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Bio-efficacy of Acetochlor 50% EC against Weed Suppression in Transplanted Rice Ecosystem

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Abstract
Field experiments were conducted at Bangladesh Rice Research Institute (BRRI), Gazipur in Aus, 2010 and BRRI Rangpur, during Boro 2011 to evaluate the performance of Acetochlor 50% EC for weed suppression, to find out an appropriate dose of the herbicide and its impacts on transplanted rice. Acetochlor 50%EC @ 200, 250 and 300 ml ha^{-1} were applied. Pretilachlor 50% EC @ 1L ha^{-1}, weed free and unweeded control was used for comparison. The most dominant weeds were *Cyperus diffornis*, *Monochoria vaginalis* and *Echinochloa crus-galli* in year 1 and *Cyperus diffornis* and *Echinochloa crus-galli* in year 2. *Cyperus diffornis* was at the higher rank of dominant in both years. Application of Acetochlor 50%EC @ 250 ml gave more than 80% weed control efficiency, lower number and dry weight of weeds which ultimately resulted in higher yield attributes and grain yield of transplanted rice that were comparable to the standard in both seasons.

Key Words: Rice, Weeds, Acetochlor, 50%EC, Pretilachlor 50%EC

Introduction

Weeds grow in each of the crop throughout the world. It is said that "Crop production is a fight against weeds" (Mukhopadhay and Ghos, 1981). Subsistence farmers in the tropics spend more time, energy and money on weed control than any other aspects of crop production (Kasasian, 1971). In Bangladesh, Boro and Aus season cover about 43.57 and 8.70% of total rice area that contribute 61.33 and 5.21% of total rice production, respectively (BBS, 2008). Weeds are claimed to the greatest yield constraint in rice crop. It implies serious negative effect on crop production and responsible for marked loss in crop yield. Severe weed infestation reduces the grain yield by 70-80% in Aus rice and 22-36% for Boro rice cultivation (BRRI, 2006; Mamun, 1990). Hence, proper weed management practices are essential to obtain better yields in transplanted paddy. Quite a lot of pre and post emergence herbicides such as butachlor, pretilachlor, oxadiazone, pyrazosulfuron ethyl, ethoxysulfuron alone or supplemented with one hand weeding have been found to be useful for weed management in transplanted paddy. Continuous use of these herbicides has to be restricted to avoid undesirable inter and intra-specific weed shift (Singh *et al.*, 2005). Sometimes single use of these herbicides cannot control a broad spectrum of weeds. Use of single herbicide might be effective for only sedges or only grass or broad leaf weeds. Acetochlor whose chemical name is "N-(ehoxymethyl)-2-chloro-6-methylacetanilide" has been developed for selective pre-emergence control of annual and perennial weeds and sedges. It is a selective herbicide, absorbed mainly by the shoots of germinating plants. It acts by inhibition of protein synthesis. It can effectively control most important perennial and annual species of broad leaf weeds, grasses and sedges in transplanted. Furthermore such type of herbicide is almost new perception in Bangladesh for control of weeds. So to give farmers a wider choice of effective herbicide there is a need to develop environmental eco friendly molecules of newer chemistries with different mode of action. Weed control management should include careful herbicide selection, use of active agent mixtures, alteration of herbicides with different mode of action, and adoption to the cultivated crop, selectivity and persistency. So, if the herbicides are applied at higher rates, they endanger to the safety of environment and the toxicological justification of application, which lead to a limitation of their use. In view of this, the present study has been undertaken to evaluate the performance of Acetochlor 50% EC for broad spectrum control of weeds, to find out an appropriate dose of the herbicide and its impacts on transplanted rice.

