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# CONTACT TOXICITY OF 40 INSECTICIDES TESTED ON PANDORA MOTH LARVAE

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*ABSTRACT:* Forty insecticides and an antifeeding compound were tested on pandora moth larvae (*Coloradia pandora* Blake) in the second and third instars. A total of 21 insecticides were more toxic at $LD_{90}$ than DDT, providing a good choice of candidates for field testing. Ten exceeded DDT in toxicity tenfold or more. These were, in descending order of toxicity at $LD_{90}$: pyrethrins, tetramethrin, Zectran MA (a degradation product of Zectran), Dursban, N-4543, allethrin, aminocarb, B-10119, Zectran, and dichlorvos. Pyrethrins, more toxic by an order of magnitude than the second place candidate, appear to be especially promising.

*OXFORD:* 145.7 X 18.52:414.12–014.4.
*RETRIEVAL TERMS:* *Coloradia pandora:* insecticides; toxicity tests; pyrethrins; pyrethroids.

The pandora moth (*Coloradia pandora* Blake)[1] defoliates principally ponderosa (*Pinus ponderosa* Laws.), Jeffrey (*P. jeffreyi* Grev. and Balf.), and lodgepole (*P. contorta* Dougl.) pines in the Western United States. Damage is periodically severe. Defoliation by this insect can kill a tree directly, or indirectly as a result of subsequent attacks by bark beetles.[2] To date, no insecticide has been developed for control of the pandora moth, and no laboratory research on this subject has been reported in the literature.

As part of an investigation in evaluating chemicals for control of forest insects, 40 insecticides and an antifeeding compound were tested in the laboratory on pandora moth larvae in the second and third instars. Pyrethrins were the most toxic. This insecticide showed promise as an especially good candidate for field testing.

## METHODS

### Test Insects

Pandora moth larvae overwinter on their host tree at the base of the needles mostly as second and third instars. Hibernating larvae were collected during winter near Chemult, Oregon.[3] They were transported to the laboratory on ponderosa pine foliage in pint-size paper food cartons and stored at 5°C until ready for use.

The larvae were removed from cold-storage and transferred to fresh ponderosa pine foliage when needed for testing. They were maintained at room temperature for at least 1 day before being used in the insecticide studies. The larvae became active and began feeding on the pine foliage soon after being removed from cold storage. The test insects averaged 52 mg in weight, with a range from 37 to 62 mg.

### Insecticides

The 40 insecticides to be tested were formulated in acetone. Concentration was based on the active principle where this was known. Stock formulations and serial dilutions were refrigerated. All formulations more than 3 days old were discarded. The antifeeding compound 24,055 was tested as a water formulation applied to ponderosa pine foliage by dipping.

The chemical names of most of the test compounds may be found in *Pesticide Index*.[4] Chemical names of eight compounds not found in the *Pesticide Index* are as follows:

B-10119; O-isopropyl S-p-tolyl (chloromethyl) phosphonodithioate.

N-3794; O-methyl S-phenyl ethylphosphonodithioate.

N-4328; O-methyl S-p-tolyl ethylphosphonodithioate.

N-4330; S-p-tert-butylphenyl O-methyl ethylphosphonodithioate.

N-4988; S-4-chloro-m-tolyl O-methyl ethylphosphonodithioate.

Ortho 5655; 5-sec-butyl-2-chlorophenyl methylcarbamate.

Zectran MA; a degradation product of Zectran; 4-methylamino-3,5-xylyl methylcarbamate.

Zectran MF; a degradation product of Zectran: 4-methylformamido-3,5-xylyl methylcarbamate.

### Testing Procedure

Second and third instar larvae were treated by topical application in groups of 10. Each concentration was replicated usually three to six times. One microliter of solution was applied to each insect on the tergum of the thorax by using an ISCO Model M microapplicator fitted with a ¼-ml tuberculin syringe and 27-gauge hypodermic needle.

