

DETERMINATION OF OXADIAZON RESIDUES IN THE FIELD TREATED SOIL WITH AND WITHOUT ORGANIC MATTER INCORPORATED

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ABSTRACT: The behavior of oxadiazon in the soil may be influenced by organic material content. The objective of this study was to determine the oxadiazon residues by chromatography as a function of organic material and soil depth. A randomized block design was used, with treatments arranged in a scheme of 2 x 4 x 8 + 1 subdivided plots with four repetitions. The plots were comprised of soil with organic matter incorporated (8 t ha⁻¹) and without organic material incorporated, and a control (0 t ha⁻¹ and 0 g ha⁻¹ of oxadiazon). The subplots were the soil depths (0.00-0.05; 0.05-0.10; 0.10-0.15 and 0.15-0.20 m) and the subsubplots were soil collection time (0, 2, 4, 8, 16, 32, 64 and 128 days after application - DAA). Oxadiazon was applied at 1 kg ha⁻¹. For residue determination, samples were quantified with high performance liquid chromatography (HPLC) using the technique of solid-liquid extraction with low temperature partitioning (SLE-LTP). In the superficial layer of 0.00-0.05 m, dissipation $t_{1/2}$ of oxadiazon was between 56 and 51 days in soil with and without organic material incorporated, respectively. Oxadiazon was found in the upper layer (0.00-0.10 m) of soil until 64 DAA and did not occur at the other depths, demonstrating low soil mobility potential. In soils incorporated with organic material, higher concentrations of oxadiazon were observed over different depths and evaluation periods.

Key-words: HPLC, dissipation half-life, organic material, herbicide.

INTRODUCTION

Herbicides are fundamental for improving the productivity of modern agriculture. However, they have caused concern regarding food security and the environmental impacts of herbicide residues. Surface and subterranean waters have been contaminated by agricultural and non-agricultural herbicide applications, as a result of the physico-chemical characteristics of the soil and of the herbicide, can increase superficial flow and cause leaching (Rozemeijer and Broers, 2007).

Leaching is one of the main methods of herbicide dispersion and affects the quality of

shallow subterranean waters (Laini et al., 2012). This process is affected by a series of environmental variables, such as temperature, precipitation and soil properties, as well as agricultural practices such as irrigation (Fait et al., 2010). And adding organic residues to agricultural soils is a widely used practice to increase organic matter content and prolong herbicide persistence (Gámiz et al., 2012).

In soil (7.0% clay and 1.3% organic matter), leaching with water did not displace oxadiazon (1.0 mg kg^{-1}) 2 cm below the soil surface (Wehtje et al., 1993), indicating that oxadiazon is sufficiently sorbed to resist leaching. The objective of this work was to determine oxadiazon residues by high performance liquid chromatography (HPLC) as a function of organic material and soil depth.

MATERIALS AND METHODS

The experiment was carried out in the experimental area at the Federal University of Viçosa, Rio Paranaíba, Minas Gerais State, Brazil, in Distroferric Red Latosol, clay texture, with the chemical characteristics of soil without organic material incorporated [$\text{pH}(\text{H}_2\text{O}) = 6.0$; $\text{OM}(\text{g dm}^{-3}) = 43.0$ and $\text{CEC}(\text{cmolc dm}^{-3}) = 6.7$] and of soil with organic material incorporated [$\text{pH}(\text{H}_2\text{O}) = 7.2$; $\text{OM}(\text{g dm}^{-3}) = 49.0$ and $\text{CEC}(\text{cmolc dm}^{-3}) = 9.6$].

For pre-emergent oxadiazon application (1 kg ha^{-1}), a pressurized backpack sprayer was used with CO_2 at 200 kPa, equipped with nozzles spaced 0.5 m apart, with two flat jet tips of 110.02, with a spray volume of 200 L ha^{-1} .

Using a randomized block design, the treatments were arranged in a scheme of $2 \times 4 \times 8 + 1$ subdivided plots with four repetitions. The plots were comprised of soil with organic material incorporated (8 t ha^{-1}), soil without organic material incorporated and the control (0 t ha^{-1} and 0 g ha^{-1} of oxadiazon). The subplots were comprised of soil depths (0.00-0.05; 0.05-0.10; 0.10-0.15 and 0.15-0.20 m) and the subsubplots of soil collection time (0, 2, 4, 8, 16, 32, 64 and 128 days after application - DAA). The dimensions of each experimental plot were $1.20 \times 2.50 \text{ m}$, totaling 16 experimental units.

The commercial compost organic material was composed of 1.0% de N; pH 6.0; 15% OC and 40% humidity. The compost was incorporated in the 0-0.40 m soil after one month. To determine oxadiazon residues, the soils of the experimental area were sampled in lateral lines parallel to the central area (1.00 m^2) of the plot, at different depths by means of PVC probes with a diameter of 0.10 m, totaling 512 soil samples.

The samples were dried in ambient air for seven days and sieved with a 2 mm mesh. They were then carried in the laboratory and packaged in plastic bags, where they remained frozen until analyzed.

