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Persistence of butachlor in sandy clay loam soil and detection of its residues in rice grain and straw

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ABSTRACT

Persistence of butachlor in clay soil was investigated under field conditions and its residues were determined in soil, rice grain and straw samples. Butachlor was applied at 1.0 kg/ha in rice field. Soil samples were collected at 1, 15, 30, 60, 90 and 120 days after butachlor application and were analyzed for residues. Rice grains and straw were sampled at harvest. HPLC was used to detect butachlor residues. The residue level of butachlor in soil was found 2.56 µg/g a day after butachlor application, which decreased to 0.0028 µg/g at harvest, respectively. However rice grains and straw samples contained 0.003 µg/g and 0.067 µg/g residues, respectively. Half-life of butachlor in the soil was found to be 12.75 days.

Key words : Butachlor, Dissipation, Residues, Rice grains, Soil, Straw samples.

Butachlor is extensively used for weed control in rice as pre-emergence, selective, systemic herbicide. It acts by inhibiting protein synthesis and absorbed primarily through germinating shoots and secondarily by roots. It translocates throughout the plant, with higher concentration in the vegetative parts than the reproductive parts. Butachlor belongs to chloroacetanilide group and commercialized in the form of Echonil, Hunter, Machete, Delchlor in India. It is very effective against annual grasses and numerous broad-leaved weeds in seeded and transplanted rice and onion (Bhowmick and Ghosh 2002, Gnanavel and Kathiresan 2002, Sondhia and Dubey 2006, Sondhia *et al.* 2006). Butachlor is rapidly lost by photo decomposition, microbial degradation and volatilization and did not pose serious problem of environmental pollution (Chen 1981, Sondhia 2006, Sondhia *et al.* 2006). Butachlor dissipates at faster rate in field conditions (Huang and Ye *et al.* 2002, Sondhia and Yaduraju 2006) and follows first order rate kinetics (Devi *et al.* 1997)**.**

Chen and Chen (1978) found that pH did not affect the degradation of butachlor but its volatilization from the aqueous solution and adsorption on soil is significantly influenced by the temperature. Butachlor degradates at faster rate at 40°C at pH 7.0 (Gill *et al.* 1997). Butachlor dissipiates rapidly in hot and clear than cold and cloudy weather, by debutoxymethylation and dechlorination, followed by hydroxylation, o-dealkylation and polymerization. Butachlor adsorption increases with increasing organic carbon content of soils with added animal manure (Prakash *et al.* 2000).

Herbicide residue estimation in soil and edible plant parts is very useful to determine the persistence of herbicide and its effect on the following crops and quality of the food and feed. Presence of residues in soil, and food grains may cause detrimental effect on animal and human health. Thus persistence of butachlor in soil, rice grains and straw were evaluated under field conditions.

MATERIALS AND METHODS

Chemicals and soil

Butachlor reference analytical standard of 99.9% purity was obtained from ACCU standard, USA. All the other chemicals and solvents used in the study were analytical grade reagents.

Dissipation study

Dissipation study was conducted at National Research Centre for Weed Science (NRCWS), Exprimental Farm, Jabalpur during 2006 in *kharif* season in a randomized block design with three replications. Butachlor (50 % WP) was applied at 1.0 kg/ha in transplanted rice in *kharif* 2006 as pre-emergence herbicide. Soil samples were collected after twenty four hour of herbicide application (1 DAS), 30, 60, 90 and 120 days after herbicide application from a depth of 0-20 cm. Replicate samples were bulked together from each plot, air-dried, powdered and passed through a 3 mm sieve to achieve uniform mixing. The paddy grain and straw were sampled at the time of harvesting (90 days).

Collection of rice grain and straw samples

500g of representative rice grains and paddy straw samples were collected from butachlor treated and untreated plots from the field experiment. The straw samples were cut in small pieces and air-dried. Rice grains and paddy straw samples were then ground on mechanical mixer and used for butachlor residue analysis.

Extraction

From rice grain and straw: Butachlor residues were extracted as described by Sondhia *et al*. (2006). Representative rice grains and straw samples (25 g) were cut into small pieces and placed in a 500 ml Erlenmeyer flask and extracted with 60 ml acetonitrile: water (7: 3) on horizontal mechanical shaker for one hour. These were filtered and again re-extracted with 40 ml of acetonitrile: water as above and filtrates were pooled together, concentrated and diluted with 5% NaCl in water (30 ml) and partitioned with n-hexane (30 ml) repeated twice. n-hexane layer was collected and concentrated to approximately 5 ml in a rotary vacuum evaporator.

