

## Long term effect of herbicides on weed shift and sustainable yields of rice-rice system under lowland conditions in southern Karnataka

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### ABSTRACT

A field experiment was conducted on sandy clay loam soil at Kathalagere, University of Agricultural Sciences, Bangalore (Bhadra command area of southern transition zone of Karnataka) during 1999 to 2006 in lowland transplanted rice-rice cropping system to know the effect of continuous use of weed management practices on weed shift and yields. Use of herbicide butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha at three days after application (DAP), applied in sequence gave broad spectrum weed control during *kharif* but its application during summer could not lower the density of sedge and grasses and consequently gave slightly lower yield by 15<sup>th</sup> season (5055 kg/ha) than rice treated with butachlor + 2,4-D EE in *kharif* and pretilachlor 0.75 kg/ha in summer (5446 kg/ha) and farmers' practice of hand weeding twice (5101 kg/ha). Further, continuous use of butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha at 3 DAP both during *kharif* and summer paved way for dominance of sedges (particularly *C. difformis* and *F. miliacea*) and grasses (*E. glabrescens*) during fourth summer crop of rice-rice system, as compared to the use of butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha at 3 DAP during *kharif* followed by pretilachlor 0.75 kg/ha during summer. Thus, rotation of butachlor + 2, 4-D EE followed by pretilachlor lowered the menace of sedges, grasses and broad leaf weeds in long term rice-rice system. Continuous use of herbicides gave rice yields (4637 to 4768 kg/ha) similar to hand weeding (4856 kg/ha) and saved weeding cost considerably. Combined use of fertilizers and FYM did not favour any weed types, density or dry weight as compared to fertilizer usage alone.

**Key words :** Herbicides, Long term effect, Rice-rice cropping system, Weed shift.

Transplanted low land rice is a unique system with standing water that has consequential influence on weed flora during the growing period. The nature and extent of weed flora in low land rice system are influenced by the puddling, standing water and the season. However, in the present day rice cultivation, the weed flora and types are also influenced by the use of herbicides for selective management of weeds (Mukherjee and Singh 2005, Rajkhowa *et al.* 2007). It was also suggested that weed management in rice could be simplified by spraying a broad-spectrum herbicide to overcome the labour drudgery during peak season. In view of this, use of herbicides is increasing at a faster rate as compared to other pesticides (Sondhia 2008). Newer molecules at low doses are being added each year due to environmental and health concern and stringent regulatory requirements (Arya *et al.* 2008). Under these circumstances, it is desirable to know the effect of long-term use of herbicides for weed management in rice on weed shift and sustainability of rice yields.

### MATERIALS AND METHODS

A field experiment was conducted on sandy clay loam soil at Agricultural Research Station, Kathalagere (Bhadra

command area of southern transition zone of Karnataka), University of Agricultural Sciences, Bangalore during *kharif* 1999 to *kharif* 2006 in lowland rice-rice cropping system to know the effect of continuous use of weed control treatments on weed shift and yields in rice-rice system. The three weed management practices namely butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha at three days after application (3 DAP) applied in sequence both during *kharif* and summer, butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha at 3 DAP during *kharif* and pretilachlor 0.75 kg/ha (3 DAP) during summer and farmers' practice of hand weeding twice (20 and 45 DAP) during both *kharif* and summer were compared at two sources of fertility levels- 100% recommended dose of fertilizer (RDF) only and combination of 75% RDF through fertilizers + 25% N through FYM (Table 2) in a randomized complete block design with four replications. The crop was raised in the month of August during *kharif* and February-March in summer season with Bhadra canal irrigation water. The crop was planted at a common spacing of 20x10 cm by using 25-30 days aged seedlings at 100% RDF level *viz.*, 100 kg N, 50 kg P<sub>2</sub>O<sub>5</sub> and 50 kg K<sub>2</sub>O/ha in *kharif* and 125 kg N, 62 kg P<sub>2</sub>O<sub>5</sub> and 62 kg K<sub>2</sub>O/ha in summer. The gross

and net plot sizes were 10x11.5 m and 3.5 X 3.0 m, respectively. The herbicides were applied by using Knapsack sprayer with 500 litre of spray volume/ha as per the treatments at 3 DAP. The species wise weed density, category wise weed density and dry weight were recorded in quadrate of 50 x 50 cm at 30, 50 DAP and harvest in all seasons.

