Movement and conversion of aldicarb and its oxidation products in potato fields

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Abstract

In Spring, the insecticide and nematicide aldicarb in the granular formulation Temik 10G (supplied by Union Carbide) was broadcast on three potato fields and incorporated by rotary cultivation. Ridges were formed by repeated runs with ridging implements. The soil was sampled in layers of 0.1 m up to 0.8 m depth three to four times during the growing season. Aldicarb itself was almost completely converted on a humic sand soil and two loam soils within one month. During the growing season, its sulphoxide and sulphone, which are toxic and are formed by oxidation, were retained mainly in the top 0.3 m of all three soils. Relatively high concentrations were measured only in the top 0.2 m, indicating limited redistribution by leaching.

Low to very low contents were found up to 0.8 m depth especially on one of the loam soils where the highest total rainfall was measured from May to October (328 mm). In a humic sand soil, leaching in the furrow was deeper than below the ridge. At the end of the growing season, the sulphoxide plus sulphone corresponded to a mass fraction of 5.7 to 6.7% of the dosage in the two loam soils and to 17% in the humic sand soil. These residues were mainly concentrated in the centre of the ridges.

Additional keywords: concentration patterns, soil types, rainfall, effect soil surface, residues.

Introduction

In recent years, there has been an increasing interest in non-volatile pesticides to control harmful nematodes in potato growing in the Netherlands. One of these pesticides is the oxime-carbamate aldicarb, 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime, which is applied as granules (Temik 10G) at planting time at a dose of active ingredient of 3 kg/ha. In soil, aldicarb is rapidly oxidized to its sulphoxide, which in turn is oxidized more slowly to aldicarb sulphone (Smelt et al., 1978a, b, c; Bromilow et al., 1980).

Aldicarb is assumed to act on nematodes mainly in the soil solution by interfering with locomotion and feeding of the hatched larvae, causing death by starvation or poisoning of part of the pupulation (Hague and Pain, 1970, 1973). The development of larvae in the roots may be further retarded or prevented by the substance or its oxidation products (Steele and Hodges, 1975; Steele, 1976). The nematicidal compounds should be present around the roots to protect them against nematodes. A thorough distribution of the nematicide in the rooting zone is essential.
Deep (15 cm) and homogeneous incorporation of the nematicide granules generally gave more reliable increases in yield and better inhibition of increase in cyst-nematodes than shallower incorporation (Moss et al., 1976) or band applications in the seed furrow (Whitehead et al., 1975). The desired depth of incorporation and equal distribution of the granules may be best obtained by rotary cultivation with L-bladed rotavators rather than with other implements (Bromilow and Lord, 1979, Whitehead et al., 1975, Smelt et al., 1976). However, deep incorporation by rotavators is costly and the seedbed may become too loose. On sandy soils, the risk for wind erosion may increase.

The redistribution and rate of conversion of a pesticide in soils in the field may be simulated with computer models. Comparisons between simulated concentration patterns and patterns measured in columns of fallow soil have given encouraging results for oxamyl (Leistra et al., 1980) and for aldicarb sulfoxide and sulphone (Bromilow and Leistra, 1980). The behaviour of aldicarb and its oxidation products in grassed soil columns in the field has been studied. (J. H. Smelt, C. J. Schut and M. Leistra, submitted). Computer simulations for that situation gave roughly the same picture for movement and conversion as the columns did (M. Leistra and J. H. Smelt, submitted).

The soil system in a ridged potato field is much more complex than in fallow or grassed soil columns. Tillage with ridging implements will drastically change the distribution of the broadcast granules. In such fields, infiltration of water after rain or sprinkler-irrigation may be uneven (Saffigna et al., 1976). This would induce deep leaching of the pesticide in some places, whereas little movement would occur elsewhere. The conversion rates of aldicarb and its oxidation products in a potato field could be different from those measured in studies with grassed soil columns and in incubation experiments under controlled conditions. These rates are relevant for assessment of the period with adequate nematicidal activity. They also govern the levels of the residues at the end of the growing season; these residues may be leached to the subsoil in the subsequent winter. This study was designed to trace possible complications in the movement and conversion of aldicarb and its oxidation products in ridged potato fields.

Materials and methods

Site of field trials and manner of application. In spring 1979, aldicarb was applied as Temik 10G granules on plots of 500 m² in potato fields on three fields in the Netherlands, near Westmaas (South Holland), Wierum (Friesland) and Vortum-Mullem (North Brabant). Soil characteristics of the top soil to 0.3 m depth and of layers down to 1 m depth are given in Table 1. The fields were fertilized as normal for seed potatoes (Wierum) and ware potatoes (the other fields).

The two loam soils were prepared by one tillage with a power take-off harrow (Lely Roterra). The humic sand soil near Vortum-Mullem was plowed a few days before treatment. The granules were broadcast over the plots with drills (2 or 3 m; 12.5 cm apart) with a studded-roller feed system. A round bar (diameter 4 cm) mounted under the feed mechanisms, spread the free-falling granules. At the time of application, there was very little wind, which promoted uniform distribution of granules. The drills were adjusted to release about 50 kg of Temik granules per