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Economics of Herbicides as a Means of Weed Control in Transplant Aman Rice

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Abstract: The experiment was carried out to evaluate the efficacy of different herbicides and to compare the economics of hand weeding and herbicidal weed control in transplant aman rice cv. BRRI Dhan 32. There were fourteen treatments viz., three levels of Acetochlor 90 EC, three levels of Ronstar 25 EC, three levels of Set-off 20 WG, three levels of Golteer 5 G, hand weeding and weedy check (no weeding). Among the applied herbicides, Acetochlor 90 EC @ 150 ml a.i. ha^{-1} showed the best performance in killing weeds (98.96%) but it was statistically identical with Acetochlor 90 EC @ 100 ml a.i. ha^{-1} and Golteer 5 G @ 30 kg ha^{-1}. The benefit cost ratio (BCR) was the highest (1.46) in Acetochlor 90 EC @ 100 ml a.i.ha^{-1} with highest profit (Tk. 13294 ha^{-1}) was obtained from the same treatment which was Tk. 2812.00 higher than the profit (Tk. 10482.00) obtained from the tratment Golteer 5 G @ 25 kg/ha. It was found that Acetochlor 90 EC @ 100 ml a.i. ha^{-1} showed its superiority over all other treatments used for controlling weeds in transplant aman rice.

Key words: Herbicide, weed control, economics , transplant aman rice

Introduction

Weeds grow in each of the crop field throughout the world. So, it is often said that "Crop production is a fight against weeds" (Mukhopadhay and Ghosh, 1981). Where there is cultivable land, there is weed. Subsistence farmers of the tropics spend more time, energy and money on weed control than any other aspects of crop production (Kasasian, 1971). Poor weed control is one of the major factors for yield reduction of rice depending on the type of weed flora and their intensity (Amarjit *et al.*, 1994). According to Isley (1960) the losses due to infestation of weeds is greater than the combined losses caused by insect pests and diseases in rice. In Bangladesh, weeds are traditionally controlled by hand weeding. This method of weed control is very much laborious, time consuming, inefficient and costly. On the other hand, 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 Mamun, 1969). Moreover, in Bangladesh during aman season, uprooting of weeds at the critical periods is difficult due to unfavourable weather and peak labour demand. In such situation, herbicides are promising alternatives in controlling weeds (Pillai and Rao, 1974; DeDatta, 1980). Now-a-days, the chemical methods of weed control are gaining popularity all over the world because of its miraculous results in crop production but most of the herbicides are very new in Bangladesh. A little information is available on the effectiveness in controlling weeds in rice, especially, in transplant aman rice in Bangladesh. The present study was, therefore, undertaken to assess the weed control efficacy of different herbicides and to compare the economics of hand weeding and herbicidal weed control in transplant aman rice.

Materials and Methods

The study was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from July to December, 1999. The experimental field was medium high belonging to the Agro-ecological zones (AEZ-9) of Old Brahmaputra Floodplain (FAO, 1988; BARC, 1997). The experiment was laid out in a randomized complete block design. There were fourteen treatments namely Acetochlor 90EC@ 75 ml a.i. ha^{-1} (T_1), Acetochlor 90EC@ 100 ml a.i. ha^{-1} (T_2), Acetochlor 90EC@ 150ml a.i. ha^{-1} (T_3),Ronstar 25EC @ 1.5L ha^{-1} (T_4), Ronstar 25EC @ 2.0L ha^{-1} (T_5), Ronstar 25EC @ 2.5 ha^{-1} (T_6), Set-off 20 WG @ 75 g ha^{-1}(T_7), Set-off 20 WG @ 100 g ha^{-1}(T_8), Set-off 20 WG @ 125 g ha^{-1}(T_9), Golteeer 5 G @ 20 kg ha^{-1} (T_{10}), Golteer 5 G @ 25 kg ha^{-1} (T_{11}), Golteer 5 G @ 30 kg ha^{-1} (T_{12}),hand weeding (T_{13}) and weedy check (T_{14})(No weed control). Acetochlor, Ronstar and Set-off were applied mixing with 500 litres water at 5 days after transplanting (DAT) but Golteer was broadcast at 3 DAT. The field was well prepared and fertilized with urea, TSP (triple super phosphate), MP (muriate of potash), gypsum and zinc sulphate @ 150, 100, 70, 60 and 10 kg ha^{-1} respectively. Thirty five day old two seedlings per hill were transplanted maintaining a distance of 25 x 13 cm^2. Other intercultural operations were done as and when necessary. The crop was harvested plot-wise at maturity. Data collection on weed control efficiency, grain and straw yields, variable cost of production and returns for different treatments were recorded. All collected data were analyzed statistically following the ANOVA technique and the mean differences were adjudged with Dancans multiple range test (Gomez and Gomez, 1984) using the statistical computer package MSTAT.

