15 July, 2009 respectively in two seasons. The unit plot size was 5m×4m. Fertilizers as urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied (except urea) as basal at the rate of 150, 100, 75, 60 and 7.5 kg ha^{-1}, respectively before final land preparation. The pre emergence herbicide (Pretilachlor) was applied at 3 DAT. Post emergence herbicide (Pyrozosulfuran-ethyl) was applied at 6-7 DAT. Urea was top dressed at 15, 30 and 45 DAT in three equal splits. Weed density was recorded with the help of a quadrant (1m×1m) placed randomly at three spots in each plot. Weeds from each treatment were cut at ground level, washed in water, sun dried, subsequently dried at 70°C for 72 hours in oven and then weighed. Grain yield data were recorded from 10 m^2 area at the center of each plot and expressed in tons ha^{-1} at 14% moisture content. Yield component data were recorded from harvest of 1 m^2 area. Recorded data were analyzed by MSTAT-C and mean values were separated following the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Weed infestation

Weed infestation was measured by recording weed number and weed dry matter. Weeding options significantly influenced weed number (Table-1) and weed dry matter (Fig. 1) of all the three popular BRRI released varieties both in 2008 and 2009. Highest weed number and weed dry matter was found in control treatment followed by BRRI weeder and lowest were obtained in hand weeding treatment both at BRRI dhan49 and BR11.

Among the herbicides, both pre and post emergence herbicide performed better than BRRI weeder treated plot but post emergence herbicide with one supplement hand weeding reduced highest weed population which is statistically similar with three times hand weeding plot. From this experiment, it was also clarified that both pre and post emergence herbicide with one supplement hand weeding reduced highest weed population than pre and post emergence herbicide without any supplement hand weeding. These results were supported by Hasanuzzaman *et al*. (2007) who found that weed density and weed dry matter were most effectively reduced by using herbicides (pretilachlor) and one mechanical weeding with BRRI weeder. Irrespective of weed management options, it was noted that mojor weeds such as. *Cynodon dactylon, Alternanthera sessilis, Paspalum distichum, Cyperus difformis L., Cyperus rotundus L., Cyperus iria L., Echinochloa crus-galli L., Echinochloa colona L.,* and *Eleusine indi L.* were associated in the experimental field. Among them, *Cynodon dactylon* were the dominant one. Hussain *et al*. (2008) reported that hand weeding is time consuming and laborious compared to mechanical and chemical control. Mazid *et al.* (2008) reported that oxadiazon applied at pre-emergence controlled major weeds but one manual weeding session was needed to control *Alternanthera sessilis, Cyperus iria* and *Paspalum distichum* weeds in direct seeded rice. Several pre-emergence herbicides including oxadiazon, butachlor, thiobencarb, pendamethylin, oxyfluorfen and nitrofen along with one supplemental hand weeding resulted in good weed control as expressed by reduced weed density and improved yields (Moorthy and Manna, 1993; Pellerin and Webster, 2004).

In the Philippines, experimental results have consistly showed that single herbicide treatment is unsatisfactory to reduce weed pressure and it helps build up of tolerant weeds, so one supplement hand weeding is needed to check yield reduction (IRRI, 1979).

Yield and yield components

Highest grain yield was obtained both at hand weeding and post emergence herbicide treated plot in case of all the three rice varieties both in 2008 and 2009, followed by pre emergence herbicide along with one hand weeding, post emergence herbicide and BRRI weeder treated plot whereas the lowest yield was recorded in control plot (Fig. 2). This indicates that both three times hand weeding and post emergence herbicide with one supplement hand weeding gave highest yield. This is an agreement by 'Studies at the Central Rice Research Institute' of India showed that in the absence of weed control, the yield loss due to weeds was 46%, if rice was direct seeded, 20% if direct seeded in puddled soil and 11% when rice was transplanted in puddled fields (De-Datta *et al*., 1974) while Mamun

(1988) observed 16.19% yield loss due to improper weeding of transplanted aman rice. Besides this, weeding is often done beyond the critical competition period, which affects efficiency of input use and reduce yield and ultimately increase the cost of production (Prasad and De-Datta, 1979).

All the yield contributing characters such as panicle no m^{-2}, panicle length, grains $panicle^{-1}$ and sterility (%) showed positive significant response to different weed management options except 1000 grain weight (Table 2-6). Highest panicle no. was obtained in hand weeding and post emergence herbicide along with one supplement hand weeding treated plot while lowest in control plot. This is partial agreement by Rahman *et al*., (2005), who reported that two hand weeding and Ronstar with one hand weeding were more congenial for tiller production than Ronstar alone. No weeding produced the lowest tiller number at all growth stage.

