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INFLUENCE OF ENDRIN ON SOIL MICROBIAL POPULATIONS AND THEIR ACTIVITY

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W. B. BOLLEN
C. M. TU

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE
PORTLAND, OREGON

W. B. Bollen is Principal Microbiologist, Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oreg.

At the time of this study, C. M. Tu was Graduate Assistant, Department of Microbiology, Oregon State University, Corvallis, Oreg. His present address is Research Institute, Canada Department of Agriculture, London, Ontario.

Keywords: Endrin, soil microbiology, pesticides, aerial tree seeding.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife --if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

SUMMARY

Endrin applied to soil at rates of more than three times the maximum that might be expected from application of endrin-treated tree seed exerted no appreciable effect on numbers of soil microbes or on ammonification, nitrification, or sulfur oxidation. The decomposition of soil organic matter, as indicated by the production of CO_2, was increased significantly in the presence of endrin.

Results of our study agree substantially with other studies, indicating that a very high rate of endrin in soil would be necessary to alter microbial properties. We conclude that the relatively insignificant amount of endrin formulation applied to forest soil from coated tree seed is unlikely to damage soil microbes and their activities.

INTRODUCTION

Endrin[1/] is used in the Douglas-fir region of the Pacific Northwest to protect aerially or hand sown forest tree seeds against rodents. Common practice is to apply 0.5 to 1 pound (about 20,000 seeds) of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) per acre or approximately one seed per 2 to 4 square feet. The seed is coated with endrin at rates of 0.5 to 1 percent of seed weight (Radwan, Crouch, and Ellis 1970). At this rate, 1 to 4 grams of endrin are applied per acre.

Small amounts of endrin may move from the seedcoat onto the soil, but the amount of chemical thus introduced into the forest environment is very small. If all of the endrin from one seedcoat entered 1 cubic inch of soil immediately beneath the seed, an endrin concentration of 3 to 6 parts per million (p.p.m.) would result. Such spots of contamination would be scattered, however, because an average of only one seed falls per 1 or 2 square feet of soil surface. Impregnating seed with endrin (Radwan, Crouch, and Ellis 1970), rather than coating it as is now done, should further reduce the amount of endrin that could reach the soil.

We have the obligation to determine the effect of any introduced chemical on the forest environment (Tarrant 1967). One important potential of introduced chemicals is the effect of such materials on soil micro-organisms and on their role in maintaining soil fertility.

MATERIALS AND METHODS

The objective of this study was to determine the effect of endrin on soil microbial populations, decomposition of native organic matter, transformation of native soil nitrogen, ammonification of peptone, nitrification of ammonium sulfate, and oxidation of flour sulfur. Endrin, 19.7 percent active ingredient, was applied to samples of three Willamette Valley soils at rates of 0, 1, and 10 p.p.m. active ingredient. Chemical, physical, and microbial characteristics of the three soils and details of methods used in the present study have been previously described (Tu and Bollen 1968).

[1/] 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonapthalene. In the study reported herein, a Shell Chemical Company emulsion containing 19.7 percent active ingredient was used. (Mention of companies or products by name does not constitute an endorsement by U.S. Department of Agriculture.)

RESULTS AND DISCUSSION

Soil Microbial Populations and Their Activity

We found no significant differences in populations of bacteria, *Streptomyces*, molds, or *Penicillia* 30 days after endrin was added to soil (table 1). These findings are similar to those of Martin et al. (1959) that endrin in concentrations up to about 1,000 p.p.m. did not affect soil micro-organisms.

This lack of effect of endrin on soil microbial plate counts is in contrast to the highly significant increase in decomposition of soil organic matter as indicated by CO_2 production (table 1). Such an increase could be the result of a stimulation of microbes unable to develop on plating media and could also be an expression of Heuppe's principle that toxic substances below an inhibitory level may act as a stimulant (Clifton 1950, p. 274-276). Although the CO_2 increase was statistically significant, the small amounts involved make it of little practical importance except to reinforce findings that microbial populations were little affected by endrin.