Results and Discussion

The efficiency of different weed control methods with grades of weed control of these weeding treatments have been presented in Table 1. Out of 10 species of weeds *Fimbristylis miliacea* was completely controlled (CC) by T_3 and T_{13} treatments. The treatments T_1, T_2, T_5, T_6, T_8, T_9, T_{10}, T_{11} and T_{12} were excellent control (EC) to *Fimbristylis miliacea*. *Scirpus juncoides* was completely controlled (CC) only by the treatments T_{13} and the treatments T_2, T_3, T_5, T_6, T_8, T_9, T_{11}, and T_{12} were excellent control (EC) capacity to *Scirpus juncoides* and T_1, T_4, T_7 and T_{10} treatments were also good controlled of these weed. *Cyperus difformis* was excellent control (EC) by T_1, T_2, T_3, T_5, T_6, T_8, T_9, T_{11} and T_{12} treatments and T_4, T_7 and T_{10} were good control (GC) to Cyperus difformis, *Monochoria vaginalis, Ludwigia hyssopifolia, Sajittaria guayanensis, Amischophacelus axillaris, Leersia hexandra* and *Rottboellia protensa* were more or less excellent control (EC) to both recommended doses and higher doses of pre-emergence herbicides but *Paspalum scrobiculatum* was completely controlled by hand weeding and higher dose of Acetochlor 90 EC @ 150 ml a.i. ha^{-1}. It is evident from the study that pre-emergence of Acetochlor, Ronstar, Set-off and Golteer at higher and recommended doses were more effective for controlling weeds than lower doses of that herbicides. Higher and recommended doses of pre-emergence herbicides reduced the weeds more or less 100%. It may be suggested from this study that hand weeding may be used for effective weed control. Higher and recommended doses of Acetochlor 90 EC, Ronstar EC, Set-off 20 WG and Golteer 5 G may be used for effective weed control instead of hand weeding at peak period of labour to minimize the cost of production. Among the different weed control treatments, the highest grain yield (5.4 t ha^{-1}) and percent grain yield increased 45.16% (Table 2) was produced by the treatment Acetochlor 90 EC @ 100 ml a.i. ha^{-1} (T_2) which was statistically different from other treatments, except the grain yield resulted from the treatment of hand weeding (T_{13}). The weedy check (T_{14}) produced the lowest amounts of grains (3.72 t ha^{-1}) and it was significantly

Table 1: Weed control efficiency (%) of different weed control methods in transplant aman rice at 60 DAT

Treatments	*Fimbristylis miliacea*	*Scirpus juncoides*	*Cyperus difformis*	*Monochoria vaginalis*	*Ludwigia hyssopifolia*	*Sagittaria guayanensis*	*Amischophacelus axillaris*	*Leersia hexadra*	*Rottboellia protensa*	*Paspalum scrobiculatum*
T_1	90.38EC	88.94GC	97.59EC	87.86GC	83.39GC	63.27FC	85.85GC	86.36GC	91.43EC	89.77GC
T_2	98.92EC	98.62EC	97.44EC	98.01EC	100C	100CC	91.94EC	93.91EC	96.18EC	89.16CC
T_3	100CC	98.51EC	98.48EC	100CC	100CC	100CC	100CC	92.56EC	100EC	100CC
T_4	88.49GC	82.42GC	86.74GC	66.00FC	70.23GC	30.55PC	78.83GC	77.45GC	66.63FC	58.26FC
T_5	96.16EC	95.99EC	91.90EC	81.90GC	92.34EC	87.64GC	89.30GC	90.64EC	90.50EC	77.41GC
T_6	98.92EC	96.42EC	96.64EC	96.69EC	96.12EC	92.36EC	97.24EC	94.02EC	90.19EC	87.23GC
T_7	85.24GC	82.74GC	80.02GC	71.52GC	76.27GC	62.91FC	66.97FC	67.08FC	62.40FC	68.79FC
T_8	95.07EC	92.84EC	91.24EC	86.98GC	88.78GC	78.55GC	72.38GC	81.74GC	72.93GC	80.04GC
T_9	99.04EC	95.53EC	95.88EC	90.91EC	94.50EC	88.36GC	90.45EC	95.60EC	78.31GC	77.51GC
T_{10}	93.20EC	87.95GC	89.02GC	81.02GC	80.26GC	80.73GC	84.81GC	78.35GC	67.77FC	59.17FC
T_{11}	98.85EC	97.09EC	98.30GC	92.94EC	97.95EC	100CC	94.94EC	92.90EC	100CC	71.33GC
T_{12}	99.60EC	99.54EC	98.86EC	97.57EC	100CC	100CC	100CC	97.18EC	87.29GC	85.51GC
T_{13}	100CC	100CC	100CC	100CC	100CC	100CC	100CC	100CC	100CC	100CC
T_{14}	-	-	-	-	-	-	-	-	-	-