Different weeding options had very low effect on panicle length. Here, highest panicle length was obtained in hand weeding treated plot (23.78) while lowest in control plot. Grains $panicle^{-1}$ showed significant response to weeding options. Highest grain $panicle^{-1}$ was recorded in hand weeding treated plot while lowest was obtained in control plot. Moreover, sterility (%) were also affected by weeding options where highest sterile grain $panicle^{-1}$ were recorded in control plot and lowest sterile grain were recorded in hand weeding and post emergence herbicide with one supplement hand weeding treated plot, respectively (Table-5). The similar trend was also observed in 2009. Variety showed little response to 1000 grain weight where highest grain weight was recorded in BR11 (22.87) and lowest in BRRI dhan39 (20.14). But different weed management options had no significant effect on 1000 grain weight.

CONCLUSION

Traditionally, our farmers control weeds by three times hand weeding. But hand weeding is laborious, time consuming and costly. Whereas, mechanical weeding through BRRI weeder is good but it also requires extra labour to remove the extra weeds remaining in the inter spaces of two rice hills. Both pre and post emergence herbicide with one supplement hand weeding performed better than herbicide without hand weeding. In most cases, farmers can't be able to apply pre emergence herbicide in right time due to time limit or other physical constraints. So, post emergence herbicide with one supplement hand weeding should be the best choice for farmers to control weed effectively with minimum cost and by this way whole farmers group will be economically benefited.

Table-1. Effect of different weeding options on weed number m^{-2} in different popular BRRI varieties in 2008 and 2009

Weeding options	Weed number m^{-2}					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	61.67 d-g	78.33 cd	83.33 cd	61.67 d-f	75.33 cd	79.33 cd
Post emergence herbicide	46 e-g	64.33 d-f	68.67 de	43.67 e-h	60.33 d-g	65.67 de
BRRI Weeder	45.67 e-g	89.33 cd	101.7 c	45.67 e-g	86.33 cd	96.33 c
Hand Weeding (3 times)	22.73 h	27 h	29.67 h	20.40 h	25 h	30.33 h
Pre emergence herbicide with one supplement hand weeding	32.33 h	34.33 gh	47 e-h	33 gh	33.33 h	47.33 e-h
Post emergence herbicide with one supplement hand weeding	26 h	31.67 h	36 fgh	25 h	30 h	36.33 f-h
Control (No weeding)	63 def	133.3 b	160.7 a	61.67 def	135 b	162 a
LSD (0.05)		25.74			24.70	
CV (%)		12.38			13.15	

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table-2. Effect of different weeding options on panicles m^{-2} in popular BRRI varieties in 2008 & 2009

Weeding options	Panicles m^{-2}					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	244.0 hijk	255.3 f-j	273.7 e-h	240.0 r	256.3 m	279.0 h
Post emergence herbicide	252.3 f-j	263.7 f-i	283.7 c-f	245.0 p	263.0 l	287.7 g
BRRI Weeder	247 g-k	260.3 f-i	271.7 e-i	250.0 o	254.3 n	273.7 i
Hand Weeding (3 times)	278.7 def	312.3 abc	329.0 a	274.0 i	314.3 d	347.0 a
Pre emergence herbicide with one supplement hand weeding	266.7 e-i	295.0 b-e	322.7 ab	266.7 k	303.3 f	329.7 c
Post emergence herbicide with one supplement hand weeding	276.7 efg	307.3 a-d	327.0 a	272.7 j	311.3 e	332.3 b
Control (No weeding)	228.0 jk	222.0 k	241.0 ijk	187.7 t	226.0 s	241.0q

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table-3. Effect of different weeding options on panicle length in popular BRRI varieties in 2008 and 2009

Weeding options	Panicle length (cm)					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	19.10 b-e	20.27 b-e	23.03 a-c	19.57 c-e	20.27 b-d	22.87 a
Post emergence herbicide	18.20 c-e	20.63 b-e	23.60 ab	18.27 fg	20.73 bc	23.60 a
BRRI Weeder	19.07 b-e	20.23 b-e	27.07 a	19.40 def	20.33 b-d	23.80 a
Hand Weeding 3 times	19.90 b-e	21.37 b-e	23.20 a-c	20.70 bc	21.43 b	23.23 a
Pre emergence herbicide with one supplement hand weeding	18.33 c-e	20.73 b-e	23.57 ab	18.43 efg	21.07 b	23.60 a
Post emergence herbicide with one supplement hand weeding	18.93 b-e	22.57 a-d	20.10 b-e	19.27 d-g	23.93 a	23.47 a
Control (No weeding)	17.13 e	17.47 de	20.73 b-e	16.87 h	18.13 g	20.24 bcd

