Indian Journal of Weed Science **44**(2): 84–87, 2012

Butachlor dissipation in rice grown soil and its residues in grain

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Received: 2 September 2011; Revised: 12 May 2012

ABSTRACT

A field experiment was conducted in an Alfisol to study the degradation of butachlor and its residues in paddy grain during *Rabi* and *Kharif* seasons of 2007-08 at College Farm, College of Agriculture, Rajendranagar. Butachlor dissipated with half life varying from 12.5 to 21.5 days when applied at the rate of 1.0 and 2.0 kg/ha under with and without organic manures conditions. The observed half life values were lower for lower dose of applied herbicide as compared to higher dose and the field half life of butachlor was more under without organic manures as compared to organic manures applied plots. Residues of butachlor in field soil were analysed by using gas chromatograph and 100% dissipation of butachlor was observed at the time of harvest of crop. Very low levels of residues were detected in rice grain below the maximum residue limit of 0.5 mg/kg. Therefore, application of butachlor in paddy for weed management can be considered safe from the point of consumption of grain.

Key words: Butachlor, Dissipation, Half life, Residues, Rice

The usage of pesticides in agriculture plays a vital role to increase the agriculture production. The indiscriminative use of pesticide has resulted in the presence of pesticide residues in different components such as agriculture commodities, soil, water, milk *etc*. which pose health hazards to human beings and animals. Among all the chemicals, use of herbicides for the control of weeds has become imperative especially in the irrigated agriculture for a wide variety of reasons like non availability of labours, high labour cost, unfavorable climatic conditions for weeding *etc*. However recommendations on chemical weed control remain incomplete if the data of toxic herbicidal residues are not provided. It is therefore, essential to undertake studies on the fate and behavior of herbicides in different crops from both environmental and agronomic considerations. Butachlor used as pre-emergence herbicide in rice for controlling grassy as well as broad leaved weeds. Information on dissipation and residues of butachlor in rice and role of different organic manures on butachlor dissipation was not available in Andhra Pradesh agro climatic conditions. Hence, present study was conducted to know the residue accumulation and dissipation of butachlor in rice.

MATERIALS AND METHODS

A field experiment was conducted on an Alfisol at College Farm, College of Agriculture, Rajendranagar for *Rabi* and *Kharif* seasons during 2007-08. Rice crop was grown in split plot design with four main (M1-FYM 10 t/ha, M2-Poultry manure 2 t/ha, M3-Vermicompost 5 t/ha and M4: Unweeded check) and two sub-treatments (T1-Pre-emergence application of butachlor 1 kg/ha, T2-Pre-emergence application of butachlor 2 kg/ha). The experimental details were as follows: F1T1-Butachlor 1 kg/ha + FYM 10 t/ha; F1T2-Butachlor 2 kg/ha + FYM 10 t/ha, P1T1- Butachlor 1 kg/ha + poultry manure 2 t/ha, P1T2-Butachlor 2 kg/ha + poultry manure 2 t/ha, V1T1-Butachlor 1 kg/ha + vermicompost 5 t/ha, V1T2-Butachlor 2 kg/ha + vermicompost 5 t/ha, C1T1-Unweeded check 1 kg/ha and C1T2-Unweeded check 2 kg/ha. The residues of the herbicide were estimated in surface soil up to harvest in different intervals. Residues of butachlor were analyzed by gas chromatography using Electron Capture Detector. The recovery studies were carried out at 2 ppm, 1 ppm and 0.5 ppm concentrations. Percent recovery of butachlor varied from 85 to 94 per cent.

Sample collection and preparation

Soil samples were collected from 6-7 spots in each plot on 0 (2 hours after application), 15, 30, 45 and 60 days after application. Soils were collected from control plots and treated plots and the samples were mixed thoroughly, air dried, ground and passed through a 2 mm sieve. A representative 1 kg sample was taken by quartering method for estimating herbicide residues. For edible parts, plants were collected randomly from each plot at harvest time. Samples kept in deep freezer were taken out at the time of analysis and brought to room temperature.

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A stock solution (1.0 mg/ml) was prepared for butachlor in acetone. A 100 microgram per ml fortification standard was prepared by taking a 5 ml aliquot in 50 ml volumetric flask with acetone. Further dilutions were made to make a 10 and 1 microgram per ml solution. Fortification trials were conducted with 1.0 and 2.0 ppm solutions and all stock, fortification and internal standard solutions were stored at -20^0C in the deep freezer until use.

The reference standard of butachlor was used for quantification, recovery and determination of retention time of the herbicide. The soil and plant edible part samples were collected from fields where no herbicide was applied. The samples were sieved/ground and the required quantity of the technical grade butachlor was added to 50 g soil/20 g plant edible part sample. All samples were replicated twice. The soil and plant edible part samples were fortified with 1 ppm and 2 ppm solutions. Control as well as blank samples were maintained to check for the contamination and interferences.