Chromatographic determination of oxadiazon was performed at the Herbicide and Soil Laboratory at the Plant Technology Department of the Federal University of Viçosa, in

Viçosa, Minas Gerais State, Brazil. The herbicide was extracted from the soil samples using solid-liquid extraction with low temperature partitioning (SLE-LTP), in accordance with the methodology proposed by Vieira et al. (2007) and Goulart et al. (2008).

Data on concentrations of oxadiazon in soil o were subjected to analysis of variance using the F test ($p < 0.05$) and to regression by the non-linear log-logistic model proposed by Seefeldt et al. (1995): $\hat{y} = C_{min} + (C_{max} - C_{min}) / (1 + (x/t_{1/2})^{-Hillslope})$. The parameters C_{max} and C_{min} correspond to the maximum and minimum levels of the concentration of oxadiazon in the soil (mg kg^{-1}); Hillslope, to the slope of the curve around $t_{1/2}$; and dissipation $t_{1/2}$ corresponds to the time of the degradation half-life (days) of the oxadiazon in the soil, or in other words the time needed for 50% of the initially applied herbicide to dissipate in the soil.

RESULTS AND DISCUSSION

Chromatography revealed significant differences in oxadiazon residue quantification for the soil with organic material incorporated (49.0 g dm^{-3} of OM) and soil without (43.0 g dm^{-3} of OM), however, both curves were similar for all soil depths sampled (Figures 1 and 2).

In the most superficial layer (0.00-0.05 m), on the day of oxadiazon application, high concentrations of oxadiazon were verified (band at 1.4 mg kg^{-1} of soil) and dissipation $t_{1/2}$ of 56 and 51 days for oxadiazon in soil with and without organic material incorporated, respectively (Figure 1A). Rahman et al. (2005) found the dissipation $t_{1/2}$ of oxadiazon in soils with added organic fertilizer was 139 and the dissipation $t_{1/2}$ of soils without was 23 days, in soil with 33.2% clay, 1.0% OM and pH (H_2O) of 7.3, in Korea, indicating the importance of OM in oxadiazon dissipation.

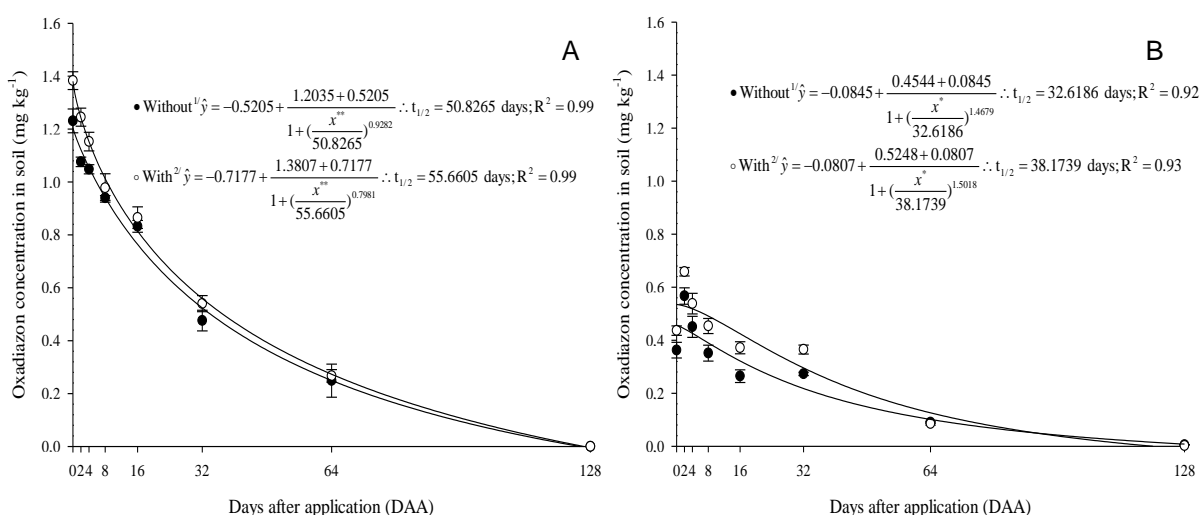


Figure 1. Oxadiazon concentrations in soil (mg kg^{-1}), at 0, 2, 4, 8, 16, 32, 64 and 128 days after application (DAA) of herbicide in Distroferric Red Latosol, at a depth of 0.00-0.05 m (A) and 0.05-0.10 m (B). ¹Without = Soil without organic material incorporated; ²With = Soil with organic material incorporated. The vertical bars associated with each symbol represent the standard deviation (\pm SD) of each mean value ($n = 4$). ** $p < 0.01$ by the F test.

Independent of the soil, at 16 DAA relatively high concentrations of oxadiazon are observed, at a level above 0.8 mg kg^{-1} . However, at 128 DAA oxadiazon was not detected in either soil (Figure 1A). Therefore, the total dissipation of the oxadiazon is relatively rapid, the same as in soil with increments of OM content, with minimal variation between the soils, such as 43.00 and 49.00 g dm^{-3} of OM. In the $0.05\text{-}0.10 \text{ m}$ layer, the residual effect of oxadiazon presented a dissipation $t_{1/2}$ of 38 days for soils with organic material incorporated and 33 days for soils without (Figure 1B). At 64 DAA, oxadiazon was not detected in either soil.