Materials and Methods

Acetochlor 50%EC is a new molecule. The commercial name of Acetochlor 50%EC is Smart 50% EC. It is a new pre emergence herbicide that evaluated at Bangladesh Rice Research Institute farm, Gazipur in Aus, 2010 and BRRI Rangpur, during Boro 2011. Acetochlor 50%EC @ 200, 250 and 300 ml ha^{-1} were applied. Pretilachlor 50% EC @ 1L ha^{-1}, weed free and unweeded control was used for comparison. The treatments were i) T1=Acetochlor 50%EC @ 200 ml ha^{-1}, ii) T2=Acetochlor 50%EC @ 250 ml ha^{-1}, iii) T3=Acetochlor 50%EC @ 300 ml ha^{-1}, iv) T4=Pretilachlor 50% EC @ 1L ha^{-1}, v) T5= Weed free by hand weeding and vi) T6=Control (Unwedded). Pretilachlor 50% EC was used to compare the new herbicide. The experiment was laid out in a RCB design with 3 replications. Forty days

old seedlings of BRRI dhan28 for Boro and 30 days of BR26 for Aus were transplanted at 20 x 20 cm spacing with 2 seedlings hill^{-1} at BRRI farm Gazipur and Rangpur. Fertilizer was applied following BRRI recommended dose. Herbicides were sprayed at 5 days after transplanting. In weed free treatment, the plots were kept weed free up to 50 DAT by two hand weeding. Weed control efficiency (WCE%) was calculated using the formula according to Rao (1985). Acetochlor 50%EC herbicide is innovative in Bangladesh and its phytotoxicity needs to be evaluated on rice crop. The phytotoxicity of the herbicide to rice plants was determined by visual observations (Yellowing leaves, burring leaf tips, stunting growth etc). The degree of toxicity on rice plant was measured by the following scale used by IRRI (1965).

1. No toxicity
2. Slightly toxicity
3. Moderate toxicity
4. Severe toxicity
5. Toxic (plant kill)

The rating of toxicity was done within 7 days after application of herbicides. It was observed three times at 3, 5 and 7 days after application of herbicide and the mean rate was calculated from 10 sample plants of a unit plot. Yields and yield contributing characters of rice were recorded after harvest. The data were analyzed following analysis of variance (ANOVA) technique and mean differences were depicted by multiple comparison test (Gomez and Gomez, 1984) using the statistical program MSTAT-C (Russell, 1986**).** The contribution of an individual weed species to the weed community was determined by its two-factor summed dominance ratio (SDR) (Janiya and Moody, 1989). This was calculated using relative weed density (RD) and relative dry weight (RDW), as follows:

$$RD\ (\%) = \frac{\text{Density of individual weed species in the community}}{\text{Total density of all weed species in the community}} \times 100 \quad \ldots\ldots [1]$$

$$RDW\ (\%) = \frac{\text{Dry weight of a given oven dried weed species}}{\text{Dry weight of all oven dried weed species}} \times 100 \quad \ldots\ldots [2]$$

$$SDR = \frac{RD + RDW}{2} \quad \ldots\ldots [3]$$

Results and Discussion

Phytotoxicity of herbicides on rice plant

Very slight to slight yellowing of rice leaves observed with the application of Acetochlor 50% (Table 1). Acetochlor 50% @ 200 and 250 ml ha^{-1} showed very slight yellowing of leaves while temporary yellowing of leaves with 300 ml ha^{-1}. It is observed that phytotoxicity symptoms were not more prominent for using this herbicide.

Table 1: Toxicity level of different herbicidal treatments on rice plants

Treatments	Rating	Symptom observed on rice crop	Toxicity level
T_1	1.12	Sometimes very slight yellowing of leaves.	No toxicity
T_2	1.17	Sometimes slight yellowing of leaves.	No toxicity
T_3	1.25	Temporary slight yellowing of leaves that recovered with in 4-6 days.	Slightly toxicity
T_4	1.10	No yellowing of leaves.	No toxicity

T1=Acetochlor 50%EC @ 200 ml ha^{-1}, T2= Acetochlor 50% EC @ 250 ml ha^{-1}, T3=Acetochlor 50% EC @ 300 ml ha^{-1} and T4=Pretilachlor 50% EC 1L ha^{-1}.

Weed composition, relative density and dry weight

Location: Gazipur, Aus/2010

Seven weed species inhabited control plot during first year in Gazipur. The infesting weed species were belonging to 4 families. These weed flora were ecologically categorized into 2 broad leaved species, 2 sedges and 3 grasses (Table 2). The weed species were belonging to Poaceae, Cyperaceae, Pontederiaceae and Nymphaceae. The broad leaved were: *Monochoria vaginalis* and *Nymphaea nouchali*, grasses: *Echinochloa crus-galli*, *Cynodon dactylon* and *Leersia hexandra*, and sedges were: *Scripus maritimus* and *Cyperus difformis*. The major weed was *Cyperus difformis* which relative weed density (RWD) and relative weed biomass (RWB) were 37.63% and 18.02%, respectively. The second top weed was *Monochoria vaginalis* which RWD and RWB was 23.63% and 19.17%, respectively. Among the weeds *Nymphaea nouchali* was the minor weed with 4.30% RWD and 3.41% RWB.