The treated insects were held in groups of 10 in 8-oz covered paper cups with ponderosa pine foliage. Dead and moribund insects were tallied 24 hours after treatment. Fifty and 90 percent mortality levels were computed by probit analysis.[5]

The antifeeding compound 24,055 was tested by dipping ponderosa pine foliage in a series of dilutions from 0.01 to 10 mg/ml and caging pandora moth larvae on the foliage after allowing the deposits to dry 1 hour. The treated foliage was inserted through the bottom of a pint-size cylindrical food carton into a vial of water. The top of the carton was covered with fine mesh cloth. The frass produced by the larvae was collected and weighed. The amount was used to estimate the amount of feeding by the larvae and, in conjunction with mortality, it showed the antifeeding influence of compound 24,055.

## RESULTS

Pyrethrins were by far the most toxic of the insecticides tested *(table 1)*. The toxicity index (times more toxic than DDT) of pyrethrins was 288 at $LD_{90}$. The next most toxic compound, a pyrethroid, was tetramethrin, with a toxicity index of 28. Another pyrethroid, allethrin, had a toxicity index of 12. Twenty-one candidates showed higher mortality at $LD_{90}$ than DDT, and 10 of these were at least 10 times more toxic. The 10 in decreasing order of toxicity at $LD_{90}$ were: Pyrethrins, tetramethrin, Zectran MA, Dursban, N-4543, allethrin, aminocarb, B-10119, Zectran, and dichlorvos.

Ten compounds were non-toxic at the highest dose tested, 100 $\mu$g/g body weight. The compounds with sample size were:

| | | | |
|---|---|---|---|
| Carbanolate | 60 | Mobam | 110 |
| Carbaryl | 70 | N-4330 | 50 |
| Crufomate | 30 | Gardona | 80 |
| Dimetilan | 60 | Thanite | 60 |
| Mesurol | 30 | Zectran MF | 70 |

One of the degradation products of Zectran, Zectran MA, was more than twice as toxic as Zectran itself. Abdel-wahab *et al.*[6] have identified the degradation products of Zectran in the bean plant and Roberts *et al.*[7] have identified them in three species of insects.

The antifeeding compound 24,055 was generally not effective in preventing feeding *(table 2)*. Some antifeeding effect was shown at a concentration of 1 mg/ml. But at the next concentration of 10 mg/ml almost all the reduced feeding activity was due to mortality. Since the margin between an antifeeding effect and insecticidal effect is narrow on pandora moth, the compound seems to offer little promise as an antifeeding agent against this insect.

Several insecticides showed enough toxicity to be good candidates for field testing. The exceptional toxicity of pyrethrins makes them an especially promising candidate for field testing. A stabilized formulation[8] has recently been developed, which may give pyrethrins enough protection against photo-oxidation to make their use in forest spraying feasible. Some promise has already been shown by stabilized pyrethrins against the western hemlock looper *(Lambdina fiscellaria lugubrosa* [Hulst] *)*.[9]

Table 1–*Contact toxicity of 40 insecticides to pandora moth larvae in second and third instars*[1]

