175 - SORPTION AND LEACHING POTENTIAL OF ACIDIC HERBICIDES IN BRAZILIAN SOILS

Sorção e potencial de lixiviação de herbicidas ácidos em solos brasileiros.

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ABSTRACT: Leaching potentials of three acidic herbicides were assessed for three different Brazilian soils, by means of the multi-layered AFi model. Values of AFi were also calculated for each herbicide using a modified model (AFi*), where sorption coefficient (Kd) values are pH-dependent. The pH-dependent Kd values estimated for all three herbicides were always higher than pH-independent Kd values calculated using average Koc data. The pH-dependent Kd values for the three herbicides evidenced a large variation from layer to layer following changes in OC and pH for the different soil depths. When OC decreases, Kd tends to decrease; on the other hand, lowering pH tends to increase Kd. For all three soils, OC and pH exhibit an overall decrease with depth. Despite differences between the pH-independent Kd and the pH-dependent Kd values, the AFi values for 2,4-D, calculated by the original multi-layered-soil model and by the modified model (AFi*), were similarly low for all three soils, mostly due to the short half-life of 2,4-D. The pH-dependent AFi values for flumetsulam were always much lower than values calculated by the original multi-layered model. Therefore, the pH-independent model appears to overestimate leaching potential of flumetsulam. The AFi values for sulfentrazone calculated by the original and the modified models were similarly high for all three soils, despite the differences in Kd values. The long half-life of sulfentrazone mostly contributed to the similar high values of AFi for the three different soils. Overall AFi values showed large differences for sulfentrazone when calculated by the original and by the modified model (AFi*), owing to its high AF value for each layer. Thus, the original AFi model would seem to markedly overestimate the leaching potential for sulfentrazone, as well as for flumetsulam for these soil conditions.

Key Index Words: Multi-layered model, pH, 2,4-D, flumetsulam, sulfentrazone.

Palavras-chave: Modelo multi-camadas, pH , 2,4-D, flumetsulam, sulfentrazone.

INTRODUCTION

An understanding of herbicide sorption and transport processes in soil is essential to solve a number of problems facing agricultural and environmental scientists. The purpose of this study was to estimate sorption and to predict transport of acidic herbicides in soils, comparing the original and modified AF models for multi-layered soils (AFi).

MATERIALS AND METHODS

In this study, leaching potentials of three acidic herbicides, 2,4-D, flumetsulam, and sulfentrazone, were assessed for three different soils of the Ribeirão Preto region, State of São Paulo, Brazil. A total soil depth of 120 cm was considered, and the net recharge rate (50 cm/yr.) in the watershed was estimated as the difference between rainfall (150 cm/yr.) and evapotranspiration (100 cm/yr.), assuming steady flow in the soil zone considered. Leaching potentials of the herbicides were assessed for multi-layered soils by means of the AFi model (Rao *et al.*,1985; Hornsby & Rao, 1998). AF is defined as the fraction of the amount of herbicide applied at the soil surface that leaches through a given soil depth. Values of AFi were also calculated for each herbicide using a modified model (AFi*) and parameters estimated as presented previously by Spadotto & Hornsby (2003), where sorption coefficient (Kd) values are pH-dependent. Herbicide sorption coefficient (Kd) values were calculated from literature data of sorption coefficient normalized for soil organic carbon content (Koc), and also estimated for 2,4-D, flumetsulam, and sulfentrazone in different layers of each soil.

RESULTS AND DISCUSSION

The pH-dependent Kd values estimated for all three herbicides were always higher than pH-independent Kd values calculated using average Koc data. The Kd values, as expected, were the lowest for the sandy soil (Typic Quartzipsamment), and highest for the clayey soil (Typic Haplorthox). The sandy soil has the lowest organic carbon (OC) content, while the clayey soil has the highest OC content. It is worth noting that the pH-independent Kd values follow primarily the decrease of OC with depth. The pH-dependent Kd values for the three herbicides evidenced a large variation from layer to layer following changes in OC and pH for the different soil depths. That is, Kd depends on a combined effect of these two soil parameters. When OC decreases, Kd tends to decrease; on the other hand, lowering pH tends to increase Kd. For all three soils, OC and pH exhibit an overall decrease with depth. However, for the loamy soil (Quartzipsammentic Haplorthox) and clayey soil, OC contents do not vary largely below 60 cm; thus, decreases in pH result in increasing Kd values for 2,4-D and flumetsulam. For the sandy soil, OC content continues to decrease with depth below 60 cm, and 2,4-D and flumetsulam Kd values drop concurrently.

The pH effect on sulfentrazone sorption is shown to be very interesting. Because of its high pK_A value (6.6), sulfentrazone Kd reaches a "maximum" value at higher pH values when compared with 2,4-D and flumetsulam. Thus, sulfentrazone Kd values do not increase when pH drops below 60 cm in all three soils. The AFi, expressed as percentage of herbicide mass applied at soil surface, was calculated for each soil. Despite differences between the pH-independent Kd and the pH-dependent Kd values, the AFi values for 2,4-D, calculated by the original multi-layered-soil model and by the modified model (AFi*), were similarly low for all three soils, mostly due to the short half-life of 2,4-D. The pH-dependent AFi values for flumetsulam were always much lower than values calculated by the original multi-layered model. Therefore, the pH-independent model appears to overestimate leaching potential of flumetsulam. The AFi values for sulfentrazone calculated by the original and the modified models were similarly high for all three soils, despite the differences in Kd values. The long half-life of sulfentrazone mostly contributed to the similar high values of AFi for the three different soils.

Overall AFi values showed large differences for sulfentrazone when calculated by the original and by the modified model (AFi*), owing to its high AF value for each layer – Figure 1. Thus, the original AFi model would seem to markedly overestimate the leaching potential for sulfentrazone, as well as for flumetsulam for these soil conditions. The herbicide sorption effect on degradation rate was not considered in this study. Greater sorption might lead to somewhat longer persistence of the herbicides in soils.

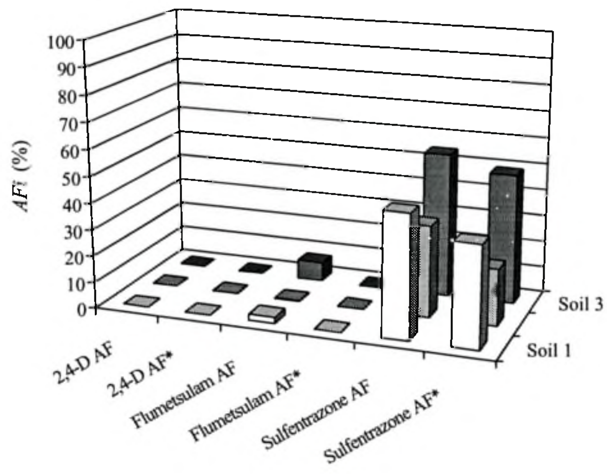

Figure 1. Overall pesticide Attenuation Factor values estimated by the original multi-layered model (*AFi*) and by the modified model (*AFi**) for Soil 1 (Quartzipsammentic Haplorthox), Soil 2 (Typic Haplorthox), and Soil 3 (Typic Quartzipsamment).

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