A representative 10 g sieved soil/5 g edible parts was extracted with 150 ml of acetone:hexane. The samples were kept overnight and filtered through buchner funnel and again the samples were rinsed with another 50 ml of acetone: hexane and the extract was evaporated, mixed with 0.3 g activated charcoal, 0.3 g florosil, 10 g anhydrous sodium sulphate and packed in the glass column. Column was eluted with 100 ml of mixture of acetone: hexane (1:9), Elutent was evaporated to dryness in a rotary evaporator at 45°C and residue is re dissolved in 5 ml of n-hexane.

Preparation of standard solutions

Standard solution of 100 ppm butachlor was prepared by dissolving 115.1 mg of technical grade herbicide in 100 ml of methanol. From this 100 ppm solution, 1 ppm standard solution was prepared and injected the sample to GC. Butachlor eluted as a peak at 11.88 minutes. GC parameters were as follows:

Name of the gas chromatograph	Shimadzu GC 2010
Name of the column	ZB-5,30 m length ID 0.53 mm, film thickness 1.50 um
Carrier gas used	Nitrogen
Carrier gas flow	53.6 ml/minute
Column temp/over temp.	220
Injector temperature	240
Injector split ratio	1:10
Detector	Electron capture detector (ECD) with Ni 63
Detector temperature	260
Make up gas flow	60 ml/minute
Retention time	11.88 min

Clean up and estimation

To a chromatographic column (2 mm I.D) 4 g of florosil followed by 10 g of anhydrous sodium sulphate was added. The concentrated extract was diluted to 10 ml with 10% acetone in hexane. Then the solution was transferred to florosil column. Container was rinsed with hexane and transferred to column. The column was eluted with about 5 ml/min and florosil eluate was concentrated to 1 ml. The extract was used for the determination of herbicide residues by GLC on ECD. One micro liter of reference standard solution of herbicide was injected. The peaks by their retention time were identified and the peak area was measured. The amount of residues of herbicide was calculated with the following formula:

$$\text{Residues in mg/kg} = \frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\mu\text{l std. injected}}{\mu\text{l sample injected}} \times \frac{\text{final volume}}{\text{wt. of the sample}} \times \text{Recovery factor}$$

RESULTS AND DISCUSSION

Dissipation of butachlor during *Rabi* season

Initial deposits in soil were estimated to be 0.768 and 0.692 mg/kg at 1 and 2 kg/ha herbicide in unweeded check. It was observed that with the passage of time the residue deposits were reduced in all the treatments, irrespective of herbicide dose and manure source. In case of higher dose of herbicide application *i.e* 2 kg/ha, herbicide residues were slightly increased than lower dose of herbicide application *i.e* 1 kg/ha. Comparatively faster rate of dissipation was observed in manure added plots than control plot. Almost 99% of the applied herbicide was dissipated by harvest time. In case of low levels of herbicide application *i.e* 1 kg/ha within the first 15 d of application, maximum of 45% of the initial amount was lost and on the 45 d of application chemical almost dissipated. The degradation followed the first order kinetics and at different doses of butachlor application, the half life values ranged from 12.54 to 21.5.

Dissipation of butachlor during *Kharif* season

Initial deposits detected were 0.555, 0.598, 0.732 and 0.862 mg/kg in farmyard manure, poultry manure, vermicompost applied plots and unweeded check at 1 kg/ha herbicide and 0.898, 0.754, 0.698 and 0.734 mg/kg at application of higher dose of 2 kg/ha, respectively. At har-

vest, almost 100% of initial deposit of butachlor was dissipated and no residues were detected with a half life of 12.54 days at 1 kg/ha herbicide application + FYM 10 t/ha, however these half life values were slightly increased to 14.33 and 17.74 d for poultry manure and vermicompost at lower dose of herbicide of 1 kg/ha. The estimated residues of herbicides was decreased from 0 days after sowing to harvest. In unweeded check, the half life values were 21.5 and 17.70 d at 1 and 2 kg/ha, respectively. Higher dose of herbicide concentration increased half life in both the cases. Similar results were also reported by kalpana *et al*.(1999).

In general, residue deposits were more during *Rabi* season (first season) than *Kharif* (second season), which might be due to physical parameters like temperature, wind velocity and moisture level. Similar observations were also reported by Kalpana *et al*. (1999) for the dissipation of pendimethalin and fluchloralin in soil, Guha *et al.* (1992) for the dissipation of fluchloralin in *Kharif* rice under West Bengal agriculture conditions, Goutam and Ashim