## RESULTS AND DISCUSSION

### Major weed flora

The major weed flora observed in the experimental fields were *Fimbristylis miliacea* L. (Link), *Cyperus difformis* L., *C. iria* L. and *Scirpus* sp L. (among sedges); *Panicum tripheron* L., *Echinochloa glabrescens* L. and *Echinochloa colona* L. (among grasses); *Ludwigia parviflora* L., *Rotala verticillaris* L., *Eclipta alba* L., *Spilanthus acmella* L., *Lindernia veronicaefolia* (L.) F. Mull and *Glinus oppositifolius* L. (among broad leaf weeds) (Table 1). Other weeds noticed in lower density were *Panicum repens* L., *Paspalum dilatatum* L. (grass), *Alternanthera sessilis* L., *Lobelia olecinoides* L., *Dopatrium junceum* L., *Cyanotis axillaris* L. and *Aeschynomene indica* L. during the experimental period from *kharif* 1999 to *kharif* 2006.

### Weed shift

To know the shift in the weed flora due to continuous use of herbicides, the data on species wise weed density/m<sup>2</sup> along with category of weeds (sedges, grass and broad leaf/m<sup>2</sup>) at 50-60 DAP 1999 *kharif* 2002 summer and *kharif* 2006 have been given (Table 1).

During initial year in 1999 *kharif*, the densities of sedge, grass and broad leaf weeds were similar between two butachlor + 2, 4-D EE treatments. However, after 6<sup>th</sup> crop rice during summer 2002, the density of sedge (particularly *Fimbristylis miliacea* and *Cyperus iria*) was three to eight times higher in application of butachlor + 2,4-D EE both during *kharif* and summer as compared to plot receiving butachlor + 2,4-D EE during *kharif* and pretilachlor in summer. While such increase was three to ten folds in grasses (*Echinochloa glabrescens* and *Panicum tripheron*) density in the former treatment as compared to the later treatment. This suggested that continuous use of butachlor + 2,4-D EE paved way for build up of sedges and grasses, as also opined by Singh and Singh (2001), while rotation with pretilachlor lowered the density of both weeds' category in the present study, as also spelt out by studies made at Coimbatore (Anon. 2006) in rice.

**Table 1. Long-term effect of herbicides on weed shift (major weed species' density, No./m<sup>2</sup>) at 50-60 DAP in 1999 *kharif* 2002 summer and 2006 *kharif* in transplanted rice**

