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Bioefficacy Evaluation and Residue Analysis of Pretilachlor for Weed Control in Transplanted Rice-Rice Cropping System

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Field experiments were conducted during *rabi* season and summer season at experimental farm of the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore). The treatments included were five doses of new formulation of pretilachlor (0.5,0.75,1.0,1.5, 3.0 kg ha^{-1}), butachlor 1.25 kg ha^{-1}, anilofos 0.4 kg ha^{-1} and rifit 0.75 kg ha^{-1} (M/s. Gharda chemical formulation) compared with hand weeding twice and unweeded control. The experiments were laid out in a randomised block design with three replications. The predominant weeds of the experimental fields were *Echinochloa crus-galli, Leptchloa chinensis* among monocots and *Marsilea quadrifoliata* among dicots. The results of the experiments revealed that, pre emergence application of pretilachlor 1.0 kg ha^{-1} and pretilachlor 0.75 kg ha^{-1} with a hand weeding at 45 DAT offered better weed control and resulted in increased yield and economics of transplanted rice, compared to the recommended weed control methods of butachlor 1.25 kg ha^{-1}, anilofos 0.4 kg ha^{-1} and rifit 0.75 kg ha^{-1} and hand weeding twice.

Key words: Pretilachlor, weed control, yield, rice

Weed infestation is one of the major constraints and contribute heavily for the loss of rice yields. Rice is the staple food and there is almost no scope for increasing rice production through an increase in rice area and hence, increasing the productivity of rice is of great concern through proper crop management (Sunada dev *et al*., 2009). Risk in labour cost and availability warrant for alternate effective and economic weed control practices. Weed control spectrum of widely used herbicides like butachlor, rifit and anilofos is quite narrow. Continuous use of herbicides with similar mode of action may lead to the shifting of weed flora and also herbicide resistance. Over dose of the herbicide will also result in residual toxicity (Singh *et al*., 2001). In the view of the above facts, it would be desirable to develop alternative herbicide. Pretilachlor (2-chloro-2'6' diethyl-N (2 propoxyethyl acetanilide) is one of the important pre-emergence herbicide, the efficacy of which have to be worked out for effective and economical weed control in transplanted rice. Hence, these experiments were planned to evaluate the efficacy of pretilachlor in transplanted rice.

Materials and Methods

The experiments were conducted during *rabi* and summer seasons at the experimental farm of the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The soil of the experimental field was clay loam in texture, alkaline in reaction (pH 8.5), medium in organic carbon (0.7%), available nitrogen (258 kg/ha) and available phosphorus (34.5 kg/ ha) and high in available potassium (465 kg/ ha). The treatments included were five doses of new formulation of pretilachlor (0.5,0.75,1.0,1.5, 3.0 kg ha^{-1}), butachlor 1.25 kg ha^{-1}, anilofos 0.4 kg ha^{-1} and rifit 0.75 kg ha^{-1} (M/s. Gharda chemical formulation) compared with hand weeding twice and unweeded control. The experiments were laid out in a randomised block design with three replications.

The herbicides were applied as spray using 750 litre of water per hectare and knapsack sprayer fitted with WFN 40 nozzle, keeping a thin film of water in the field. The hand weeding treatment (T9) received two hand weedings at 20 and 45 days after transplanting (DAT). The experiment was conducted with rice variety CO 43 and CO 47 were used in *rabi* and summer respectively, following all recommended package of practices.

Results and Discussion

Weed flora

The weed density was grouped into monocot and dicot wee ds.The predominant weeds of the experimental fields were *Echinochloa crus-galli* (18%), *Leptchloa chinensis* (49.5%) among monocots and *Marsilea quadrifoliata* (32.1%) among dicot weeds

Weed density

All the weed control treatments significantly reduced the weed density in *rabi* season. (Table 1) Higher dose of Pretilachlor (3.0 kg ha^{-1}) reduced the individual weed density significantly. As per the F test,

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Table 1. Effect of treatments on weed density (No m^{-2}) at panicle initiation stage

