This Week's Citation Classic

Lichtenstein E P & Schulz K R. The effects of moisture and microorganisms on the persistence and metabolism of some organophosphorous insecticides in soils, with special emphasis on parathion. *J. Econ. Entomol.* 57:618-27, 1964.
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This paper stresses the importance of environmental conditions such as moisture and microorganisms on the metabolic fate of parathion in soil. The insecticide was least persistent in soils with a high moisture content, but was not lost through volatilization. Depending on populations of soil microorganisms, the insecticide was either hydrolyzed or reduced to aminoparathion. Bacteria had no effect on this reduction, but yeast did. Parathion persisted longest in soils of low microorganism activity. Para-oxon was hydrolyzed within 12 hours after its application to soil, while aminoparathion and ρ-nitrophenol disappeared within two and 16 days, respectively. [The *SCI*® indicates that this paper has been cited in over 110 publications since 1964, making it the 8th most-cited paper published in this journal.]

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"It was in November 1951 when a group of entomologists from the midwestern states met in Chicago and decided to establish a regional research project for the investigation of the environmental fate of pesticide chemicals *after* their use for agricultural pest control. I was hired in November 1953 to conduct this project, being headquartered at the University of Wisconsin in Madison. At that time, some of the major goals were the determination of the persistence properties or 'disappearance' of commonly used insecticides in and from soils as well as the potential contamination of crop and vegetable plants, which grew in these soils. The term 'half-life,' borrowed from radioactive decay processes, was then used widely in order to express the relative persistence or nonpersistence properties of a particular agricultural chemical. As time progressed, it became more evident that the degradation and detoxication of agricultural pest-control agents were functions of a variety of environmental factors, thus making it impossible to set an absolute 'half-life' for these chemicals.

"Our work during the 1950s showed rather rapidly that the 'persistence' or 'disappearance' of chlorinated hydrocarbon insecticides—used widely at that time—was dependent on factors such as soil types, temperature, and application rates[1] and that the enzymatic conversion of one insecticide to another, such as aldrin to dieldrin, was dependent on the presence of soil microorganisms[2] and soil temperature.[3] All this research was conducted during 1958-1960 and, compared to today's technology, was executed utilizing relatively nonsensitive analytical methods.

"Around 1961, when gas-liquid chromatography and more refined methods of thin-layer chromatography became available, it was felt that the time had come to further investigate the importance of soil microorganisms relative to the degradation of insecticides, in particular that of the widely used organophosphorus insecticide parathion. We also felt that this time (1962-1963) studies should address themselves to the formation and fate of as many potential parathion metabolites as possible. By utilizing at that time both gas-liquid chromatography and the colorimetric Averell-Norris method, it was possible to obtain a more complete picture as to what happened to the originally applied parathion. Results obtained and published in 1964 point to the importance of soil microorganisms, in this case primarily yeast, relative to the oxidative or reductive metabolism of the insecticide. All these data may also have had some effect on the use of the term 'biodegradable compounds.' Since soil microflora differs from one area to another, it is understandable why the fate of a particular pesticide is different under different environmental conditions. As a final remark I would like to quote a sentence from our 1964 publication stating that 'most of the applied aminoparathion had disappeared one day after soil treatment.' Experiments conducted in our laboratory over a decade later[4,5] with ^{14}C-parathion, however, indicate that aminoparathion had not 'disappeared from the soil,' but had become unextractable and, therefore, 'bound' to the soil.

"It appears to me that the 1964 paper has been highly cited because it emphasized the importance of environmental conditions, in particular the presence of microorganisms, that affect the metabolism and degradation of agricultural chemicals in soils. When, in 1970, the Entomological Society of America at their annual meeting honored me with the J.E. Bussart Memorial Award, it was stated, among other things, that I 'was the first to suggest the involvement of microorganisms in soils to alter the fate of insecticides.'"

1. **Lichtenstein E P & Schulz K R.** Persistence of some chlorinated hydrocarbon insecticides as influenced by soil types, rate of application and temperature. *J. Econ. Entomol.* 52:124-31, 1959.
2. --. Epoxidation of aldrin and heptachlor in soils as influenced by autoclaving, moisture and soil types. *J. Econ. Entomol.* 53:192-7, 1960.
3. --. Breakdown of lindane and aldrin in soils. *J. Econ. Entomol.* 52:118-24, 1959.
4. **Katan J, Fuhremann T W & Lichtenstein E P.** Binding of ^{14}C-parathion in soil: a reassessment of pesticide persistence. *Science* 193:891-4, 1976.
5. **Lichtenstein E P, Katan J & Anderegg B N.** Binding of "persistent" and "nonpersistent" ^{14}C-labeled insecticides in an agricultural soil. *J. Agr. Food Chem.* 25:43-7, 1977.