Treatments	Kharif 1999 - 50 DAP (1 <sup>st</sup> Crop)													Total Weeds	
	Sedge				Grass			Broad leaf							
	Fm	Cdf	Total	Pt	Eg	Total	Lp	Rv	Ea	Sa	Go	Total			
T1 - Butachlor+2,4-D EE + FYM	5.6	0.8	6.4	1.6	2.0	3.6	8.4	7.2	6.4	3.6	15.6	46.0	56.0		
T2 - Butachlor+2,4-D EE + FYM#	12.0	0.8	12.8	2.0	1.2	3.2	9.6	3.6	16.8	11.2	9.2	60.0	76.0		
T3 - Hand weeding + FYM	9.6	8.8	18.4	0.4	2.0	2.4	12.8	12.4	5.6	3.6	12.0	63.6	84.4		
T4 - Butachlor + 2,4-D EE - FYM	6.0	0.8	8.4	1.6	2.0	3.6	4.8	8.4	6.0	8.8	8.0	43.6	55.6		
T5 - Butachlor+ 2,4-D EE - FYM#	8.0	2.4	11.6	0.8	2.0	3.6	5.6	2.8	12.0	4.8	4.0	41.6	56.8		
T6 - Hand weeding - FYM	9.6	1.6	10.8	0.4	2.0	2.4	4.0	2.8	3.6	0.4	14.0	36.8	50.0		
Summer 2002 - 50 DAP (6 <sup>th</sup> crop)															
Treat-ments	Sedge				Grass			Broad leaf						Total Weeds	
	Fm	Cdf	Ci	Total	Eg	Pt	Total	Ea	Sa	Rv	Go	Lp	Total		
T1 - Butachlor+2,4-D EE + FYM	42.0	6.0	33.0	81.3	12.0	2.0	14.0	24.0	52.8	4.0	4.0	4.0	103.2	198.5	
T2 - Butachlor+2,4-D EE + FYM#	21.2	3.2	13.0	34.0	1.0	0.0	3.2	22.8	20.0	0.0	2.0	11.0	66.0	103.2	
T3 - Hand weeding + FYM	33.2	2.0	26.8	62.0	5.5	0.0	9.2	10.0	10.0	2.0	9.0	4.0	58.0	129.3	
T4 - Butachlor + 2,4-D EE - FYM	26.0	6.0	32.0	64.0	27.2	8.0	35.2	6.0	27.0	2.0	9.0	12.8	60.0	159.8	
T5 - Butachlor+ 2,4-D EE - FYM#	14.8	1.2	0.0	16.0	14.0	4.8	19.2	14.0	29.0	0.0	0.0	4.0	57.2	92.0	
T6 - Hand weeding - FYM	44.8	10.0	50.0	105.2	10.0	2.0	20.0	15.2	18.0	0.0	6.0	6.0	59.2	184.0	
Kharif 2006 - 60 DAP (15 <sup>th</sup> crop)															
Treat-ments	Sedge				Grass			Broad leaf						Total Weeds	
	Cdf	Sc	Fm	Ci	Total	Ec	Total	Ea	Sa	Lp	Rv	Lv	Go		Total
T1 - Butachlor+2,4-D EE + FYM	6.0	15.0	10.0	10.0	42.8	0.0	0.0	0.0	23.0	5.0	6.0	0.0	0.0	34.0	76.8
T2 - Butachlor+2,4-D EE + FYM#	10.0	12.0	6.0	6.0	35.0	0.0	0.0	3.0	15.0	10.0	3.0	0.0	0.0	34.5	69.5
T3 - Hand weeding + FYM	19.3	16.0	4.0	0.0	43.3	8.0	11.0	0.0	3.0	15.0	9.0	9.0	24.0	60.0	114.3
T4 - Butachlor + 2,4-D EE - FYM	8.0	0.0	15.0	0.0	25.3	0.0	3.0	2.0	6.0	11.0	8.0	7.0	17.0	58.0	86.3
T5 - Butachlor+ 2,4-D EE - FYM#	6.0	5.0	11.0	0.0	23.0	2.0	4.0	0.0	16.0	11.0	0.0	3.0	7.0	37.0	64.0
T6 - Hand weeding - FYM	3.0	24.0	11.0	8.0	46.8	2.0	2.0	0.0	8.0	7.0	8.0	3.0	25.0	58.0	106.8

T1 and T4 = Butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha as pre-em., 3 days after planting applied in sequence (3 DAP) during both *kharif* and summer seasons; # = T2 and T5 = butachlor and 2,4-D EE applied in sequence as in T1 and T4 during *kharif* followed by pretilachlor 0.75 kg/ha as pre-em., 3 DAP (only during summer season); +FYM = 75% NPK through fertilizer + 25 % through FYM; - FYM = 100% NPK through fertilizers only (100 kg N, 50 kg P<sub>2</sub>O<sub>5</sub>, 50 kg K<sub>2</sub>O/ha in *kharif* and 125 kg N, 62 kg P<sub>2</sub>O<sub>5</sub>, 62 kg K<sub>2</sub>O/ha in summer, FYM - 0.6%N, 0.5% P and 1.2% K; K = *kharif*, S = summer season;

Fm = *Fimbristylis miliacea*, Cdf = *Cyperus difformis*, Ci = *Cyperus iria*, Sc = *Scirpus spp.*, Eg = *Echinochloa glabrescens*, Ec = *Echinochloa colona*, Pt = *Panicum tripheron*, Lp = *Ludwigia parviflora*, Ea = *Eclipta alba*, Go = *Glinus oppositifolius*, Rv = *Rotala verticillaris*, Sa = *Spilanthus acmella*, LV = *Lindernia veronicaefolia*.

However, during *kharif* 2006, the weed density of these two categories did not vary much, as both the treatments received butachlor + 2, 4-D EE (Fig. 1). Nevertheless, the density of broad leaf weeds was lower in treatment receiving pretilachlor during summer followed by butachlor + 2,4-D EE during *kharif* than the continuous use of butachlor + 2,4-D EE during both *kharif* and summer seasons (Table 1 and Fig. 1). The nature and type of weed control due to continuous use of herbicide was also reported at Coimbatore (Anon. 2006). Further, weed density was higher in all treatments particularly during summer 2002 than the *kharif* rice in 1999 and 2006.