Location: Rangpur, Boro/2011

The number of infesting weed species was more in second year in Rangpur (8 species) than first year in Gazipur (Table 2). The monocot weed species were *Scirpus maritimus, Cyperus diffornis, Echinochloa crus-galli, Fimbristylis miliacea, Leersia hexandra, Cynodon dactylon, Oxalis europea* and *Cyperus iria*. The major weed specie was *Cyperus diffornis* with 51.39% RWD and 34.96% RWB followed by *Echinochloa crus-galli* which RWD and RWB were 15.97 and 32.57%, respectively. The minor weed in year 2 was *Oxalis europea* with 1.39% RWD and 0.37% RWB.

Table 2: Weed composition, relative density (RWD) and biomass (RWB) in control plot

Name of Weed Species	Family	Class	RWD (%)	RWB (%)
	Year 1 (Aus, 2010), Location: Gazipur			
Echinochloa crus-galli	Poaceae	Grass	12.90	26.74
Scripus maritimus	Cyperaceae	Sedge	4.30	11.00
Monochoria vaginalis	Pontederiaceae	Broad leaf	23.66	19.17
Cyperus diffornis	Cyperaceae	Sedge	37.63	18.02
Cynodon dactylon	Poaceae	Grass	12.90	10.98
Nymphaea nouchali	Nymphaceae	Broad leaf	4.30	3.41
Leersia hexandra	Poaceae	Grass	4.30	10.70
	Year 2 (Boro, 2011), Location: Rangpur			
Echinochloa crus-galli	Poaceae	Grass	15.97	32.57
Fimbristylis miliacea	Cyperaceae	Sedge	6.94	6.69
Scripus maritimus	Cyperaceae	Sedge	2.08	0.67
Cynodon dactylon	Poaceae	Grass	9.03	10.83
Cyperus diffornis	Cyperaceae	Sedge	51.39	34.96
Oxalis europea	Oxalidaceae	Broad leaf	1.39	0.37
Leersia hexandra	Poaceae	Grass	6.94	10.78
Cyperus iria	Cyperaceae	Sedge	6.25	3.12

Sum dominance ratio (SDR) and weed ranking:

The summed dominance ratio (SDR) is more informative than any other single measure in reflecting the contribution of a species in a community. The three most dominant weeds in year 1 were *Cyperus diffornis, Monochoria vaginalis*, and *Echinochloa crus-galli*. Higher rank of dominant weed was *Cyperus diffornis* in year 1. In year 2, *Cyperus diffornis* and *Echinochloa crus-galli* were the most dominant weeds. *Cyperus diffornis* was at the higher rank of dominant followed by *Echinochloa crus-galli* L. in year 2 (Figs. 1 and 2). Sedges were dominant weeds (11.94 - 27.83% SDR in year 1 and 4.69 - 43.17 % SDR in year 2) followed by grasses (6.65 – 19.41 % SDR in year 1 and 8.86-24.27% SDR in year 2) and broadleaved weeds (7.50 – 21.41 % SDR in year 1 and 1.38% SDR in year 2).

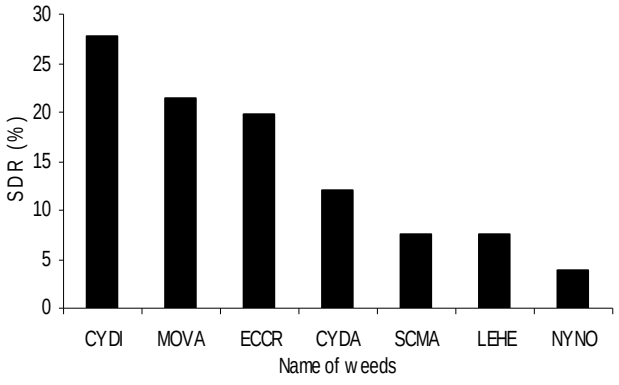

Fig 1: Weed dominance ranking in weedy plot (year 1)
CYDI=*Cyperus diffornis,* MOVA=*Monochoria vaginalis,* ECCR=*Echinochloa crus-galli,* CYDA=*Cynodon dactylon,* SCMA=*Scripus maritimus,* LEHE=*Leersia hexandra* and NYNO=*Nymphaea nouchali.*