The amounts of endrin applied, even at the highest rate of 10 p.p.m., were so low that neither the endrin itself nor the inactive ingredients of the formulation could have directly contributed significantly to the increased CO_2 production which could have come from the traces of carbon introduced in the chemical formulation. Korte (1966) showed that some soil microbes can attack and degrade endrin, probably in several stages. However, microbial metabolism of many pesticides and other exotic substances in nature may not provide a source of energy nor elements necessary for growth; this phenomenon is termed cometabolism (Alexander 1967, p. 331-342).

Table 1.--*Effect of endrin on populations of soil microbes and decomposition of soil organic matter*[1/]

Variable	Endrin (p.p.m.)		
	0	1	10
Total bacteria (millions/gm. of soil)	126	142	168
Streptomyces (percent of total bacteria)	58	71	65
Total molds (thousands/gm. of soil)	148	109	130
Penicillia (percent of total molds)	51	50	52
Decomposition of soil organic matter--carbon evolved as CO_2 (mg./80 g. soil/30 days)	<u>13</u>	<u>15</u>	<u>17</u>

Note: p.p.m. = parts per million.

[1/] Data are averages of duplicate determinations for each of the 3 soils incubated at 28° C., with water content near field capacity, for 30 days. Values underlined are significantly different from one another at the 1-percent level of probability.

Transformation of Soil Nitrogen in the Presence of Endrin

None of the differences between untreated soils and those to which endrin was added were significant in terms of ammonification or nitrification of soil nitrogen (table 2). Similar findings were reported by Martin et al. (1959) and Jones (1956).

The interaction between soils and treatments was highly significant, both for soil ammonium and nitrate. This means only that the three soils reacted to treatments somewhat differently in magnitude of response.

Findings from this portion of the study support results of the microbial investigations and indicate further that the presence of endrin at rates up to 10 p.p.m. had no deleterious effect on the function and activity of soil micro-organisms.

Table 2.--*Effect of endrin on the transformation of native soil nitrogen*[1/]

Endrin treatment (parts per million)	NH_4^+-N	NO_2^--N	NO_3^--N
	Parts per million		
0	66.67	0.40	23.00
1	95.83	.60	18.50
10	75.83	.62	20.17

1/ Data are averages of duplicate determinations for each of the 3 soils incubated at 28° C., with water content near field capacity, for 30 days. No differences between levels of endrin were significant at the 5-percent level of probability.

Transformation of Peptone, Ammonium Sulfate, and Sulfur in the Presence of Endrin

None of the differences between endrin treatments were significant in the case of soils to which peptone, ammonium sulfate, or flour sulfur were added (table 3). These data further confirm the lack of effect of endrin on soil microbial populations and their activity seen in other portions of this study. They also give added support to the findings of Jones (1956) that endrin, along with several other chlorinated hydrocarbon insecticides, is not toxic to ammonification below a rate of 1,000 p.p.m. nor to nitrification below a rate of 100 p.p.m.

Table 3.--*Effect of endrin on the transformation of peptone, ammonium sulfate, and flour sulfur*[1/]

Soil treatment	Data expressed as	Endrin (p.p.m.)		
		0	1	10
		- - *Parts per million* - -		
Soil + peptone at 1,000 p.p.m. N	NH_4^+-N	692	755	767
Soil + ammonium sulfate at 200 p.p.m. N	NO_3^--N	60	56	44
Soil + flour sulfur at 1,000 p.p.m. S	SO_4^{-2}-S	278	288	328

Note: p.p.m. = parts per million.

[1/] Data are averages of duplicate determinations for each of the 3 soils incubated at 28° C., with water content near field capacity. Incubation periods were 5 days for soil plus peptone and 30 days for soil plus ammonium sulfate and soil plus flour sulfur. No differences between levels of endrin were significant at the 5-percent level of probability.

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