Integrated Weed Management in Transplanted Rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted during the *kharif* season of 2010 and 2011 at the Regional Research Station, Kalimpong (1250 m a.s.l), to find out effective and suitable method of weed control in transplanted rice under mid hill conditions. The major weed found in control plot were *Echinochloa crus-galli, Echinochloa colonum, Cynodon dactylon Cyperus rotundus, Cyperus iria, Cyperus difformis, Fimbristylis miliaceae, Ammania baccifera, Ludwigia parviflora.* Pre-emergence application of metsulfuron methyl + chlorimuron ethyl supplemented with one hand weeding at 40 DAT, provided a broad – spectrum weed control and was significantly superior to rest all other integrated approach of weed control. The highest weed-control efficiency (91.4%) was also recorded under this treatment. The grain yield was highest with hand weeding thrice (6.61 t/ha) which was comparable with treatment of metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) supplemented with one hand weeding (6.47 t/ha). The highest benefit : cost ratio was with metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) supplemented with one hand weeding at 40 DAT (2.18) and was followed by pretilachlor (0.5 kg/ha) followed by one hand weeding (2.14). Metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) followed by one hand weeding at 40 DAT controlled weed population and gave yield at ributing traits and yield comparable to those of hand weeding thrice and proved more remunerative than other weed management practices.

Keywords: *Kharif, metsulfuron methyl, chlorimuron ethyl, fimbristylis miliaceae, Ammania baccifera*

Rice is an important crop of India contributing 45% to the total food grain production. Weed management is one of the major factors, which affect rice yield. Uncontrolled weeds cause grain yield reduction upto 76% under transplanted conditions (Mukherjee and Singh, 2005). Therefore, timely weed control is imperative for realizing desired level of productivity. Major weed flora in transplanted rice consisted of *Echinochloa colona*, *Echinochloa crusgalli*, *Digitaria sanguinalis*, *Panicum repens*, *Cynodon daectylon*, *Cyperus* rotundus, *Cyperus difformis*, *Fimbristylis milliacea*, *Ammania baccifera, Lippa nodiflora, Marsilea quadrifoliata* and *Commelina benghalensis* (Halder and Patra, 2007). Weed competition is more in early stage particularly grasses and in later stage field is mostly affected by broad leaf weeds. Rice plant needs 2-3 hand weeding for

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optimum grain yield. However, manual weeding is tedious, labour intensive and costly. On the other hand continuous use of high dose herbicide for long period leads to weed shift from grasses to non-grasses and annual sedges is being observed in transplanted rice (Mishra *et al*., 2007). The herbicides provide effective control of annual grasses and sedges when applied and its effect last upto 3-5 days after application. So the only option left to the farmer is to go for chemical weed control along with manual weeding during critical period of crop weed competition. In view of above facts, it would be desirable to develop an alternative weed management technique that will be economical to the farmers. Hence the present investigation was undertaken to test the efficacy of herbicides either alone or in combination with manual weeding against weed population and yield of transplanted rice.