Table 1. Residues (mg/kg) and dissipation of butachlor in rice grown soil

Treatment	Days after application					Half-life
	0	15	30	45	60	
Butachlor 1 kg/ha + FYM 10 t/ha						
Rabi	0.642	0.309	0.179	0.065	0.006	
Kharif	0.555	0.353	0.208	0.086	0.004	
Mean	0.598	0.331	0.193	0.075	0.005	12.54 days
			Y= 0.2584–0.024x			
Butachlor 2 kg/ha + FYM 10 t/ha						
Rabi	0.885	0.521	0.233	0.104	0.018	
Kharif	0.898	0.462	0.304	0.112	0.012	
Mean	0.891	0.491	0.268	0.108	0.015	18.81 days
			Y= 0.3541–0.016 x			
Butachlor 1 kg/ha + poultry manure 2 t/ha						
Rabi	0.634	0.420	0.223	0.085	0.005	
Kharif	0.598	0.352	0.241	0.108	0.008	
Mean	0.616	0.386	0.232	0.096	0.006	14.33 days
			Y=0.4258–0.021x			
Butachlor 2 kg/ha + poultry manure 2 t/ha						
Rabi	0.823	0.461	0.261	0.106	0.007	
Kharif	0.754	0.306	0.218	0.086	0.006	
Mean	0.788	0.383	0.239	0.096	0.011	15.84 days
			Y=0.5841–0.019x			
Butachlor 1 kg/ha + vermicompost 5 t/ha						
Rabi	0.754	0.381	0.208	0.146	0.018	
Kharif	0.732	0.442	0.253	0.123	0.012	17.70 days
Mean	0.743	0.411	0.230	0.134	0.015	
			Y= 0.3569–0.017x			
Butachlor 2 kg/ha + vermicompost 5 t/ha						
Rabi	0.746	0.563	0.286	0.166	0.012	
Kharif	0.698	0.452	0.234	0.122	0.013	18.81 days
Mean	0.722	0.507	0.260	0.144	0.012	
			Y= 0.5427–0.016x			
Unweeded check 1kg/ha						
Rabi	0.768	0.623	0.242	0.112	0.008	
Kharif	0.862	0.692	0.356	0.218	0.012	
Mean	0.815	0.657	0.299	0.165	0.010	21.5 days
			Y=0.3148–0.014x			
Unweeded check 2 kg/ha						
Rabi	0.692	0.522	0.236	0.120	0.019	
Kharif	0.734	0.568	0.208	0.106	0.014	17.70 days
Mean	0.713	0.545	0.222	0.113	0.016	
			Y=0.4625–0.017x			

Table 2. Residues of butachlor in rice grain (mg/kg)

Treatment	Residues in grain (*Rabi*)	Residues in grain (*Kharif*)
F1T1: Butachlor 1 kg/ha + FYM 10 t/ha	0.0042	0.0051
F1T2: Butachlor 2 kg/ha + FYM 10 t/ha	0.0063	0.0074
P1T1: Butachlor1 kg/ha + poultry manure 2 t/ha	0.0054	0.0048
P1T2: Butachlor 2 kg/ha + poultry manure 2 t/ha	0.0078	0.0095
V1T1: Butachlor 1 kg/ha + vermicompost 5 t/ha	0.0029	0.0035
V1T2: Butachlor 2 kg/ha + vermicompost 5 t/ha	0.0094	0.0074
C1T1: Unweeded check	0.0015	0.0021
C1T2:Unweeded check	0.0029	0.0032
MRL Values	0.05	0.05

(1994) for residue and persistence of pendimethalin in groundnut. Photo-decomposition might be another factor for the loss of these herbicides from soil due to high temperatures during *Rabi* as compared to *Kharif* season (Guha *et al*. 1992, Abhram *et al*. 1987, Savage and Jordan 1980).

Butachlor residues in rice grain

The residues of butachlor in paddy grain were below maximum residual limits (Table 2). Maximum residue value of 0.0095 mg/kg was observed at 2 kg/ha of herbicide (with poultry manure) during *Kharif* season. However, in both seasons and in all the treatments, the detected residues were below maximum residue limits of 0.05 µg/g (The Pesticide Chemical News Guide 1985). As a part of applied herbicides were adsorbed to soil, a part may be leached down to deeper layers and the initial deposits of butachlor were dissipated at the time of harvest of the crop may contributed to lower levels of herbicides in rice grain. (Annual reports of AICRP on Weed Control 2001).

Residues of butachlor in field soil were also analyzed at the time of harvest of crop by using gas chromatograph and 100% dissipation of butachlor was observed. The observed half life values were lower for lower dose of applied herbicide as compared to higher dose. In rice grain, the residues were below the maximum residue limits (0.05 µg/g). Therefore, it may be concluded that pre-emergence application of butachlor in rice for weed management could be considered safe from the point of consumption of rice at the harvest.

ACKNOWLEDGEMENT

Authors are indebted to the Indian Council of Agricultural Research, New Delhi for funding the adhoc project "Herbicide persistence and management in soil and their residues in edible parts of vegetables" and the All India Coordinated Research Programme on Weed Control, ANGRAU, Hyderabad for providing the infrastructural facilities.

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