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table-4. Effect of different weeding options on grains panicle^{-1} in popular BRRI varieties in 2008 and 2009

Weeding options	Grains panicle^{-1}					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	58.33 fg	63.67 d-f	65.33 d-f	55.67 k	62.33 h-j	60 i-k
Post emergence herbicide	63.67 def	74.67 b-d	72 c-e	62.67 hi	74.67 de	67 gh
BRRI Weeder	66.33 def	74.67 b-d	64 d-f	67.67 f-h	76 de	57 jk
Hand Weeding 3 times	77 a-d	82.33 a-c	88 a	74.67 de	83.33 bc	94.33 a
Pre emergence herbicide with one supplement hand weeding	66.33 d-f	74.67 b-d	82.33 a-c	65 g-i	76.67 de	79 cd
Post emergence herbicide with one supplement hand weeding	74 b-e	77 a-d	87 ab	73 ef	77.33 de	85 b
Control (No weeding)	48.33 g	61 ef	66.67 def	47 l	63 ghi	68.67 fg

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table-5. Effect of different weeding options on sterility (%) in popular BRRI varieties in 2008 and 2009

Weeding options	Sterility (%)					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	18.67 f-i	15.67 i-k	19.33 e-i	18 fgh	15 hij	20.33 d-g
Post emergence herbicide	23 b-e	16.67 hij	20.33 d-h	22.33 bcd	16 hi	22.33 b-d
BRRI Weeder	26 ab	20.67 d-g	21.33 c-f	24.33 abc	19 d-h	22 b-e
Hand Weeding 3 times	16.67 hij	11.67 l	10.67 l	17.33 gh	12.33 i-k	9.667 k
Pre emergence herbicide with one supplement hand weeding	18.33 f-i	12.67 kl	16.67 g-j	17.67 gh	12.33 i-k	18.33 e-h
Post emergence herbicide with one supplement hand weeding	15.67 ijk	11.00 l	13.33 jkl	18 fgh	11.33 jk	12.66 i-k
Control (No weeding)	27.67 a	23.67 b-d	25 abc	25.67 ab	21.67 c-f	26.67 a

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table-6. Effect of different weeding options on 1000 grain weight (gm) in popular BRRI varieties in 2008 and 2009

Weeding options	1000 grain weight (gm)					
	2008			2009		
	BRRI dhan39	BRRI dhan49	BR11	BRRI dhan39	BRRI dhan49	BR11
Pre emergence herbicide	20.30 d	21.53 c	22.63 ab	20.33 d	21.73 c	22.77 ab
Post emergence herbicide	20.37 d	21.87 bc	22.80 a	20.33 d	21.87 bc	22.80 a
BRRI Weeder	20.37 d	21.83 bc	22.97 a	20.27 d	21.87 bc	22.73 ab
Hand Weeding 3 times	20.30 d	21.70 c	23.37 a	20.27 d	21.73 c	22.87 a
Pre emergence herbicide with one supplement hand weeding	20.27 d	21.57 c	22.80 a	20.30 d	21.67 c	22.90 a
Post emergence herbicide with one supplement hand weeding	20.37 d	21.87 bc	22.93 a	20.33 d	22.13 abc	22.90 a
Control (No weeding)	20.30 d	21.89 bc	22.93 a	20.27 d	22.03 abc	22.67 ab