Materials and Methods

The field study was conducted during *kharif* season of 2010 and 2011 at Regional Research Station (Hill Zone), Kalimpong (20^0 31' and 27^0 31' North latitude and between 87^0 59' and 88^0 53' East longitude) under the aegis of Uttar Banga Krishi Viswavidyalaya at about 1250 m above mean sea levels to study the integrated method of weed control in transplanted rice. The soil was sandy loam in texture, high in organic carbon (0.91%), available N (206 kg/ha), P_2O_5 (22.6 kg/ha) and K_2O (229.7 kg/ha) content with pH 5.3. The rainfall distribution was very erratic and total rainfall received during 2006 and 2007 (July-September) was 1331 and 1408 mm, respectively. Twenty five days old seedling of rice cv. Sarju 52 was transplanted at spacing of 20x15 cm on 26 July 2006 and 28 July 2007, respectively. Uniform fertilizer dose of 120 kg N + 26.2 kg P + 33.3 kg K + 25 kg $ZnSO_4$ /ha was applied to the field. The half dose of N and entire dose of phosphorus, potash and zinc sulphate applied at basal and remaining N was top dressed in two equal splits, first at tillering (55 days after transplanting (DAT)) and second at panicle initiation stage (75 DAT). The experiment comprising 12 weed control treatment, viz. butachlor (1 kg /ha), pretilachlor (1 kg/ha), 2, 4-DEE (1 kg/ha), anilofos (0.60 kg/ha), metsulfuron methyl (10 % WP) + chlorimuron ethyl (10 % WP)) (0.01 kg a.i./ ha), and half dose of each above herbicide along with one hand weeding 40 DAT, hand weeding (20, 40 and 60 DAT) and weedy check (Table 1). The experiment was laid out in randomised block design with three replications. All the herbicides were applied as pre-emergence 3 DAT except anilofos and 2,4-DEE were apply 10 DAT as spray using knapsack sprayer, fitted with flat fan nozzle at spray volume of 500 l/ ha. The data on total weed population, weed biomass and nutrient depletion of weeds were taken at 60 DAT with the help of random quadrat (0.25 m 0.25 m) at two places and then converted into per square meter. Weed control efficiency was calculated on the basis of dry matter production of weeds at 60 DAT (Satao and Nalandwar, 1992). Weed index recorded after harvesting of crop (Yadav *et al.,* 1997). Crop and weed samples were analyzed for uptake of nitrogen, phosphorus and potash as per standard laboratory procedures. Nutrient uptake by weeds and crop were calculated by multiplying the dry matter yield with the nutrient content. The total rainfall received during the crop seasons was 1139 and 903 mm in 2003 and 2004, respectively. The economic analysis of each treatment was done on the basis of prevailing market prices of the input used and outputs obtained under each treatment. Herbicide price for calculating economics were butachlor Rs.380 /lit, pretilachlor 340 /lit, anilofos Rs 340/lit, 2-4 DEE Rs. 280/lit and almix Rs. 150 /8 g.

Results and Discussion

Weeds

Predominant weed species that infested the field consisted of grasses [*Echinochloa crus-galli* (L.) Beauv, *Echinochloa colonum* (L.) Link, *Cynodon dactylon* (L.) Pers.], sedges [*Cyperus rotundus* (L.), *Cyperus iria* (L.), *Cyperus difformis* (L.), *Fimbristylis miliaceae* (L.) Vahl] and broad leaf weeds [*Ammania baccifera* (L.) Rottb, *Ludwigia parviflora* (L.), *Phyllanthus niruri* L.].

All the herbicidal treatments either alone or along with one hand weeding proved significantly superior to weedy check in reducing weed density and dry weight of weeds at 60 DAT (Table 1). Amongst control measures, application of Metsulfuron methyl + chlorimuron ethyl (0.005 kg/ ha) supplemented with one hand weeding at 40 DAT recorded significantly lower weed density and dry weight of weeds, which was followed by pretilachlor (0.50 kg/ ha) supplemented with one hand weeding at 40 DAT, and

Table 1. Effect of treatments on weed density, weed dry weight, weed control efficiency and nutrition depletion by weed at 60 DAT (Pooled data of two years).

