

Persistence of 2,4-dichlorophenol, 2,4,5-trichlorophenol, 2,3,7,8-tetrachlorodibenzo-p-dioxin, and 2,3,7,8-tetrachlorodibenzofuran in Soils of a Forest Ecosystem Treated With 2,4-D/2,4,5-T Herbicide in Eastern Canada.

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In 1989, soil samples were obtained from areas of cleared forest in New Brunswick, Canada where 2,4-D/2,4,5-T herbicide was applied in one or more application at 3 to 10 lbs/acre between 1956 and 1965. Soil samples were also taken for purpose of comparison in areas documented not to have been sprayed with herbicide. Samples of 2,4-D/2,4,5-T herbicide applied during the period were also analysed for active ingredient, chlorophenols, chlorinated dioxins, and chlorinated dibenzofurans.

Both 2,4-dichlorophenol and 2,4,5-trichlorophenol were detected in soils from sprayed areas at 0 to 2 inches depth, but not below. These phenols were not detected in soils from unsprayed areas. These phenols are the expected breakdown products of the herbicides mixture. Their presence suggests that they are relatively persistent in the environment when applied to this soil type.

Residues of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) were detected up to 20 pg/g in the upper 2 inches of soil. Residues were also found at greater depths at lower concentrations at one test site. 2,3,7,8-tetrachlorodibenzofuran was not found in soil samples from sprayed or unsprayed areas.

Residues of hepta and octachlorodibenzo-p-dioxin, heptachlorodibenzofuran, and octachlorodibenzofuran were found in the upper soil from both tested and comparison sites. This is a reflection of general atmospheric fallout in New Brunswick, which is neither heavily populated nor industrialized in the areas sampled.

This study indicates that chlorophenols and 2,3,7,8-TCDD derived from 2,4-D/2,4,5-T herbicide formulations are persistent in silty podzolic soils in the eastern Canadian forest environment, existing as residues for as long as 25 years after herbicide application. Degradation by ultraviolet light, bacteria and dilution by leaching are slow under these soil conditions.

If 2,3,7,8-TCDD is applied to the land surface, it is expected that it will remain at or near the surface due to its strong adherence to naturally occurring organic carbon in the soil. To examine vertical distribution of 2,3,7,8-TCDD in soil, Belli et al. (1980) investigated concentration versus depth data collected on three dates following an industrial accident at Seveso, Italy in 1976. The amount of 2,3,7,8-TCDD found in the top 15 cm was about 95 percent after 3 months, 88 percent after 12 months and 60 percent after 27 months. Yanders et al. (1989) reported that 12 years after spraying oil containing 2,3,7,8-TCDD on roads at Times Beach, Missouri, no dioxin was discovered deeper than about 20 cm. This is consistent with Belli's findings (of 17 cm after 12 months) because the Times Beach soil was covered with asphalt a year or so after application.

Di Domenico et al. (1990) modelled the temporal decrease in 2,3,7,8-TCDD concentration in soil at Seveso, based on 5.5 years of data. Their model predicted about 38 percent of the initial concentration will remain after 1 year, 28 percent after 5 years, 19 percent after 10 years and 6 percent after 25 years.

Yanders et al. (1989) analyzed preserved soil 12 years and 16 years after oil containing 2,3,7,8-TCDD was sprayed on roads in Times Beach, Missouri. They found essentially no decrease in concentration or change in contamination depth between these two dates.

2,3,7,8-TCDD decomposes by photolysis if exposed to sunlight. Mill (1985) reported a half-life of TCDD in water of 130 hours in winter, or 52 hours in summer. Decomposition by photolysis becomes less important if 2,3,7,8-TCDD is contained within soil because it is effectively isolated from light.

Further evidence of environmental persistence of TCDD includes the finding of 2,3,7,8-TCDD residues in small mammals trapped on the Elgin Air Force Base in Florida 15 years following the onset of an Agent Orange spray program. Levels of 2,3,7,8-TCDD in these organisms were similar to the mean levels found in soils from the area (Young et al., 1987). In mammals, 2,3,7,8-TCDD is absorbed through the gastrointestinal tract and through intact skin (cited in Geyer et al., 1986). Past studies have found 2,3,7,8-TCDD in small mammals which burrow in contaminated soil. Routes of animal exposure are ingestion of plant roots, contaminated insects, and other terrestrial invertebrates (Young et al., 1987); or ingestion of contaminated soil while grooming (Young et al., 1975; Cockerham and Young, 1983). Based on these findings, a study of small mammals was performed in conjunction with the soil investigation.

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