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

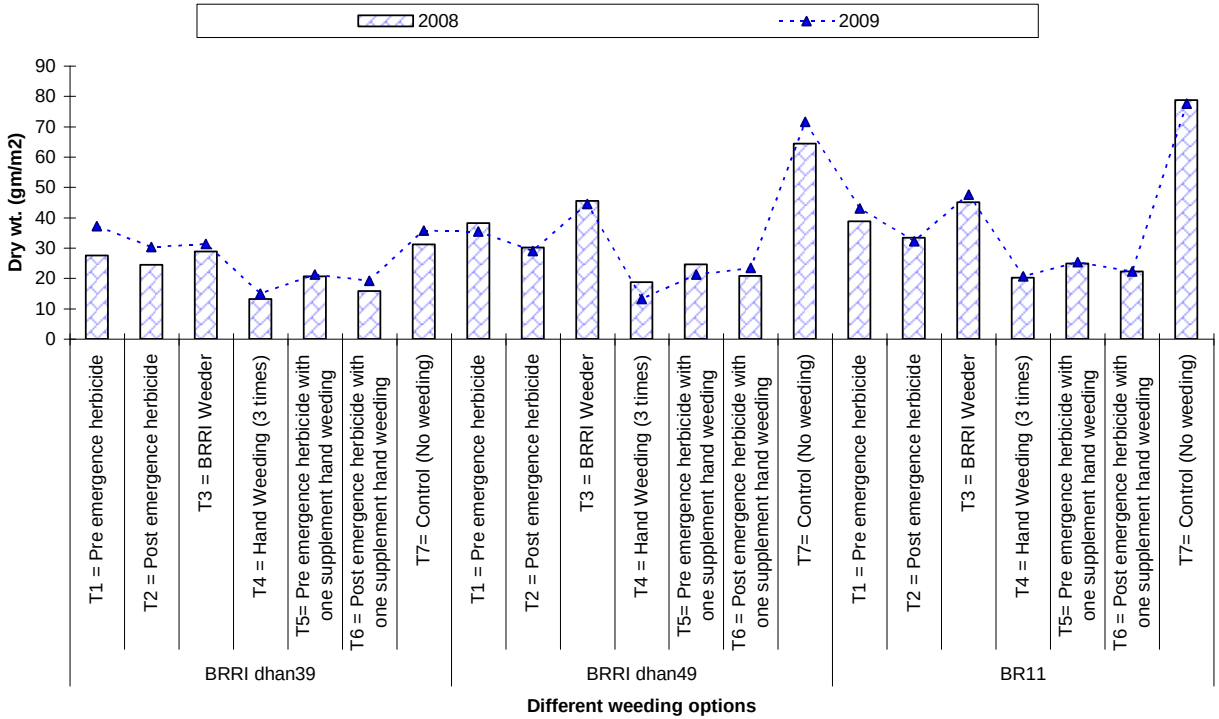

Fig.1: Effect of different weeding options on weed dry matter (gm/m2) in different popular BRRI realeased aman varieties in 2008 and 2009

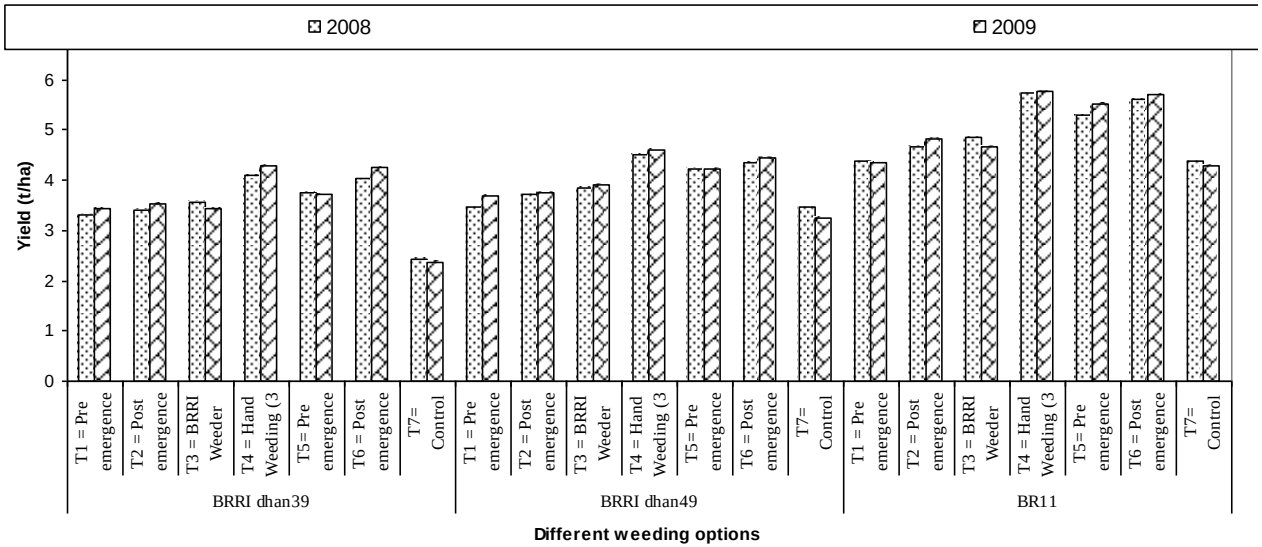

Fig.2: Yield of different BRRI varieties under different weeding conditions in 2008 and 2009 (Aman Season)

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