Das et al. (2003) reported that after applying 400 g ha^{-1} of oxadiazon to rice, 64% of oxadiazon was dissipated in the first 20 days after application (DAA), in soils with 5.84 g kg^{-1} of OM; pH 7.1 and 46.5% of clay. In this same experiment, oxadiazon remained for more than 60 DAA, at which time residues of 0.5% were detected by gas-liquid chromatography in the soils of the rhizosphere of rice, with a dissipation $t_{1/2}$ of 12 days.

The oxadiazon concentration in the $0.10\text{-}0.15 \text{ m}$ layer was slightly higher for the soil with organic material incorporated than in the soil without, with dissipation $t_{1/2}$ of 9 and 5 days, respectively (Figure 2A). At 8 and 16 DAA, residues of oxadiazon were not detected in the soils, either with or without organic material incorporated (Figure 2A).

This demonstrates a low amount of oxadiazon leaching into the deepest soil layers. At the $0.15\text{-}0.20 \text{ m}$ layer, the oxadiazon concentration was $\leq 0.35 \text{ mg kg}^{-1}$ at 0 DAA, regardless of the soil evaluated (Figure 2B). The dissipation $t_{1/2}$ remained short, at 9 days for soil with organic material incorporated, and 5 days for soil without. However, the behavior of the oxadiazon in the soil was similar at the $0.10\text{-}0.15 \text{ m}$ layer (Figure 2B).

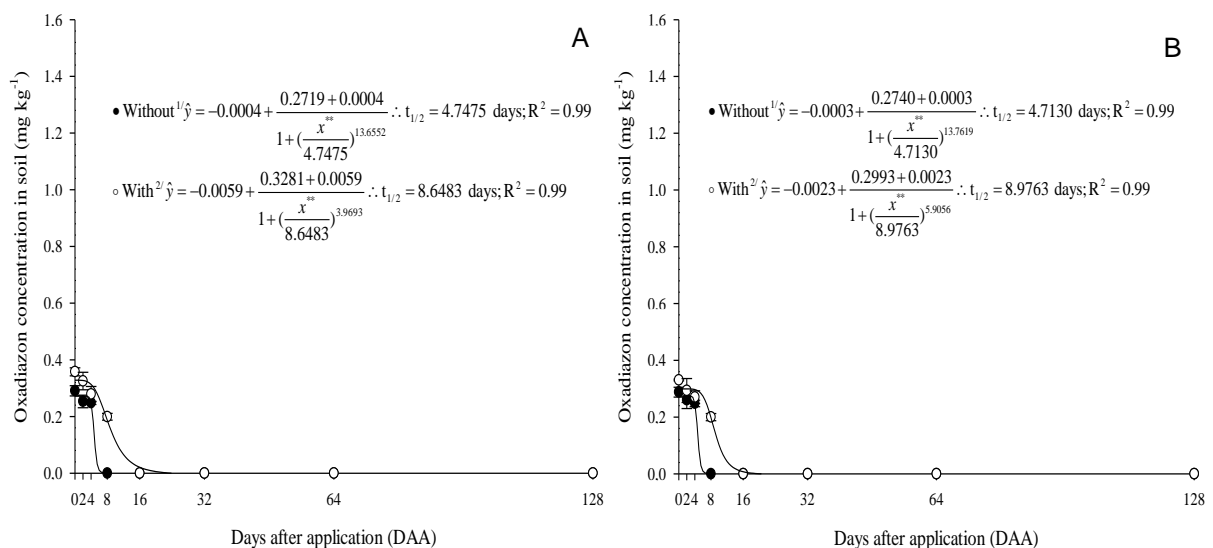


Figure 2. Oxadiazon concentrations in soil (mg kg^{-1}), at 0, 2, 4, 8, 16, 32, 64 and 128 days after application (DAA) of herbicide in Distroferric Red Latosol, at a depth of $0.10\text{-}0.15 \text{ m}$ (A) and $0.15\text{-}0.20 \text{ m}$ (B). ¹Without = Soil without organic material incorporated; ²With = Soil with organic material incorporated. The vertical bars associated with each symbol represent the standard deviation (\pm SD) of each mean value ($n = 4$). $**p < 0.01$ by the F test.

Niemczyk and Krause (1994) did not detect oxadiazon residues in the $0.225\text{-}0.250 \text{ m}$

layer with the presence of straw at the soil surface in 1988, but on two occasions in 1989, residues of 0.10 and 0.20 mg kg⁻¹ were found in this layer. This demonstrates the low mobility of oxadiazon, as also found in this work.

CONCLUSION

Oxadiazon was found in the upper layer of the soil (0.00-0.10 m) up to 64 days after application, but very low concentrations were found at other depths, demonstrating the low mobility potential of this herbicide. In soils with higher organic matter content, higher concentrations of oxadiazon were observed at different depths and evaluation periods.

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