From soil samples: Soil samples (25 g) were placed in a 500 ml Erlenmeyer flasks and extracted with methanol (50 ml) on horizontal mechanical shaker for one hour, which were filtered and again re-extracted with 50 ml of methanol and filtered. Filtrates of same sample were pooled together and partitioned with n-hexane (30 ml) repeated twice. n-hexane layer was collected and evaporated to dryness in a rotary vacuum evaporator and dissolved in methanol.

Cleanup : A glass column was packed with 6 g of silica gel, activated charcoal and in between two layers of anhydrous sodium sulphate was added. Columns were pre-conditioned with n-hexane and concentrated extracts of soil, grains and straw samples were poured on the top of the column and eluted with 20 ml of n-hexane. Elutes were collected and concentrated to dryness in a rotary vacuum evaporator and dissolved in 5 ml methanol.

HPLC coupled with PDA detector was employed to detect butachlor residues in soil, wheat grains and straw. Phenomenex C-18 (ODS) column (250 x 4.6 mm) and acetonitrile: water (70:30 v/v) was used as mobile phase at a flow rate of 1 ml/min at 230 nm. Using these conditions butachlor was eluted at 2.7 minutes. The time of dissipation of 50% (DT_{50}) of the highest concentration was calculated from the equation DT_{50}= 0.693/k.

RESULTS AND DISCUSSION

Dissipation of butachlor in soil

Under rice field conditions the initial concentration of butachlor at 1.0 kg/ha treatment was 2.56 µg/g that dissipated to 1.167 µg/g, 0.726 µg/g by 30 and 60 days, respectively. There was a steady decrease in the residue level of butachlor and it was found 0.079 and 0.0028 µg/g after 90 and 120 days, respectively. Dissipation pattern of butachlor under field conditions is given in Figure 1. The half-life value of butachlor under rice field condition was found to be 12.75 days (Table 1).

Residues of butachlor in rice grain and straw

Rice grains and rice straw samples collected at the time of harvest from the field showed 0.003 µg/g and 0.067 µg/g of butachlor residues. The residues level detected at harvest was well below MRL (maximum residue limit) value prescribed for butachlor (0.25 µg/g).

The dissipation data of butachlor under field is shown in Figure 1. Dissipation of butachlor was subsequently quite rapid in field conditions. It is well established fact that persistence of most pesticides in the soil is influenced by the organic carbon of the soil (Bhumhorst *et al*. 1990, Sondhia 2008) and other environmental factors such as soil moisture and temperature (Rahman 1997). High organic matter and neutral pH, of the soil favoured the degradation of butachlor in soil (Prakash *et al*. 2000, Sondhia 2006, 2008). These findings are similar to those

Table 1. Butachlor residues in soil and rice crop

Day after Spraying (DAS)	Residues* (µg/g) Butachlor application (1.0 kg/ha)
0	2.56
30	1.167
60	0.726
90	0.079
120	0.0028
Rice straw	0.003
Rice grains	0.067
Half-life (days)	14.46

* Average of four replications.

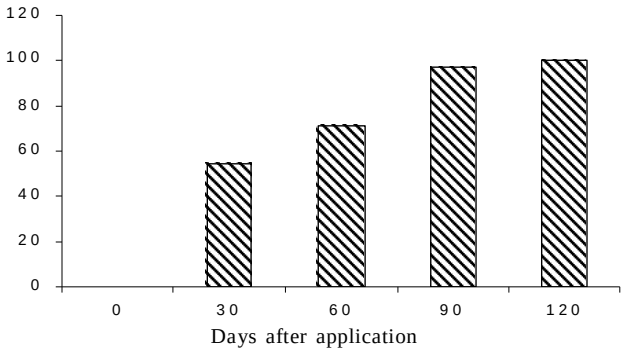

Fig. 1. Dissipation of butachlor residues in rice soil under field conditions.

reported by Mabbayad *et al.* (1984) and Sondhia *et al.* (2005, 2006).

It is clear from the study that butachlor dissipates at a faster rate under field conditions. Though the residues of butachlor were detected in soil, rice grains and straw at the time of harvesting but that were well below the maximum residue level (MRL) of 0.25 µg/g. The data generated here indicate persistence of butachlor residues in soil upto 120 days and bioaccumulation of its residues in rice grains and straw which may be significant in terms of residual contamination in long term continuous application of butachlor.

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