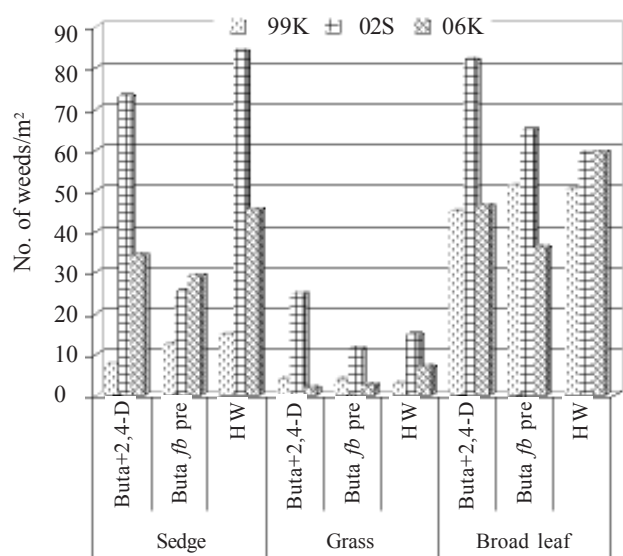


Fig. 1. Shift in weed flora in terms of density of weeds category – sedge, grass and broad leaf weeds (No/m<sup>2</sup>) due to continuous use of herbicides in transplanted rice-rice system during *kharif* 1999 to *kharif* 2006 (Averaged over sources of fertility) (K = *kharif*, S = summer season)

### Paddy Yield

The data on paddy yield (kg/ha) for the years 1999 *kharif* to 2006 *kharif* along with overall mean are provided (Table 2).

During 2006 *kharif*, the grain yield of rice was slightly higher in butachlor + 2, 4-D EE with FYM alone (5449 kg/ha) than fertilizer alone (5052 kg/ha). Among weed control treatments, grain yield obtained in hand weeding was similar (5101 kg/ha) to the plots treated with butachlor + 2, 4-D EE during *kharif* and pretilachlor in summer (5446 kg/ha) and it was slightly lower in treatment receiving both butachlor + 2,4-D EE in *kharif* and summer season (5055 kg/ha) (Table 2). Weed management practices gave slightly higher yields with plot dressed with fertilizer + FYM (5130 to 5716 kg/ha) than the use of fertilizer alone (4928 to 5177 kg/ha).

It is clear that use of herbicide butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha during *kharif* and pretilachlor 0.75 kg/ha in summer resulted in paddy yield similar to that of hand weeding. Use of fertilizer + FYM favoured slightly higher yield (5343 kg/ha) than the use of fertilizer alone (5059 kg/ha) even after 15<sup>th</sup> crop (Table 2) indicating favorable cumulative effect of FYM on paddy yield in the later years, as also spelt out by its favorable effect on yield by Ramakrishna *et al.* (2007) in rice with integration of FYM and fertilizer dose.

The effect of weed management practices and sources of fertility levels appeared to have conspicuous effect on grain yield over period of time (Table 2). Averaged over 15 seasons, the paddy yield in butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha (3 DAP) during *kharif* followed by pretilachlor 0.75 kg/ha (3 DAP) during summer gave simi-

Table 2. Long term effect of weed management practices on paddy yield in transplanted rice with and with out farm yard manure during *kharif* 1999 (first season) to *kharif* 2006 (fifteenth season) in rice- rice system

Treatment details	Grain yield (kg/ha)														Mean
	1999 K	2000 S	2000 K	2001 S	2001 K	2002 S	2002 K	2003 K	2004 K	2005 S	2005 K	2006 S	2006 K		
T1 - Butachlor+2,4-D EE + FYM	4844	4944	5177	5319	4500	3389	3480	4167	3831	3674	5408	5219	5182	4549	
T2 – Butachlor+2,4-D EE + FYM#	5028	5389	5567	5139	4220	3444	3860	4226	4002	4159	5082	6000	5716	4756	
T3 - Hand weeding + FYM	5610	5538	5666	4884	4613	3611	3913	4286	3582	3992	5381	6131	5130	4795	
T4 – Butachlor + 2,4-D EE - FYM	4892	6069	5323	5083	4507	2944	4046	4048	3488	3808	6087	5100	4928	4725	
T5 – Butachlor+ 2,4-D EE – FYM#	5338	6083	5680	5276	4813	3667	3929	3726	3178	3441	6087	5751	5177	4780	
T6 – Hand weeding - FYM	5412	5999	5275	5167	4747	3678	4115	4583	3861	4352	5924	5729	5071	4916	
LSD (P=0.05)	NS	NS	NS	NS	436	739	367	NS	NS	784	2043	NS	NS	NS	
Averaged over farm yard manure / fertilizer treatments															
Butachlor 0.75 kg + 2, 4-D EE 0.4 kg	4868	5507	5250	5201	4503	3167	3763	4107	3659	3741	5748	5159	5055	4637	
Butachlor 0.75 kg + 2, 4-D EE 0.4 kg#	5183	5736	5624	5208	4517	3556	3894	3976	3590	3800	5584	5876	5446	4768	
Hand weeding (20 and 45 DAP)	5511	5764	5471	5026	4680	3645	4014	4435	3722	4172	5652	5930	5101	4856	