Treatment	Time of application	Dose (kg/ ha)	Weed density (no./m^2)	Weed dry weight (g /m^2)	WCE (%)	Nutrient depletion by weed (kg /ha)		
	(DAT)		(60 DAT)	(60 DAT)		N	P	K
Butachlor	3	1.00	161.3	54.6	73.9	13.2	3.8	16.1
Pretilachlor	3	1.00	148.6	47.8	77.3	10.9	2.3	15.1
Anilofos	10	0.60	167.2	69.1	67.0	14.1	2.6	18.3
2,4-DEE	10	1.00	170.3	79.6	61.9	17.9	4.1	27.6
Metsulfuron methyl +Chlorimuron ethyl	3	0.01	162.3	70.6	66.2	18.7	3.7	24.3
Butachlor + One hand weeding*	3	0.500	150.4	32.7	84.5	6.8	1.5	9.3
Pretilachlor + One hand weeding*	3	0.500	130.7	29.8	85.6	4.9	1.1	7.1
Anilofos + One hand weeding*	10	0.300	152.8	40.3	80.7	7.9	1.9	11.6
2,4-DEE + One hand weeding*	10	0.500	158.6	43.2	79.5	8.9	1.9	12.1
Metsulfuron methyl +Chlorimuron ethyl + One hand weeding*	3	0.005	46.4	18.2	91.0	3.1	0.6	4.0
Hand weeding thrice	20,40 and 60	-	3.6	1.6	99.3	3.0	0.5	3.6
Weedy check		-	312.6	208.6	-	23.6	4.5	26.6
SEm±			9.8	6.5		0.6	0.1	0.5
CD (P=0.05)			23.0	16.8	-	1.1	0.3	1.3

* Hand weeding at 40 days after transplanting (DAT)

Table 2. Effect of treatments on yield attributes, yield, nutrient uptake and weed index of transplanted rice (Pooled data of two years).

Treatment	Dose (kg/ ha)	Yield attributes				Grain yield (t/ha)	Straw yield (t/ha)	Nutrient uptake by crop (kg/ ha)			Weed index (%)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Benefit: cost ratio
		Effective tillers (m^2)	Panicle weight (g)	Grain/ panicle (no.)	1000 grain weight (g)			N	P	K				
Butachlor	1.00	271	2.5	72	22.1	5.57	6.53	74.5	15.6	106.7	15.7	19627	15891	1.80
Pretilachlor	1.00	276	2.4	78	22.6	5.61	6.98	79.8	14.5	109.3	15.1	20276	19663	1.96
Anilofos	0.60	264	2.0	67	22.1	5.35	6.47	69.4	13.1	99.3	19.0	19326	15103	1.78
2,4-DEE	1.00	259	2.0	55	20.9	5.06	6.34	62.6	11.5	88.9	23.6	19463	11364	1.58
Metsulfuron methyl +Chlorimuron ethyl	0.01	263	2.1	63	21.9	5.13	6.21	64.2	12.3	94.3	22.7	19951	12931	1.64
Butachlor + One hand weeding*	0.500	281	2.4	80	22.6	6.23	7.35	93.1	15.0	109.3	5.7	20851	20487	1.98
Pretilachlor + One hand weeding*	0.500	301	2.5	86	22.7	6.31	7.56	99.7	16.3	113.5	4.6	20119	22956	2.14
Anilofos + One hand weeding*	0.300	279	2.4	80	22.3	6.08	7.10	91.3	15.2	119.3	8.1	19509	21809	2.11
2,4-DEE + One hand weeding*	0.500	277	2.1	78	22.1	5.96	7.05	85.7	14.8	115.6	9.9	19484	20089	2.03
Metsulfuron methyl +Chlorimuron ethyl + One hand weeding*	0.005	302	2.6	90	23.1	6.47	7.68	107.2	20.2	121.5	2.2	20545	24434	2.18
Hand weeding thrice (20,40 and 60 DAT)		308	2.8	93	23.1	6.61	7.94	113.5	21.7	125.6	-	27065	25895	1.94
Weedy check		208	1.8	51	20.3	4.01	5.09	49.9	9.5	65.7	39.3	16025	6098	1.38
SEm±		9.7	0.1	3.9	0.2	0.13	0.16	0.88	0.74	2.89				
CD (P=0.05)		22	0.3	8.1	0.4	0.24	0.29	1.83	1.61	6.34				

* Hand weeding at 40 days after transplanting (DAT)

was at par with hand weeding thrice for weed dry weight at maximum growth stage (60 DAT). However, when the herbicides were applied alone

pretilachlor (1 kg/ha) recorded the least weed population and weed dry weight and was at par with butachlor (1 kg/ha), and significantly superior to rest of alone chemical treatments. Amongst all the treatments, metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT recorded the highest weed control efficiency (91.4%) followed by pretilachlor (0.50 kg/ha) supplemented with one hand weeding at 40 DAT (85.6%).