Treatments	First season (*rabi*)			Second season (summer)		
	Leptochloa chinensis	*Echinochloa crus-galli*	Marsilea quadrifoliata	Leptochloa chinensis	*Echinochloa crus-galli*	Marsilea quadrifoliata
Pretilachlor 0.5 kg ha^{-1}	1.14	1.01	1.03	1.44	0.881	1.06
	(13.3)	(9.3)	(10.6)	(26.6)	(6.6)	(10.6)
Pretilachlor 0.75kg ha^{-1}	1.03	0.673	0.856	1.25	0.982	1.01
	(10.0)	(4.0)	(6.6)	(17.3)	(8.6)	(9.3)
Pretilachlor 1.0 kg ha^{-1}	1.03	0.532	0.796	1.22	0.698	0.881
	(10.0)	(1.3)	(5.3)	(16.0)	(4.0)	(6.6)
Pretilachlor 1.5 kg ha^{-1}	0.946	0.159	0.669	1.15	0.698	0.881
	(8.0)	(0.6)	(4.0)	(13.3)	(4.0)	(6.6)
Pretilachlor 3.0 kg ha^{-1}	0.897	0.156	0.548	1.06	0.550	0.698
	(7.3)	(0.6)	(2.6)	(10.6)	(2.6)	(4.0)
Rifit 0.75 kg ha^{-1}	1.08	0.823	0.796	1.11	1.04	1.01
	(12.0)	(5.3)	(5.3)	(12.0)	(10.0)	(9.3)
Anilofos 0.4 kg ha^{-1}	1.05	0.832	0.960	1.15	0.799	1.15
	(11.3)	(6.0)	(9.3)	(13.3)	(5.3)	(13.3)
Butachlor 1.25 kg ha^{-1}	1.12	0.709	0.910	1.15	0.954	0.796
	(15.3)	(4.6)	(7.3)	(13.3)	(8.0)	(5.3)
Hand weeding twice	0.917	0.624	0.832	1.18	0.698	0.747
	(6.6)	(3.3)	(6.0)	(14.6)	(4.0)	(4.6)
Unweeded control	1.07	1.08	1.259	1.55	1.32	1.41
	(11.3)	(11.3)	(16.6)	(35.3)	(20.6)	(25.3)
SEd	0.07	0.06	0.06	0.04	0.20	0.08
CD (P=0.05)	NS	0.416	0.251	0.057	0.104	0.099

Figures in the parenthesis are original values

All herbicide treatments were followed by one hand weeding at 45 DAT

critical difference at five percent level of probability was computed for comparison of treatment means. In summer season also the same trend was observed. At panicle initiation, pretilachlor 3.0 kg ha^{-1} was followed by hand weeding twice and pretilachlor 1.5 kg ha^{-1} in reducing the weed density. In both seasons, the standard herbicides rifit, anilofos and butachlor recorded relatively higher density of individual weeds compared to higher doses of test herbicide (pretilachlor 3.0,1.5 and 1.0 kg ha^{-1}).

Weed dry weight

Pre emergence application of Pretilachlor 3.0 kg ha^{-1} registered lower weed biomass as a result of reduction of weed density by herbicidal action (Table 2). Pretilachlor 1.5 and 1.0 kg ha^{-1} also offered effective and comparable weed control similar to its higher dose (3.0 kg ha^{-1}) and rifit, but better than the standard herbicide (anilofos and butachlor). Invariably, the lowest dose of the test herbicide (pretilachlor 0.5 kg ha^{-1}) did not inhibit either the weed seed germination or weed growth, might probably be a sublethal dose for the weed species present in the present study. The same trend was observed in both the seasons. Sanjoy Saha and Rao (2008) also have reported an increase in weed dry weight as the crop growth advanced.

