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Qualitative Evaluation of the Effect of a Soil Detoxicant on Aldicarb Persistence

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Aldicarb is a highly active systemic miticide, insecticide and nematicide. The active ingredient is 2-methyl-2- (methylthio) propionaldehyde 0- (methylcarbamoyl) oxime and the product trade name is TEMIK®. The most significant biological effect of aldicarb and its sulfoxide and sulfone metabolites is acute toxicity due to inhibition of acetylcholinesterase (Harvey 1975). In addition, aldicarb is extremely toxic to mammals, the oral LD_{50} to rats being about 1 mg/kg (Payne et al. 1966).

Persistence of pesticides in soils depends on their chemical and physical characteristics, soil properties, environmental factors, and microbial populations (Edwards 1966). The half-lives of aldicarb and its metabolites range from 4 to 8 weeks in agricultural soils (Andrawes et al. 1971; Anon 1983). Jones (1976) reported that aldicarb passes through various degradation processes without any known adverse effects on soil microorganisms. Spurr and Sousa (1974) found that mycorrhizal relationships appear to be largely unaffected by aldicarb.

The objective of this study was to evaluate the effectiveness of a commercially available soil detoxicant, OXYBAC™, against aldicarb. OXYBAC™ purportedly consists of a variety of dehydrated aerobic microorganisms that when applied to soil are capable of completely decomposing herbicides and insecticides within 2 weeks.

MATERIALS AND METHODS

Soils representing four series in Texas were utilized for the tests. The soils were: i) Lake Charles clay (Typic Palludert; fine montmorillonitic, thermic), ii) Houston Black clay (Udic Pallustert; fine montmorillonitic, thermic), iii) Wolfpen sandy loam (Arenic Paleudalf; loamy, siliceous, thermic) and, iv) Patilo fine sandy loam (Grossarenic Paleustalf; loamy, siliceous, thermic). The pH values were 6.3, 7.8, 6.2, and 6.3 respectively. The Patilo soil was adjusted to pH 7.5 by addition of calcium carbonate so that both acidic and alkaline soils of fine and coarse texture could be represented.

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Soil samples were air dried and ground to pass a sieve with 0.5 mm openings. Samples of 10 g dry soil were transferred into 15 x 150 mm test tubes and 2.0 ml of water was added to the clay soils and 1.5 ml to the sandy soils to obtain a tension of approximately 3 MPa. The total depth of the soil in the tubes was 5 cm. Each tube containing soil was considered an experimental unit.

Aldicarb powder (99% purity) was obtained from Union Carbide, Co., Inc., Research Triangle Park, North Carolina; and, reconstituted as a stock solution. The quantity of aldicarb added to soil samples was based on a commercial rate of 12 Kg/Ha of TEMIK® (0.6 Kg aldicarb/Ha). It was added to the 2.5 cm soil depth at a rate of 2.5 µg aldicarb per 10 g of dry soil. Some soil samples did not receive aldicarb and served as controls.

The soil detoxicant OXYBAC™, was obtained from BioBasics, Inc., Catoosa, Oklahoma and was prepared for soil application according to instructions on the label. It was rehydrated in warm water ($30^{o}C$) by continuous stirring for 1 hour using a magnetic stirrer. Treatments consisted of applying or not applying OXYBAC™ to aldicarb-treated soil. The concentration was 4.8 g OXYBAC™ per liter of water. Application rate was 3.6 µl per 10 g soil. It was added to the soil surface. Soils were then incubated in open containers at $23^{o}C$.

At each sampling time of 1, 2, and 3 weeks two experimental units (10 g soil) of OXYBAC™-treated, non-OXYBAC™-treated, and control soils were prepared for extraction. The contents of the tubes were poured into petri dishes and dried in a chemical fume hood at room temperature. The dry samples were then transferred to 150-ml Erlenmeyer flasks containing 20 ml of petroleum ether and 5 ml acetone. The flasks were shaken periodically and the solvent allowed to evaporate overnight. The soil samples were reconstituted with 15 ml of petroleum ether, shaken and passed through a Whatman No. 1 filter. The filtrate was collected and evaporated to a volume of 2.5 ml which corresponded to approximately 1 µg aldicarb per ml assuming total recovery of added aldicarb and that no decomposition occurred after addition to soil.

Bioassay was used for detecting presence of aldicarb because instrumentation was not available for chromatrographic assays. Bioassays utilized 7-day old flies (Musca domestica L.) contained in 25-ml vials. The strain is susceptible to insecticides and is designated as sbo (stubby wing, brown body, and ocra eye color) for the three mutations present. The internal surface of the vials was coated by adding 1 or 1.5 ml of the soil extract and rotating the vial on its side while the solution evaporated. After complete evaporation, five flies were carefully transferred to each vial. The cotton-plugged vials contained a small cotton square saturated with diluted honey as a food source for the flies. Effects of aldicarb on the flies were recorded after 24 hours of exposure. Effects of the soil extractant was determined from the non-aldicarb control samples. Results were expressed as percent mortality.

