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# Residues of Metolachlor Herbicide in Soil and Potato Tubers Under Indian Tropical Conditions

S. B. Singh,[1] N. T Yaduraju,[2] G. Kulshrestha[1]

[1]Division of Agricultural Chemicals, and [2]Division of Agronomy, Indian Agricultural Research Institute, New Delhi. 110 012. India

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Metolachlor [2-chloro-6'-ethyl-N-(2-methoxy-1-methylethyl)acet-o-toluidide] is a selective pre-emergence herbicide of chloroacetanilide group introduced by Ciba Giegy (Gerber et al. 1974). This herbicide is commonly used in irrigated potato production (Hogue 1986; Burgard et a1.1993), soybean (Sugiyama and Kobayashi 19931, sorghum, peanuts and corn for the control of *Echinocloa crusgalli, Digitaria bifocicula-ta, Amaranthus viridis, Cyperus esculentus, Setaria viridis, Striga asiatica, Eleucine indica, Portulaca oleracea* and *Trianthema monogyna* (Chesters and Simsiman 1989).

The herbicide is absorbed both by roots and shoots of seedlings and inhibit root elongation. Early seedling growth is restricted due to inhibition of cell division and enlargement, cortical cell expansion and mitotic activity (Deal and Hess 1980). Biochemically and physiologically metolachlor affects protein and lipid synthesis, gibberallic acid induced reactions, respiration and photosynthesis (Phillai et a1.1979).

Potato is a major cash crop in north India which is infested by a large variety of weeds. Very recently metolachlor has been accorded registration for weed control in India.There are varying reports on dissipation of this herbicide under field conditions. The half life of disappearance in soil (0-15cm) was calculated to be 80 to 142 days under temprate conditions (Frank et al. 1991). However, no information is available on persistence of metolachlor in field conditions in India. Present study was carried out to investigate the fate of metolachlor in soil and its uptake and persistence in potato tubers under tropical north Indian conditions.

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*Correspondence to:* S. B. Singh

## MATERIALS AND METHODS

The technical samples (97%) and formulated product (Dual, 50 EC) were obtained from Hindustan Ciba-Geigy Ltd. Solvents used for extraction, cleanup and gas chromatographic analysis were analytical grades and were distilled before use.

Potato crop (var. Kufri Badshah) was grown in plots on burrows at the farm of Indian Agricultural Research Institute, New Delhi in November 1992. Metolachlor (Dual 50 EC) was applied pre-emergent @ 1 and 2 kg a.i. $ha^{-1}$. Each treatment including the control was replicated three times in randomized blocks. The samples of soil (66.2% sand, 17.1% silt, 16.7% clay and 0.41% organic carbon) from 0-7.5 cm depth were drawn randomly from replicates after 0, 4, 10, 21, 31 and 42 days. Potato tubers and soil samples were also collected at harvest time (65 days). The samples were collected in polyethylene bags and brought immediately to the laboratory for analysis. The maximum and minimum temperatures during the experiment ranged between 12.7 and 23.4°C, 3.9 and 17.2°C, respectively.

The extraction and cleanup of the soil and crop samples was carried out within one hour of sample collection. A representative 50 g sample of both soil and potato tubers was taken for analysis. Air dried and sieved soil sample was extracted with hexane (150 ml) by shaking on a mechanical shaker for 1 h. The extract was then filtered through Buchner funnel followed by reextraction with hexane (2 X 50 ml). The combined filtrate was passed through a column of anhydrous sodium sulfate and solvent was evaporated to dryness on a rotary evaporator. The residue was finally dissolved in hexane : acetone (4:l) for gas chromatographic analysis.