Table 2. Effect of treatments on dry weight (kg ha^{-1}) of total weeds

Treatments	First season (*rabi*)			Second season (summer)		
	Active tillering	Panicle intiation	Harvest	Active tillering	Panicle intiation	Harvest
Pretilachlor 0.5 kg ha^{-1}	73.1	175.0	325	96.2	246.0	290.0
Pretilachlor 0.75kg ha^{-1}	44.4	138.0	277	79.4	154.0	167.0
Pretilachlor 1.0 kg ha^{-1}	40.6	84.8	215	61.2	92.4	154.0
Pretilachlor 1.5 kg ha^{-1}	34.2	72.7	193	55.3	89.7	105.0
Pretilachlor 3.0 kg ha^{-1}	32.9	62.6	188	38.8	63.6	94.4
Rifit0.75 kg ha^{-1}	43.1	124.0	256	68.2	129.0	216.0
Anilofos 0.4 kg ha^{-1}	50.3	142.0	265	68.4	105.0	173.0
Butachlor 1.25 kg ha^{-1}	49.3	167.0	273	57.8	86.4	162.0
Handweeding twice	38.6	80.6	221	17.8	85.7	122.0
Unweeded control	142.0	222.0	395	175.0	347.0	472.0
SEd	11.3	14.0	32	7.8	14.0	45.0
CD (P=0.05)	23.7	29.0	69	16.3	29.0	95.0

Herbicide treatment were followed by one hand weeding at 45 DAT

Weed control efficiency

Analysis of weed control efficiency is important because it is directly correlated with yield (Table 3). Saha Sanjoy (2006) stated that 43.2% yield loss in rice due to severe crop weed competition. The data on weed control efficiency revealed that there was general decrease in weed control efficiency over stages of growth in *rabi* season in contrast to summer season where there was increase in weed control efficiency as the crop growth stage progressed. Invariably higher dose of pretilachlor (3.0,1.5,1.0 kg ha^{-1}) enhanced the weed control efficiency as against the anilofos, butachlor and rifit. The same trend was observed in all growth stages in summer season also.

Table 3. Weed control efficiency (%) of various weed control treatments

Treatment	First season (*rabi*)			Second season (summer)		
	Active tillering	Panicle intiation	Harvest	Active tillering	Panicle intiation	Harvest
Pretilachlor 0.5 kg ha^{-1}	48.8	21.3	17.6	45.0	29.1	38.6
Pretilachlor 0.75kg ha^{-1}	68.9	37.9	29.8	54.6	55.6	64.6
Pretilachlor 1.0 kg ha^{-1}	71.6	61.9	45.6	65.0	73.3	67.4
Pretilachlor 1.5 kg ha^{-1}	76.1	67.4	51.5	68.4	74.9	77.8
Pretilachlor 3.0 kg ha^{-1}	77.0	71.9	52.4	77.8	81.7	80.0
Rifit0.75 kg ha^{-1}	69.8	44.0	35.2	61.0	62.8	54.2
Anilofos 0.4 kg ha^{-1}	64.7	36.2	32.8	60.9	69.7	63.3
Butachlor 1.25 kg ha^{-1}	65.5	25.0	30.9	66.9	75.1	65.6
Handweeding twice	72.9	63.8	43.9	94.8	75.3	74.1
Unweeded control	-	-	-	-	-	-

Herbicide treatment were followed by one hand weeding at 45 DAT

Phytotoxicity

Pretilachlor at 1.5 and 3.0 kg ha^{-1} exhibited severe crop phytotoxicity, which affected crop growth adversely. No crop phytotoxicity was seen with Pretilachlor at 1.0 kg ha^{-1}, 0.75 kg ha^{-1} and other standard herbicides viz., butachlor, anilofos and rifit (Table 2). Even though Pretilachlor at 3.0 and 1.5 kg ha^{-1} recorded lower weed density, due to crop phytotoxicity crop yields were reduced . Pretilachlor 1.0 kg ha^{-1} recorded higher yield, which was on par with pretilachlor 0.75 kg ha^{-1}, butachlor 1.25 kg ha^{-1}, anilofos 0.4 kg ha^{-1}, rifit 0.75 kg ha^{-1} and hand weeding twice.