Completely control (CC): 100% Excellent control (EC): 90-99% Good control (GC): 70-89% Fair control (FC): 40-69%
Poor control (PC): 20-39% Slightly control (SC): 1-9% No control (NC): 0

Table 2: Percent increase of production of grain and straw yield over control in transplant aman rice cv. BRRI Dhan 32 due to different weed control methods

Treatments		Grain yield		Straw yield	
		t ha^{-1}	% increase	t ha^{-1}	% increase
Acetochlor 90 EC @ 75 ml a.i. ha^{-1}	T_1	4.72	26.88	5.26	36.26
Acetochlor 90 EC @ 100 ml a.i. ha^{-1}	T_2	5.40	45.16	6.08	57.51
Acetochlor 90 EC @ 150 ml a.i. ha^{-1}	T_3	4.61	23.92	5.02	30.05
Ronstar 25 EC @ 1.5 L ha^{-1}	T_4	4.42	18.82	4.93	27.72
Ronstar 25 EC @ 2.0 L ha^{-1}	T_5	4.91	31.99	5.53	43.26
Ronstar 25 EC @ 2.5 L ha^{-1}	T_6	4.31	15.86	4.71	22.02
Set-off WG @ 75 g ha^{-1}	T_7	4.12	10.75	4.58	25.65
Set-off WG @ 100 g ha^{-1}	T_8	4.65	25.00	5.26	36.27
Set-off WG @ 125 g ha^{-1}	T_9	4.02	8.06	4.41	14.25
Golteer 5 G @ 20 kg ha^{-1}	T_{10}	4.63	24.46	5.14	33.16
Golteer 5 G @ 25 kg ha^{-1}	T_{11}	5.02	34.95	5.82	50.78
Golteer 5 G @ 3 kg ha^{-1}	T_{12}	4.48	20.43	4.96	28.49
Hand weeding	T_{13}	5.21	40.05	5.91	53.11
Weedy check	T_{14}	3.72	-	3.86	-

Table 3: Cost of production, return and benefit cost ratio (BCR) of transplant aman rice cv. BRRI Dhan 32

Treatments	Cost of production (Tk.)			Yield (t ha^{-1})		Gross return (Tk.)				
	Variable fixed cost	Weeding cost	Total cost	Grain yield	Straw yield	Grain	Straw	Total (Tk.)	Net profit	BCR
T_1	27272.0	1140.00	28412.00	4.72	5.26	33040.00	3682.00	36722.00	8310.00	1.29
T_2	27272.0	1490.00	28762.00	5.40	6.08	37800.00	4256.00	42056.00	13294.00	1.46
T_3	27272.0	2190.00	29462.00	4.61	5.02	32270.00	3514.00	35784.00	6322.00	1.21
T_4	27272.0	1440.00	28712.00	4.42	4.93	30940.00	3451.00	34391.00	5679.00	1.2
T_5	27272.0	1890.00	29162.00	4.91	5.53	34370.00	3871.00	38241.00	9079.00	1.31
T_6	27272.0	2340.00	29612.00	4.31	4.71	30170.00	3297.00	33467.00	3855.00	1.13
T_7	27272.0	1065.00	28337.00	4.12	4.58	28840.00	3206.00	32046.00	3709.00	1.13
T_8	27272.0	1390.00	28662.00	4.65	5.26	32550.00	3682.00	36232.00	7570.00	1.26
T_9	27272.0	1715.00	28987.00	4.02	4.41	28140.00	3087.00	31227.00	2240.00	1.08
T_{10}	27272.0	1180.00	28452.00	4.63	5.14	32410.00	3598.00	36008.00	7556.00	1.27
T_{11}	27272.0	1460.00	28732.00	5.02	5.82	35140.00	4074.00	39214.00	10482.00	1.36
T_{12}	27272.0	1740.00	29012.00	4.48	4.96	31360.00	3472.00	34832.00	5820.00	1.2
T_{13}	27272.0	4200.00	31472.00	5.21	5.91	36470.00	4137.00	40607.00	9135.00	1.29
T_{14}	27272.0	00.00	27272.00	3.72	3.86	26040.00	2702.00	28742.00	1470.00	1.05