T1 and T4 = Butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha as pre-em., 3 days after planting applied in sequence (3 DAP)during both *kharif* and summer seasons; # = T2 and T5 = butachlor and 2,4-D EE applied in sequence as in T1 and T4 during *kharif* followed by pretilachlor 0.75 kg/ha as pre-em., 3 DAP (only during summer season); +FYM = 75% NPK through fertilizer + 25 % through FYM; - FYM = 100% NPK through fertilizers only (100 kg N, 50 kg P<sub>2</sub>O<sub>5</sub>, 50 kg K<sub>2</sub>O/ha in *kharif* and 125 kg N, 62 kg P<sub>2</sub>O<sub>5</sub>, 62 kg K<sub>2</sub>O/ha in summer, FYM - 0.6%N, 0.5% P and 1.2% K; K = *kharif*, S = summer season; NS = Not significant at P = 0.05 ; Rice crop could not be raised owing to paucity of irrigation water in the command area in summer 2003 and 2004; During 1999 to 2004 Cv. IR-64 and 2005 to 2006 Cv. MTU 1010 were used.

lar yield (4768 kg/ha) as that of hand weeding twice (4856 kg/ha), but slightly higher than butachlor 0.75 kg + 2,4-D EE 0.4 kg/ha (3 DAP) both during *kharif* and summer (4637 kg/ha), as a result of differences in the controlling ability of weeds. This indicates that continuous use of same kind of herbicide slightly lowered the paddy yields owing to lack of control of weeds particularly sedges during summer. This conspicuous effect of rotation of herbicide was clear on lowering the sedges menace particularly during summer in 2002 as result of relative more effectiveness of pretilachlor over butachlor in lowering sedges density as also observed by Rajkhowa *et al.* (2001). The yield levels obtained in this study by rotation of herbicides was also reported by Kathirvelan and Vaiyapuri (2004) and Anon. (2006). Further, the addition of FYM along with fertilizer helped rice in producing slightly higher yields in later years (by 14<sup>th</sup> and 15<sup>th</sup> crop) than mere fertilizer application only, as also observed in long-term trial in weed management on finger millet –groundnut cropping system at Bangalore (Anon. 2006a). Averaged over 15 seasons and eight years, beneficial effect of FYM could not be visualized on paddy yield (4700 kg/ha) as compared to use of mere fertilizer only (4807 kg/ha) (Table 2).

The cost spent by using butachlor + 2,4-D EE during *kharif* and summer and butachlor + 2,4-D EE during *kharif* followed by pretilachlor in summer were Rs. 1450/- and Rs. 1300/ha, respectively as against Rs. 7080/ha in hand weeding. Thus use of herbicide saved weeding cost by Rs. 5630/- to Rs. 5780/ha over hand weeding in one cycle of rice-rice system.

From this study, it can be inferred that use of herbicide butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha (3 DAP, applied in sequence) gave broad spectrum of weed control during *kharif*, but its application during summer could not lower the density of sedge and grasses and consequently gave slightly lower yield by 6<sup>th</sup>, 14<sup>th</sup> and 15<sup>th</sup> season (3167, 5159 and 5055 kg/ha, respectively) than rice treated with butachlor + 2,4-D EE in *kharif* and pretilachlor in summer (3556, 5876 and 5446 kg/ha, respectively). Continuous use of butachlor 0.75 kg + 2, 4-D EE 0.4 kg/ha (3 DAP) both during *kharif* and summer paved way for dominance of sedges (particularly *C. difformis* and *F. miliacea*) and grasses (*E. glabrescens*) during fourth summer crop of rice– rice system. Thus, the rotation of herbicides-

butachlor + 2, 4-D EE followed by pretilachlor is desirable to lower the menace of sedges, grasses and broad leaf weeds in long term rice- rice system and compared similar to hand weeding (20 and 45 DAP). Application of FYM along with fertilizers did not favour development of any particular weeds or weed types. Thus use of herbicides was cheaper than hand weeding.

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