| Insecticide | Insects tested | Dosage needed for . . . | | Toxicity index at $LD_{90}$[2] |
|---|---|---|---|---|
| | | $LD_{50}$ | $LD_{90}$ | |
| | *No.* | ——— μg/g body weight ——— | | |
| Pyrethrins | 718 | 0.34 | 0.68 | 288 |
| Tetramethrin | 180 | 1.9 | 6.9 | 28 |
| Zectran MA | 150 | 3.6 | 8.6 | 23 |
| Dursban | 180 | 5.7 | 13 | 15 |
| N-4543 | 90 | 4.8 | 15 | 13 |
| Allethrin | 159 | 7.3 | 16 | 12 |
| Aminocarb | 120 | 11 | 16 | 12 |
| B-10119 | 70 | 12 | 18 | 11 |
| Zectran | 380 | 8.3 | 19 | 10 |
| Dichlorvos | 145 | 9.4 | 19 | 10 |
| Naled | 330 | 8.6 | 21 | 9.3 |
| GS-13005 | 238 | 15 | 22 | 8.9 |
| Trichlorfon | 210 | 12 | 26 | 7.5 |
| N-4988 | 100 | 12 | 33 | 5.9 |
| Phosphamidon | 140 | 64 | 85 | 2.3 |
| Imidan | 138 | 28 | 107 | 1.8 |
| N-4328 | 120 | 54 | 110 | 1.8 |
| N-3794 | 120 | 43 | 142 | 1.4 |
| Dimethoate | 120 | 100 | 155 | 1.3 |
| Dimethrin | 130 | 73 | 163 | 1.2 |
| Propoxur | 130 | 86 | 176 | 1.1 |
| p,p'-DDT | 220 | 63 | 196 | 1.0 |
| Ortho 5655 | 130 | 21 | 199 | .98 |
| Bux | 90 | 132 | 253 | .77 |
| Sumithion | 312 | 35 | 332 | .59 |
| Diazinon | 160 | 38 | 398 | .49 |
| Malathion | 218 | 193 | 496 | .40 |
| TDE | 150 | 92 | 676 | .29 |
| Bromophos | 310 | 127 | 726 | .27 |
| Ronnel | 180 | 305 | 1575 | .12 |

[1]Natural mortality in the controls was 0.4 percent (5 of 1320 acetone-treated insects died).

[2]Toxicity relative to the standard DDT: $LD_{90}$ DDT/$LD_{90}$ candidate = toxicity index.

Table 2–*Mortality and feeding inhibition of pandora moth larvae in second and third instars caused by antifeeding compound 24,055*[1]

| Concentration (mg/ml) | Insects | Dead and moribund | Frass produced | Feeding inhibition[2] |
|---|---|---|---|---|
| | *No.* | *Percent* | *Milligrams* | *Percent* |
| 0.0 | 30 | 0 | 410 | – |
| .01 | 30 | 0 | 466 | 0 |
| .1 | 30 | 0 | 593 | 0 |
| 1 | 30 | 13 | 138 | 66 |
| 10 | 30 | 78 | 83 | 80 |

[1]72-hour holding time.

[2] $\left[1-\frac{\text{Frass produced by treatment}}{\text{Frass produced by control}}\right] \times 100.$

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## NOTES

[1] *Lepidoptera: Saturniidae.*

[2] Carolin, V.M., Jr. and J. A. E. Knopf. *The pandora moth.* U.S. Dep. Agr. Forest Pest Leaflet 114, 7 p. 1968.

[3] Collections were made by George L. Downing, John Larson, and Robert L. Lyon with the cooperation of personnel of the Chemult Ranger District, Winema National Forest, U.S. Forest Service, Chemult, Oregon.

[4] Frear, Donald E. H. *Pesticide Index.* Ed. 4. 399 p. State College, Penn.: College Sci. Publishers. 1969.

[5] Probit analysis computer program provided by Gerald S. Walton, U.S. Forest Service, Upper Darby, Penn. 19082.

[6] Abdel-wahab, A. M., R. J. Kuhr, and J. E. Casida. *Fate of $C^{14}$-carbanyl-labeled aryl methylcarbamate insecticide chemicals in and on bean plants.* Agr. Food Chem. 14(3):290-298. 1966.

[7] Roberts, R. B., R. P. Miskus, C. K. Duckles, and T. T. Sakai. *In vivo fate of the insecticide Zectran in spruce budworm, tobacco budworm, and housefly larvae.* Agr. Food Chem. 17(1): 107-111. 1969.

[8] Miskus, R. P., and T. Andrews. *Stabilization of pyrethroid compositions.* Patent No. 637065. April 1970.

[9] Bogaard, T. *A comeback for pyrethrum?* Agr. Chem. 24(12): 23. 1969.

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