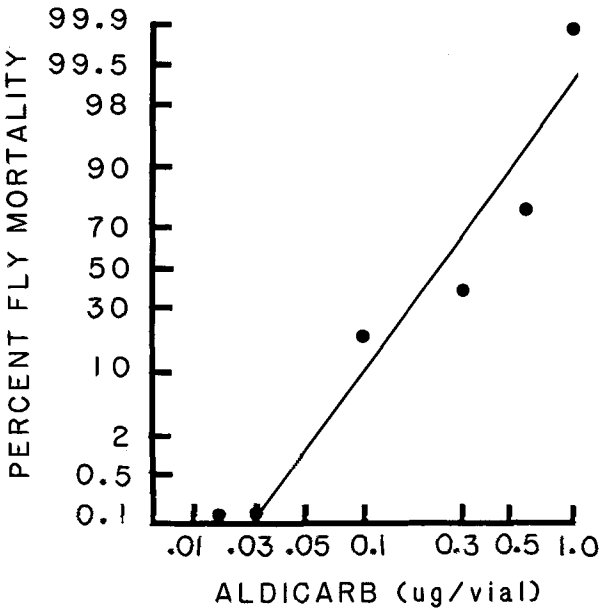

Figure 1. Calibration curve indicating the dose-response of flies exposed to aldicarb in glass vials. The plot is on a probit scale.

RESULTS AND DISCUSSION

A dose-response curve for susceptibility of flies to aldicarb was determined using standard solutions. Flies were susceptible to aldicarb at exposures of greater than 0.03 µg aldicarb per bioassay vial (Figure 1). The dose response curve using probit methods (Finney 1950) indicated a mean linear response in mortality of flies as the dose was increased to 1 µg per vial (Figure 1). Aldicarb added to soil and extracted immediately provided a similar relationship indicating complete extraction of aldicarb. The soil-extractant, after the drying procedure, did not reduce viability of the flies during the 24 hours of exposure.

The effect of OXYBAC™ on degradation of aldicarb was not apparent from bioassay when flies were exposed to 60% (1.5 ml) of the soil-extracted aldicarb. For all treatments the bioassays indicated 100% mortality of flies. Apparently, the dosage exceeded the 1 µg dosage of aldicarb required to kill all flies (Figure 1). Assuming no degradation of the 2.5 µg aldicarb added to the soils then 60% of this quantity would be 1.5 µg and exceeded the dosage required to kill all flies. Over the 3 week incubation period, OXYBAC™ did not degrade enough of the aldicarb

to lower the concentration from 1.5 µg to less than 1.0 µg. All flies exposed to only the dryed extractant from soil not treated with aldicarb survived.

Reduction in the quantity of the soil-extracted aldicarb, from 60% to 40%, exposed to the flies resulted in one fly surviving in some treatments (Table 1). OXYBAC™ increased degradation of aldicarb in the Houston Black since one of five flies survived in the bioassay for the 2- and 3-week incubation treatments. According to the standard curve (Figure 1) the quantity of aldicarb exposed

Table 1. Mortality of Musca domestica L. as affected by extracts from four soils that were amended with aldicarb and treated or not treated with OXYBAC™. Extractions were made immediately after treatments and again at 1, 2, and 3 weeks.†

Soil	pH	Aldicarb only Replicates I	Aldicarb only Replicates II	Aldicarb plus OXYBAC™ Replicates I	Aldicarb plus OXYBAC™ Replicates II
		% mortality of flies			
			0-week		
Houston Black	7.8	100	100	100	100
Lake Charles	6.3	100	100	100	100
Wolfpen	6.2	100	100	100	100
Patilo	7.5	100	100	100	100
			1-week		
Houston Black	7.8	100	100	100	100
Lake Charles	6.3	100	100	100	80
Wolfpen	6.2	100	100	100	100
Patilo	7.5	100	100	100	100
			2-week		
Houston Black	7.8	100	100	80	80
Lake Charles	6.3	100	100	100	100
Wolfpen	6.2	100	100	100	100
Patilo	7.5	100	100	100	100
			3-week		
Houston Black	7.8	100	100	80	80
Lake Charles	6.3	100	100	100	80
Wolfpen	6.2	100	100	100	100
Patilo	7.5	100	80	80	80

† The flies were exposed to 40% of the extracted aldicarb. When flies were exposed to 60% of the extracted aldicarb 100% mortality of flies occurred for all treatments.

to the flies would be approximately 0.5 µg. Since 40% of the aldicarb added to the soil was 1 µg it appears that OXYBAC™ increased degradation of aldicarb for this soil. However, aldicarb was still present in this soil at 3 weeks regardless of treatment with OXYBAC™.

The influence of OXYBAC™ in enhancing degradation of aldicarb in the other three soils was not as detectable as for the Houston Black (Table 1). For the Lake Charles clay only one of the replications at 1 week and one at 3 weeks indicated any degradation of aldicarb. For the Wolfpen soil no treatments indicated degradation, and for the Patilo soil the results are confounded somewhat because one replication of the 3-week incubation not receiving OXYBAC™ also indicated degradation of aldicarb (Table 1).

From this investigation it is apparent that OXYBAC™ was not able to completely degrade aldicarb in any of the soils in 3 weeks. Additional research is needed on the product if its efficacy is to be established. Effective products have potential use when soil is contaminated with pesticides, and their development is encouraged.

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