Value of unhusked rice Tk. 7.00/kg Value of straw Tk. 0.70/kg Value of Acetochlor Tk. Value of Ronstar Tk.
Value of Set-off Tk. Value of Golteer Tk. Cost of a labour Tk. 60/day

different from any other treatments. The lowest yield ha^{-1} in the weedy check (T_{14}) might be due to the result of effects 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 influenced the reduction of all yield components and finally the grain yield.

The highest straw yield (6.08 t ha^{-1}) and percent straw yield increase 57.51% was produced in the treatment (T_2) Acetochlor 90 EC @ 100 ml a.i. ha^{-1} (Table 2) which was statistically similar to the treatments of hand weeding (T_{13}), Golteer 5G @25 kg ha^{-1} (T_{11}) and Ronstar 25 EC @ 2.0 l ha^{-1} (T_5). However, the straw yield in the treatment weedy check (T_{14}) was significantly the lowest (3.86 t ha^{-1}).

Economic performance of different methods of weed control treatments; Among the 14 treatments, T_{14} was weedy check. Another thirteen was weed controlling treatments. In case of weedy check, there was no involvement of cost for weed control. In the treatment T_{13} (two hand weeding) was required 70 labours for weeding and involvement of weeding cost Tk. 4200.00. In case of herbicidal weed control treatments involvement of - weeding cost for one hectare of T. aman rice was Tk. 1140.00, 1490.00, 2190.00, 1440.00, 1890.00, 2340.00, 1065.00, 1390.00, 1715.00, 1180.00, 1460.00 and 1740.00 for the treatment T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9 T_{10} T_{11} and T_{12} respectively. Excluding weeding cost, cost of production of BRRI Dhan32 was calculated Tk. 27272.00. The cost of production BRRI Dhan32 (including weeding cost was the highest (Tk. 31472.00 ha^{-1}) for the treatment T_{13} (hand weeding) and the lowest (Tk. 27272.00 ha^{-1}) for the treatment T_{14} (weedy check) (Table 3). The highest gross return (Tk. 42056.00 ha^{-1}) was obtained from the treatment T_2 (Acetochlor90 EC @ 100 ml a.i. ha^{-1}) and the lowest gross return (Tk. 28742.00 ha^{-1}) was obtained from the weedy check (T_{14}) treatment. It could be seen from the economic analysis (Table 3) that the application of Acetochlor 90 EC @ second highest profit was obtained Golteer 5G @ 25 kg ha^{-1} (T_{11}) and the second highest benefit cost ratio was found in 100 ml a. l. ha^{-1}

(T_2) maximized the profit and benefit cost ratio was the highest (1.46) in the same treatment. the same treatment. The recommended doses of these herbicide showed the highest benefit cost ratio in their group but the highest doses of these herbicides showed the lowest benefit cost ratio in their group. These might be due to some unidentified toxicity of the highest doses of Acetochlor 90 EC, Ronstar 25 EC, Set-off 20 WG and Golteer 5G. In case of recommended doses of herbicidal treatments (Acetechlor 90 EC and Golteer 5 G) were profitable than hand weeding. This might be because of less production due to higher weed competition and higher number of labours required for weeding out the field and higher labour cost. Similar results were also reported by BRRI (1988). The highest profit (Tk. 13294.00 ha^{-1}) was obtained from Acetochlor 90 EC @ 100 ml a. I. ha^{-1} (T_2) which was Tk. 2812.00 higher than the profit (Tk. 10,482.00) obtained from the treatment from Golteer 5 G @ 25 kg ha^{-1} (T_{11}). In fine, it may be concluded from economic point of view that when labour is a limiting factor, herbicide may serve as an alternative means of weed control and Acetechlor 90 EC @ 100 ml a. I. ha^{-1} is a better substitute to hand weeding in transplanted aman rice (BRRI Dhan 32).

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