Samples of potato tubers (50 g) were chopped and extracted with 100 ml of mixture of acetone and hexane (1:3, V/V) by grinding in a Waring Blender for 2 min. The contents were filtered. The residual matter after filtration was blended twice more with 100 ml mixture of acetone and hexane (1:3, V/V) and the extracts were combined. The organic layer was separated. The aqueous layer was extracted twice with ethyl acetate (2x50 ml) after adding aqueous sodium chloride solution. The organic layer was again separated. The combined organic extract (hexane and ethyl acetate) was evaporated on a rotary evaporator to dryness. The residue was dissolved in hexane: acetone (4:l) prior to injection into gas chromatograph.

Gas chromatographic analysis of metolachlor was carried out on a Hewlett Packard model 5890 series II gas chromatograph equipped with HP 3396 series II integrator using electron capture detector. Various column materials used in standardization, the temperature conditions of the instrument, the retention time and sensitivity of estimation of metolachlor are given in Table 1.

Table 1. Gas Chromatographic conditions for metolachlor analysis

| Column material | Temperature(°C) oven/inj/Det | $N_2$ flow (ml/min) | Rt (min) | Sensitivity (ng) |
|---|---|---|---|---|
| Capillary OV-110 | 180/250/300 | 2 | 8.64 | 0.60 |
| Megabore OV-1 | 170/220/300 | 20 | 6.73 | 0.15 |
| Megabore OV-17 | 170/250/300 | 20 | 5.48 | 0.15 |
| Packed OV-225 | 210/250/300 | 30 | 4.52 | 0.30 |

## RESULTS AND DISCUSSION

Metolachlor was well detected by GC using electron capture detector. Maximum sensitivity of 0.15ng of metolachlor was obtained on megabore column containing OV-1 and OV-17 packing materials (Table 1) .Extracts of soil and potato tubers were analysed on megabore column using OV-1 packing material. The temperatures of oven, injection port and detector were maintained at 170, 220 and-300°C, respectively and nitrogen flow was 20 ml $min^{-1}$ The extracts of control soil and potato tubers did not show any interfering peak in gas chromatograph (Figure 1). Recovery of metolachlor from fortified samples of soil and potato tubers averaged 78 and 84% respectively.

The application of metolachlor @ 1 and 2 Kg $a.i.ha^{-1}$ resulted the deposits of 6.10 and 9.47 ppm respectively in soil (0-7.5cm depth, Table 2) -Residues declined consistently with time in soil upto a month. Thereafter, it disappeared rapidly.

The logarithmic plots (Figure 2) of herbicide residues versus time for both the levels of treatment also suggested that dissipation of metolachlor occurred in two distinct phases. The times for 50% dissipation were calculated from regression equation. At the lower and higher rates of metolachlor application, the $RL_{50}$ values were 26.9 and 21.9 days respectively which were in well agreement with the results reported by Ismail and Wei (1993). The dissipation of metolachlor followed

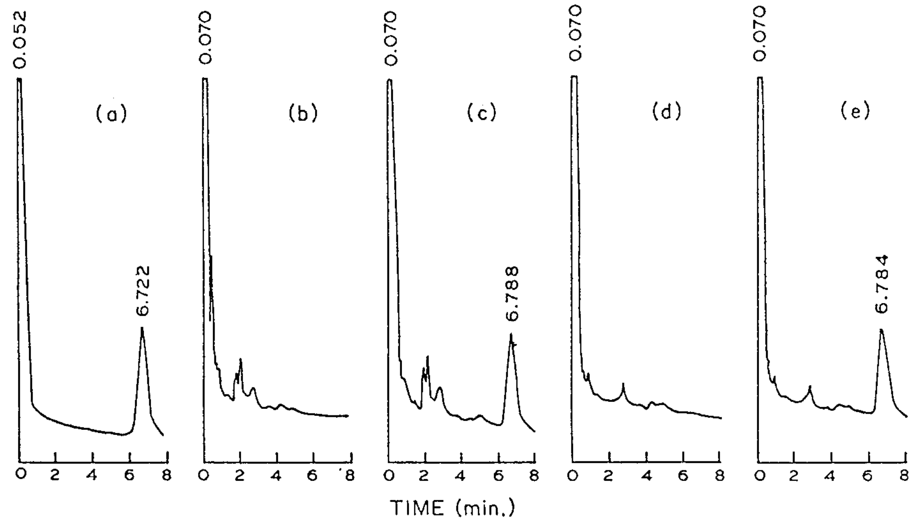

Figure 1. Gas chromatograms of (a) Standard metolachlor (b) Soil blank (c) Soil treated with metolachlor (d) Potato tubers blank (e) Potato tubers treated with metolachlor.

