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TOXICITY OF AEROSOLS TO LARCH CASEBEARER LARVAE

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ABSTRACT: Six insecticides were tested in the laboratory as aerosols against larch casebearer larvae. Their toxicity was determined by both direct contact and residual contact on filter paper. All six were highly toxic at less than 1.05 μg/ cm^2 (the equivalent of 1.5 oz./acre). In decreasing order of toxicity at LD_{90} (direct contact) the insecticides tested were: Zectran, malathion, Sumithion (0.24 - .26 oz./acre), pyrethrins, Matacil (0.45 - .50 oz./acre), and Gardona (1.4 oz./acre). For field trial of the three most toxic materials, a dosage of 2 oz./acre is suggested.
OXFORD: 145.7 X 18.13 *Coleophora laricella:* 453–414.12.
RETRIEVAL TERMS: Coleophora laricella; insecticides; aerosols; Zectran; malathion; Sumithion; Matacil; Gardona; toxicity tests.

The larch casebearer *(Coleophora laricella* (Hübner)*)* was discovered in Idaho in 1957, and by 1966 it had spread through three fourths of the western larch type in Washington, Idaho, and Montana.[1,2] Some tree mortality has occurred after 10 years of defoliation in Idaho, although a complex of insects may be involved.[3]

Denton and Tunnock[2] have summarized field tests of insecticides for control of the larch casebearer in the West and have reported on a successful test of low-volume technical malathion at 0.6 lb. actual/acre. No laboratory research on insecticides against this insect has been reported.

Six insecticides were given a preliminary examination in the laboratory. Our aim was to find candidate insecticides as toxic as or more toxic than malathion to larch casebearer larvae.

METHODS

Insects

Overwintering 2nd and 3rd instar larch casebearer larvae were flown by air express from Idaho[4] on western larch twigs. They were held in cold storage at 42°F. for a maximum of 33 days until needed for testing. This length of storage showed no effect on the natural mortality in samples of untreated, control insects. Infested larch twigs were brought out of cold storage the day before testing. They were placed in 1/2-gallon cylindrical food cartons at 73° to 79°F. and 33- to 52-percent R.H. and given a 24-hour photoperiod (18-hours high intensity light and 6-hours low intensity light). A 6-ounce, clear, plastic container was attached to the cover to let in light and induce the photopositive larvae to migrate to the container. By the next day essentially all of the larvae became active and could be easily collected with a camel's hair brush and transferred to 100- by 20-mm. plastic, disposable petri dishes (10 larvae/dish) for testing.

Insecticide Formulation

A search for a suitable insecticide carrier led to the selection of a mixture of Superior Spray Oil 7N[5] and tripropylene glycol monomethylether in the ratio 9/1 (v/v). Many solvents[6] tested were of themselves moderately to highly toxic, i.e., 40 to 100 percent mortalities at a dosage of 2.9 pints/acre. The chosen carrier system caused 8.9 percent mortality compared to 8.6 percent for the untreated control insects. Insecticide solutions were formulated anew on each day of use.

Bioassay Procedure

Larvae in their cases were treated in groups of 10, with an aerosol having a maximum droplet size of 50μ and a 20 μ MMD. The method of Lyon *et al.*[7] was used with the exception that the spray liquid was atomized with an unmodified No. 40 DeVilbiss nebulizer. A constant spray volume equivalent to 2.9 pints/acre (measured as a deposit) was used throughout the tests.

The aerosols were assessed by two different methods: (1) *direct plus residual action*—the larvae were placed on filter paper in a 100- by 20-mm. plastic petri dish and sprayed, then held for post-treatment observation on this treated filter paper in a closed petri dish; and (2) *direct contact action only*—the larvae were sprayed then transferred to a clean untreated filter paper in a petri dish. In both methods the insects were held without feeding at 70° to 78°F. and 31- to 50-percent R.H. for 24 hours before mortality observations were made. Method (1) was designed to provide some notion of the potential residual action of the candidate insecticides. Method (2) was designed to show the toxicity of that part of the aerosol that impinged directly on the insect.

RESULTS AND DISCUSSION

The mortality response to different dosage rates *(table 1)* was plotted on log-probability paper and regression curves were fitted by eye. In fitting regression lines to the data in method (2) (direct contact only), parallelism with data in method (1) was assumed. This was necessary because of the limited number of points on some of the curves from method (2). LD_{90} (dosage that caused 90 percent mortality) values taken from the regression curves showed that the aerosols of all the candidate insecticides were extremely toxic to larch casebearer larvae *(table 2)*. By direct contact only (method [2]), 90 percent mortality was obtained with less than 1.5 oz./acre for Gardona, about 0.5 oz./acre for

Table 1—*Response of 2nd and 3rd instar larch casebearer larvae to aerosols of six insecticides*

Insecticide	Insects	Mortality[1] at dosage of (oz./acre actual): .0096	.024	.048	.096	.24	.48	.96
	No.	*Percent*						
		METHOD 1: DIRECT PLUS RESIDUAL CONTACT[2]						
Sumithion	180	9	26	97	100	100	100	–
Zectran	300	–	25	78	98	100	100	–
Pyrethrins	281	1	18	74	74	93	100	–
Malathion	294	–	–	37	72	93	100	100
Matacil	150	12	34	12	75	89	–	–
Gardona	120	–	–	9	4	45	89	–
		METHOD 2: DIRECT CONTACT ONLY[3]						
Zectran	90	–	–	23	48	92	–	–
Malathion	49	–	–	–	–	89	–	–
Sumithion	120	–	4	12	34	89	–	–
Pyrethrins	110	–	–	23	–	45	89	–
Matacil	59	–	–	–	–	77	86	–
Gardona	60	–	–	–	–	–	45	78

[1]Corrected by Abbott's formula.

