Effects of Soil Moisture and Landscape Position on the Maximum Rate of 2,4-D Mineralization

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Objective

To assess the impact of slope position and soil moisture on the fate of 2,4-D in the plough layer.

Background and Significance

2,4-D [2,4-(dichlorophenoxy) acetic acid] is one of the most widely used herbicides in Canada for the post-emergent control of broadleaf weeds in annual and forage crops. This herbicide has been found as a pollutant in non-target sources such as rainwater and potable water. Agricultural fields vary spatially with respect to physical, chemical, and agrometeorological conditions. The heterogeneity of soil properties in agricultural fields influences the behaviour of 2,4-D. An improved understanding of the spatial variability of soil properties that affect the fate of 2,4-D should enhance pesticide fate modeling, particularly for topographically complex landscapes.

Methodology

Soil was obtained from a topographically complex landscape near Deerwood, Manitoba (Figure 1). Three slope positions were sampled (upper, middle, and lower) at two depths (0-5 cm and 5-15 cm). Microcosm incubation experiments using radio-labeled (^{14}C) 2,4-D with four different soil moisture contents (50, 75, 100, 125% of field capacity) were used to assess the mineralization of 2,4-D over 90 days.

2,4-D molecule

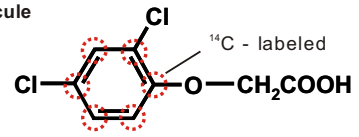


Figure 1: Topography, and sampling locations, Deerwood, Manitoba.

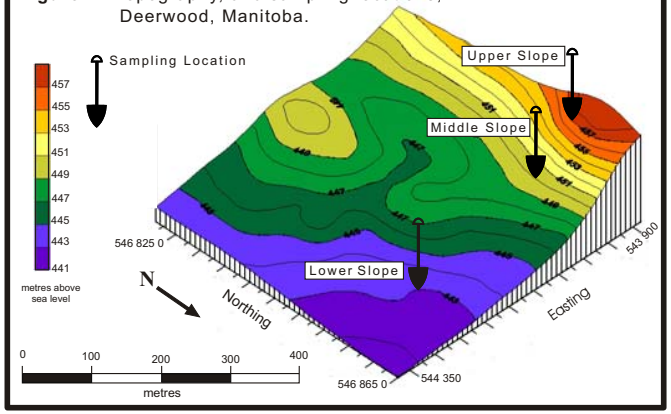


Figure 2: 2,4-D half-life at three slope positions, two sampling depths, and four soil moisture contents.

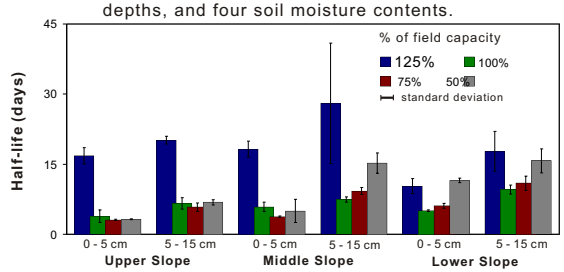
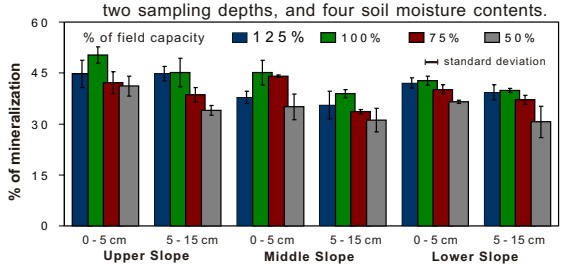


Figure 3: 2,4-D maximum total mineralization at three slope positions, two sampling depths, and four soil moisture contents.



Results and Discussion

On average, the 2,4-D half-life was consistently longer at 125% of field capacity than all other moisture treatments (Figure 2). Half-life varied from a maximum of 28 days at 125% of field capacity in the 5-15 cm layer of the mid-slope position to less than 5 days at 75% of field capacity in the 0-5 cm layer of the upper slope position at 90 days. Overall, half-life was longer in the 5-15 cm depth as compared to the 0-5 cm depth (Figure 2).

Total Mineralization at 90 days was consistently greater in soils at 100% of field capacity than all other moisture treatments (Figure 3). The maximum percent of mineralization varied from 50% in the upper slope at 100% of field capacity to 30% in the middle and lower slopes at 50% of field capacity. On average, the

Conclusions

This study demonstrated that there is a substantial variability in 2,4-D half-life and maximum 2,4-D mineralization within agricultural fields. Therefore, the 10 day half-life derived from literature and used in 2,4-D fate modeling is imprecise. Soil moisture is one of the most variable properties within topographically complex landscapes and necessitates further investigation as one of the factors that affect the persistence of 2,4-D in the soil environment. Precise information on the fate of 2,4-D is a critical component in maintaining environmental integrity within the Canadian agricultural ecosystem.

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