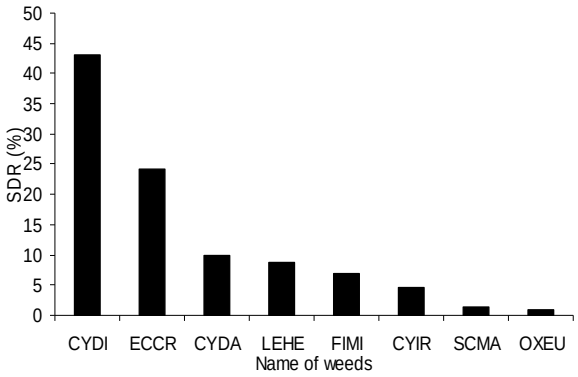

Fig 2: Weed dominance ranking in weedy plot (year 2) CYDI=*Cyperus diffornis, E*CCR=*Echinochloa crus-galli,* CYDA=*Cynodon dactylon,* LEHE=*Leersia hexandra,* FIMI=*Fimbristylis miliacea,* CYIR= *Cyperus iria,* SCMA=*Scripus maritimus* and OXEU= *Oxalis europea*

Weed control efficiency (WCE):
In first year (Location: Gazipur, Aus/2010), weed control efficiency increased with increases of herbicide dose irrespaetive of weed species. Treatment, T1 controls all the weeds less than 80% where as T2, T3 and T4 (check) control more than 80%. Treatment, T2 controls *Echinochloa crus-galli* by 82.55%, *Scripus maritimus* 84.41%, *Monochoria vaginalis* 83.29%, *Cyperus difformis* 87.31%, *Cynodon dactylon* 58.96%, *Nymphaea nouchali* 83.89% and *Leersia hexandra* 83.97% which is similar to T1 (check). The trend of weed control efficiency in second year was similar as first year (Location: Rangpur, Boro/2011). The weed control efficiency increased with increases of herbicide dose irrespaetive of weed species. All treatment controls most of the weeds more than 80%. Treatment, T2 controls *Echinochloa crus-galli* by 85.56%, *Fimbristylis miliace* 81.88%, *Scripus maritimus* 82.64%, *Cynodon dactylon* 48.58%, *Cyperus difformis* 88.27%, *Oxalis europea* 35.44, *Leersia hexandra* 88.837% and *Cyperus iria* 86.57% which is comparable to T1 (check). Kabir *et. al.*,(2002) also found that Acetochlor 90%EC@ 75, 100 and 150 ml ha^{-1} controlled *Fimbristylis miliace, Scripus maritimus, Cyperus difformis, Monochoria vaginalis* and *Leersia hexandra* effectively. It is evident from the study that the pre-emergence herbicide Acetochlor 50% EC @ 250 and 300 ml ha^{-1} were effective for controlling weed than lower dose of that herbicide. Acetochlor 50% EC @ 250 and 300 ml ha^{-1} reduced the weeds more than 80%. It may be suggested from this study that Acetochlor 50% EC @ 250 ml ha^{-1} may be used for effective weed control option instead of hand weeding at peak period of labor to minimize the cost of production.

Table 3: Effect of Acetochlor 50% on weed control efficiency in transplanted rice

Name of weeds	WCE (%)			
	T1	T2	T3	T4
Year 1 (Aus, 2010), Location: Gazipur				
Echinochloa crus-galli	73.40	82.55	85.89	88.62
Scripus maritimus	76.09	84.41	87.53	87.01
Monochoria vaginalis	68.50	83.29	88.66	85.08
Cyperus difformis	70.81	87.31	87.69	84.14
Cynodon dactylon	37.71	58.96	51.04	47.92
Nymphaea nouchali	73.15	83.89	83.22	81.88
Leersia hexandra	74.79	83.97	85.04	80.98
Year 2 (Boro, 2011), Location: Rangpur				
Echinochloa crus-galli	81.08	85.56	87.53	82.45
Fimbristylis miliacea	82.58	81.88	83.14	92.00
Scripus maritimus	82.64	82.64	86.11	90.00
Cynodon dactylon	45.83	48.58	70.65	42.00
Cyperus difformis	80.68	88.27	87.01	85.02
Oxalis europea	26.58	35.44	41.77	48.24
Leersia hexandra	89.19	88.33	92.00	84.21
Cyperus iria	65.97	86.57	90.00	84.01