Correlation analysis

Simple correlation between weed characters and plant characters were calculated assuming a cause and effect relationship. All the growth and yield component correlated significantly and positively with grain yield in both seasons, except plant height in the *rabi* season (Table 4). However, the association was the closest during summer season, indicating that these parameters studied were the yield contributing factor in summer than in *rabi*. Among the parameters, leaf area index and grains $panicle^{-1}$associated maximum with grain yield followed by tillers and panicles in both the seasons.

Herbicide residue analysis

The herbicide residues in the post harvest soil, rice grain and straw analysed for various doses of pretilachlor during *rabi*, indicated that the residue were below detectable levels (Table 5). During summer all other treatments, except the highest dose of pretilachlor recorded the terminal residues below detectable levels in grain, straw and post harvest soil. Highest dose of pretilachlor 3.0 kg ha^{-1}

Table 4. Correlation coefficient between weed character and crop (Rice)

Treatment	Grain yield	Weed DMP	Weed population	Plant height at harvest	Tillers at harvest	LAI at flowering	Productive tillers	1000 grain weight
Weed DMP	-0.804**							
Weed population	-0.877**	0.890**						
Plant height at harvest	0.698**	-0.483**	-0.546**					
Tillers at harvest	0.776**	-0.675**	-0.677**	0.886**				
LAI at flowering	0.872**	-0.668**	0.754**	0.896**	0.892**			
Productive tillers	0.746**	-0.612**	-0.678**	0.934**	0.907**	0.911**		
Thousand grain weight	0.670**	-0.510**	-0.606**	0.756**	0.758**	0.782**	0.771**	0.708**

** significant at 0.01%

registered minimum residues in paddy straw and post harvest soil. As such there was no residue build up either in plant produce or rice soil. The same results were observed in anilofos and no detectable amount was found in the soil at harvest of the crop (Krishnamurthi, 2001)

Table 5. Effect of treatments on yield attributes and yield (kg ha^{-1}) of rice

Treatment	First season (*rabi*)		Second season (summer)	
	Panicles (no m^{-2})	Yield (kg ha^{-1})	Panicles (no m^{-2})	Yield (kg ha^{-1})
Pretilachlor 0.5 kg ha^{-1}	240	5249	304	4977
Pretilachlor 0.75kg ha^{-1}	315	5580	320	5588
Pretilachlor 1.0 kg ha^{-1}	315	5737	345	5822
Pretilachlor 1.5 kg ha^{-1}	249	5395	314	5417
Pretilachlor 3.0 kg ha^{-1}	256	5292	309	5296
Rifit 0.75 kg ha^{-1}	274	5522	326	5515
Anilofos 0.4 kg ha^{-1}	280	5524	334	5491
Butachlor 1.25 kg ha^{-1}	286	5466	336	5566
Hand weeding twice	315	5680	341	5800
Unweeded control	235	3047	289	2773
SEd 27.3	187	3.8	142	
CD (P=0.05)	57.4	393	7.9	298

Herbicide treatment were followed by one hand weeding at 45 DAT

Yield and yield attributes

The grain yield of rice was significantly influenced by the weed control treatments over unweeded control (Table 5). The grain yield ranged from 3047 to 5737 and from 2773 to 5822 kg ha^{-1} during *rabi* and summer respectively. The highest grain yield of 5737 and 5822 kg ha^{-1} were obtained with pretilachlor at 1.0 kg ha^{-1} during r*abi* and summer respectively. This was due to reduced weed population, dry weight and no residual effect in the corresponding season. It enhanced the uptake of nutrients by crop coupled with growth characters and yield favouring attributes. The most important factors deciding the grain yield *viz.,* panicles m^{-2} (no.), panicle length, grains panicle^{-1} and 1000 grain weight were the highest with pretilachlor at 1.0 kg ha$^{-1.}$ Hand weeding twice followed the treatment T3 and this might be due to increased competition free environment with no crop toxicity and consequent growth and increase in yield parameters and yield.

Conclusion

It can be concluded that pre emergence application of pretilachlor 1.0 kg ha^{-1} with a hand weeding at 45 DAT provided better weed control and resulted in increased yield and economics of transplanted rice, compared to the recommended weed control methods.

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