first order rate kinetics. The initial slow rate could be due to degradation and adsorption on soil. After one month herbicide dissipated rather rapidly. Although there were no rains during this period, the field was

Table 2. Dissipation of metolachlor in soil (0 - 7.5cm) and harvest time residues in potato tubers

| | Herbicide dosage | | | |
|---|---|---|---|---|
| | 1 Kg ha$^{-1}$ | | 2 Kg ha$^{-1}$ | |
| Days | Residue* (ug g$^{-1}$) | Dissipation (%) | Residue* (ug g$^{-1}$) | Dissipation (%) |
| SOIL | | | | |
| 0 | 6.10+0.01 | - | 9.47+0.07 | - |
| 4 | 5.79+0.03 | 5.1 | 8.80+0.11 | 7.1 |
| 10 | 5.00+0.05 | 18.1 | 7.47+0.05 | 21.2 |
| 21 | 3.95+0.02 | 35.3 | 5.97+0.15 | 36.9 |
| 31 | 2.72+0.12 | 55.5 | 3.38+0.08 | 64.4 |
| 42 | 0.44+0.01 | 92.8 | 0.71+0.02 | 92.6 |
| 65 | 0.04+0.005 | 99.3 | 0.05+0.001 | 99.9 |
| TUBERS | | | | |
| 65 | BDL | | BDL | |

BDL Below detectable limits
* Average of three replicates

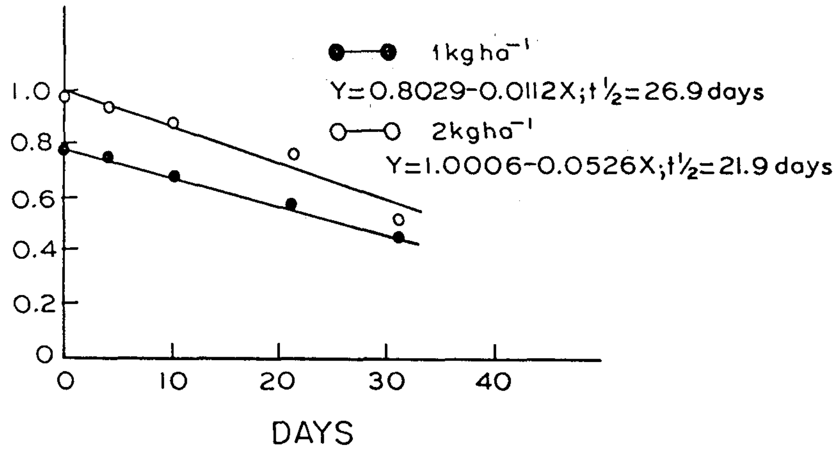

Figure 2. Linear plot for dissipation of metolachlor from soil.

irrigated several times. Due to sufficeint water solubility, metolachlor have leached down with irrigation water (Masse et a1.1994). At harvest approximately 0.5% metolachlor residues persisted in soil irrespective of rates of application. The residues of metolachlor were below detectable limits in potato tubers at harvest time (65 days) from both the rates of applications.

The above studies show that metolachlor does not persist in soil when applied under north Indian tropical conditions. However, the persistence may differ under different agroclimatic zones due to wide difference in climatic conditions in different regions. More studies on the persistence in different regions would help better understanding of its environmental behaviour and efficacy under varied agroclimatic conditions. The faster rate of dissipation after 31 days may be due to its leaching to the deeper layers of soil. Hence leaching behaviour of metolachlor needs investigation.

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