T1=Acetochlor 50% EC @ 200 ml ha^{-1}, T2= Acetochlor 50% EC @ 250 ml ha^{-1}, T3=Acetochlor 50% EC @ 300 ml ha^{-1} and T4=Pretilachlor 50% EC 1L ha^{-1}.

Yield and yield contributing characters
Effect of Acetochlor 50%EC on yield and yield contributing characters are shown in Table-4. Panicles $panicle^{-1}$ and grain yield in both locations were significantly influenced by different treatments. Panicles m^{-2} and 1000-grain weight did not differ significantly due to different treatments. But numerically T4 and T3 produced maximum panicles m^{-2} in year 1 and 2, respectively, and T4 gave higher 1000-grain weight in both years. Both panicles m^{-2} and 1000-grain weight where minimum in control (T6). Significantly highest grains $panicle^{-1}$ was recorded from T2 which was similar with T3 followed by T1 in year 1. In year 2, significantly maximum grains $panicle^{-1}$ was obtained from T1. The second maximum grains $panicle^{-1}$ was found in T2 treatment which statistically identical with T3, T4 and T5. Significantly lowest grains $panicle^{-1}$ was recorded from T6 treatment. Different herbicidal treatments had significant influence on grain yield in both years. Significantly highest grain yield (4.72 t ha^{-1}) was obtained from T4 which was identical with T5 in year 1. All Acetochlor 50% treatments produced identical grain yield which was above 4 t ha^{-1}. In year 2, T1 produced highest grain yield (5.37 t ha^{-1}) which was identical with T2, T3, T4 and T5. Among different

herbicidal treatments highest grain yield (5.4 t ha^{-1}) and percent grain yield increased by 45.16% was obtained by the treatment Acetochlor 90% EC @ 100 ml ha^{-1} (Kabir *et. al.,* 2002). Significantly lowest grains yield was recorded from T6 treatment might be due to the result of the lowest performance of yield contributing characters. This happened due to severe infestation of various species of weeds in the field and greater competition for moisture, space, air, light, nutrients between weeds and rice plants which influence the reduction of all yield components and finally the yield components.

Table 4: Effect of Acetochlor 50% on yield and yield contributing characters of transplanted rice

Treatments	Panicle m^{-2} (no.)	Grains $panicle^{-1}$ (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})
Year 1 (Aus, 2010), Location: Gazipur				
T1	206.00	107.79 bc	18.94	4.14 b
T2	204.33	118.74 a	18.85	4.35 b
T3	218.00	113.91 ab	19.00	4.31 b
T4	263.33	105.42 c	20.25	4.72 a
T5	251.67	95.22 d	19.18	4.66 a
T6	168.00	76.66 e	19.26	3.70 c
CV (%)	19.04	4.20	3.85	5.23
Year 2 (Boro, 2011), Location: Rangpur				
T1	246.66	90.76 a	19.96	5.37 a
T2	246.00	71.91 b	20.39	5.01 a
T3	296.66	74.98 b	20.59	5.35 a
T4	290.66	63.50 b	20.85	4.91 a
T5	293.00	67.69 b	21.02	5.55 a
T6	269.66	64.27 b	20.02	3.74 b
CV (%)	8.19	10.35	2.85	7.29

T1=Acetochlor 50% EC @ 200 ml ha^{-1}, T2= Acetochlor 50% EC @ 250 ml ha^{-1}, T3=Acetochlor 50% EC @ 300 ml ha^{-1}, T4=Pretilachlor 50% EC 1L ha^{-1}, T5= Weed free by hand weeding and Y6=Unweeded (control).

Conclusion

From the study it is concluded that Acetochlor 50%EC @ 250 ml. ha^{-1} controlled weeds effectively and produced optimum grain yield in both seasons and locations. No plant injury was observed during the crop growing period due to the application of Acetochlor 50% EC.

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