[2]Larvae placed on filter paper in petri dish, sprayed, and observed in closed dish.

[3]Larvae sprayed, transferred to clean untreated filter paper in petri dish.

Table 2—LD_{90} *values from eye-fitted regression curves for aerosol applications of six insecticides to larch casebearer larvae*

Insecticide	LD_{90} in ounces actual/acre		Increase in toxicity due to residual action[3]
	Direct contact only[1]	Direct and residual contact[2]	
	Ounces		
Zectran	0.24	0.064	3.8X
Malathion	.25	.190	1.3X
Sumithion	.26	.048	5.4X
Pyrethrins	.45	.130	3.5X
Matacil	.50	.190	2.6X
Gardona	1.40	.600	2.3X

[1]See footnote 3 table 1.
[2]See footnote 2 table 1.
[3] $\frac{LD_{90}\text{Contact Only}}{LD_{90}\text{Contact and Residual}}$ = Increase due to residual action.

pyrethrins and Matacil, and about 0.25 oz./acre for Zectran, malathion and Sumithion. (All oz./acre dosage figures were calculated by weighing the aerosol deposited in the aerosol chamber in $\mu g/cm^2$. Dosage of actual insecticide in $\mu g/cm^2$ was translated to its equivalent in oz./acre by the simple formula: $\mu g/cm^2 \div 0.7 = $ oz./acre.).

Residual toxicity on filter paper (method [1]) was appreciable with all but malathion *(see table 2)*, and 90 percent mortalities were obtained at 0.6 oz./acre for Gardona, 0.1-0.2 oz./acre for pyrethrins, malathion, and Matacil, and about 0.05 oz./acre for Sumithion and Zectran.

Because these data were obtained in the laboratory, there is no assurance that they accurately foretell the relative or absolute effectiveness of aerosols of the various candidates in the field. Actual field tests against the target insect would be needed. A suitable field test dosage can be estimated on the basis of the laboratory findings. Assuming no residual action, to be on the conservative side, it took about 0.25 oz./acre for the most toxic insecticides—Zectran, malathion, and Sumithion—to produce 90 percent mortality. This was the amount deposited in the spray chamber. But in past field work, the amount of spray actually deposited in the field was usually 25 percent to 75 percent of the total released from the airplane. Therefore, our laboratory deposit data multiplied by 4 would yield a conservative estimate of the application rate/acre needed, or about 1 oz./acre for Zectran, malathion, and Sumithion. Because of the "ideal" controlled conditions in spray chamber tests, we believe that doubling this laboratory-based estimate may more closely predict the adequate field dosage. This would then bring our estimate to 2 oz./acre for Zectran, malathion, and Sumithion. Therefore, the rule-of-thumb suggested here to translate the laboratory dosage (measured as deposit/unit area) to the field is to multiply by a factor of 8.

The prospect of using pyrethrins successfully in field applications has recently improved because of the development of a stabilized formulation which protects pyrethrins for several hours against photo-degradation.[8]

Notes

[1]Denton, R. E. *The larch casebearer in Idaho—a new defoliator record for western forests.* U.S. Forest Serv. Int. Forest & Range Exp. Sta. Res. Note 51, 6 p. 1958.

[2]Denton, R. E., and Tunnock, S. *Low-volume application of malathion by helicopter for controlling larch casebearer.* J. Econ. Entomol. 61(2): 582-583. 1968.

[3]Honing, F. W.; Tunnock, S.; and McGregor, M. D. In *Forest insect conditions in the United States 1967.* Forest Serv., U.S. Dep. Agr. p. 17. 1968.

[4]Supplied by F. W. Honing, Division of State and Private Forestry, Forest Service, U.S. Dep. Agr., Missoula, Montana.

[5]Courtesy of Sun Oil Co., 1600 Walnut Street, Philadelphia, Pa. Trade names and commercial products or enterprises are mentioned solely for necessary information. No endorsement by the U.S. Department of Agriculture is implied.

[6]Including deodorized kerosene, diesel oil, cyclohexanone, Isopar M, and several glycol ethers.

[7]Lyon, Robert L.; Page, Marion; and Brown, Sylvia J. *Tolerance of spruce budworm to malathion. . . .Montana, New Mexico populations show no differences.* U.S.D.A. Forest Serv. Res. Note PSW-173, Pacific SW. Forest & Range Exp. Sta., Berkeley, Calif. 6 p. 1968.

[8]Miskus, R. P., and Andrews, T. L. *Stabilization of pyrethrins.* Patent pending. 1969.

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