Weedy check resulted in the highest uptake of nutrients by weeds. The lowest uptake of nutrients through weeds was recorded with metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT, which was at par with hand weeding thrice. The lowest amount of weed dry weight owing to better control of weeds under above treatment resulted in the lowest nutrient uptake. Pretilachlor (1 kg/ha) as pre-emergence herbicide was found better in controlling total weeds and removed the lower amount of nutrient than butachlor (1 kg/ha) and metsulfuron methyl + chlorimuron ethyl (0.01 kg/ha).

Yield attributes and yield

The effect of different weed management practices on the number of effective tillers, panicle weight, number of grain/panicle and 1000 grain weight was significant. Maximum yield attributes were recorded in hand weeding thrice plots because less weeds were observed in this plot, which may have resulted in increased nutrient, water, space and light supply toe the rice crop due to absence of crop-weed competition. This in turn might have resulted in greater photosynthesis and hence better translocation of photosynthesis besides larger sink and stronger reproductive phase, as reflected in maximum effective tiller/m^2, panicle weight, grain/panicle and test weight (Table 2). Amongst the integrated control measures metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) along with hand weeding at 40 DAT resulted in higher yield attributes and was at par with hand weeding thrice, which recorded highest yield attributing traits.

The grain and straw yield were significantly influenced by different control measures. metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT, resulted in significantly higher grain (6.47 t/ha) and straw yield (7.71 t/ha) over the rest of the treatments except pretilachlor (0.5 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT, and was at par with hand weeding thrice which had highest grain (6.61 t/ha) and straw (7.90 t/ ha) yield (Table 2). This could be attributed to efficient control of weeds which reduce the nutrients uptake by weeds and resulted in better growth and yield attributes to rice crop. The highest reduction in grain yield due to weeds (39.3%) was registered in weedy check treatment. Application of metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT, resulted in the lowest reduction in grain yield (2.2%) due to less weed population and dry weight of weeds, which was followed by pretilachlor (0.5 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT (4.5%).

Nutrient uptake

The NPK uptake by crop increased significantly by applying various weed management practices (Table 2). The lowest nutrient depletion by crop was recorded under weedy check treatment because of poor biomass production. However, hand weeding thrice resulted in highest depletion of major nutrient by crop. Amongst treatments significantly maximum nutrient depletion was observed with metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT, and was at par with pretilachlor (0.5 kg/ha) as pre-emergence supplemented with one hand weeding at 40 DAT. The higher uptake of nutrients by crop with above treatments could be attributed to more availability of nutrients in soil owing to less depletion of nutrients by weeds (Singh and Singh, 2007). Further, these treatments recorded minimum weed index of 2.2 and 4.6 %, respectively. The lower weed index obtained in these treatments indicates lesser percent yield reduction due to minimum weed competition.

Economics

In modern agriculture practicability of any weed control measures can be judged on the basis of its benefit cost ratio (BCR). Table 2 revealed that amongst various control measures the higher net profit of Rs 24,434 kg/ha and BCR of 2.18 was obtained with metsulfuron methyl +

chlorimuron ethyl followed by one hand weeding at 40 DAT. This was closely followed by pretilachlor followed by hand weeding. Though hand weeding trice had given more net return (Rs. 25895) in comparison to other treatment and it gave lower BCR of 1.94. The lower BCR value in this treatment was mainly due to higher cost involved in manual weeding. These finding resembles that of Behra and Jena (1998).

It was concluded that pre-emergence application of metsulfuron methyl + chlorimuron ethyl (0.005 kg/ha) followed by one hand weeding at 40 DAT controlled effectively total weed population, weed biomass and gave higher yield attributing traits and yield comparable to those of hand weeding thrice and proved more remunerative than other measurement practices.

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