AN EXPERIMENT IN CONTROLLING DDT-RESISTANT CODLING MOTH, CARPOCAPSA POMONELLA L.[1]

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The presence in British Columbia of a race of the codling moth, *Carpocapsa pomonella* L., resistant to DDT was demonstrated in a laboratory experiment in 1958 by Marshall (1). The same year, in an attempt to save the crop in the orchard that was most heavily attacked by the DDT-resistant insect, second brood spraying was carried out with a new insecticide that had given good results in 1957 against what had been considered a normal codling moth population. The new insecticide was the carbamate Sevin (N-methyl-1-naphthyl carbamate).[3]

The results of this late spraying were encouraging enough to justify a careful orchard assessment of Sevin in 1959. To broaden the experiment a second new insecticide, having a molecule structurally quite different from either DDT or Sevin, was also examined. It was the organo-phosphate Ethion (O, O, O′, O′-tetraethyl, S, S′-methylene bisphosphorodithioate)[4].

Experimental

An orchard in the Glenmore district near Kelowna was used for both the 1958 and 1959 experiments. In 1958 one acre was sprayed twice, and in 1959 seven acres were sprayed five times.

The trees were mature McIntosh and Delicious with a diameter of 20 to 30 feet, and an average height of about 18 feet. One series of seven plots was in a block of McIntosh trees, and a second series of seven plots, sprayed with the same materials and the same equipment, in a block partly of McIntosh and partly of Delicious trees.

The two experimental chemicals were applied to separate half-acre plots, each containing 20 to 30 trees, with three different orchard concentrate sprayers. Of these a 1955 model Turbo-Mist[5] and a 1959 model Swanson[6] were independently powered with gasoline engines. The third machine was a compact, experimental power-take-off unit designed and built at the Summerland Research Station. Designated Okanagan Experimental Sprayer Mark II, it is the subject of a separate article by McMechan and Williams (2). DDT was applied to only one plot (duplicated) with the Turbo-Mist machine.

In the course of the season three cover sprays were applied against the first brood codling moth, and two against the second brood. The first application was made a week after petal-fall.

DDT and Sevin were used as 50 per cent wettable powders, and Ethion as a 25 per cent wettable powder. The dosage in all plots was 50 imperial gallons of spray concentrate per acre.

Fruits were analyzed for spray deposits immediately following the last cover spray, and again, at harvest 34 days later. Ten apples were sampled from each of six trees per plot.

At harvest the numbers of worm-infested and "stung" fruits were noted in 500 fruits sampled from each of five 25-bushel bins from the centre trees of each plot.

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[2] Entomologist and Chemist respectively.

[3] Union Carbide Corp., White Plains, New York, U.S.A.

[4] Niagara Chemical Div. Food Machinery Corp., Middleport, New York, U.S.A.

[5] Okanagan Turbo Sprayers Ltd., Penticton, British Columbia.

[6] Swanson Sprayers, Okanagan Centre, British Columbia.

Results

Bearing in mind the percentage of active ingredient in each of the three insecticides, and the quantities applied per acre, the chemical determinations listed in Table 1 show that the three different sprayers applied roughly similar amounts of insecticides to the tops, and to the bottoms, of the trees. In each case about one-fourth as much insecticide was deposited on the fruits in the tops of the trees 12 to 15 feet above ground as on the fruits in the bottoms of the trees.

TABLE I—Average Spray Deposits from Duplicate Plots Following Last Cover Spray

Plot	Machine	Material	Amount per acre, lb.	Parts per million	
				Top of tree	Bottom of tree
1	Turbo-mist	DDT 50%	12	1.9	9.2
2	Turbo-mist	Sevin 50%	6	1.0	4.1
3	Expt. Mark II	Sevin 50%	6	0.8	3.5
4	Swanson	Sevin 50%	6	1.3	4.0
5	Turbo-mist	Ethion 25%	12	1.4	5.1
6	Expt. Mark II	Ethion 25%	12	0.8	4.4
7	Swanson	Ethion 25%	12	1.3	4.3

Table 2 giving the spray deposits immediately following the last spray application, and the residue that was present 34 days later, suggests that Sevin is less persistent, and Ethion more persistent, than DDT. (In a short article there is only room to tabulate averages; but the averages do sum up what was suggested by the unabridged results.)

TABLE II—Average Spray Deposits, Bottoms of Trees, Immediately Following Last Spray Application and at Harvest, 34 Days Later

Plot	Machine	Material	Amount per acre, lb.	Parts per million	
				Last spray	Harvest
1	Turbo-mist	DDT 50%	12	9.2	3.3
4	Swanson	Sevin 50%	6	4.0	0.8
7	Swanson	Ethion 25%	12	4.3	2.2

The next table shows that many more fruits were injured by the codling moth in the plots sprayed with DDT than in the plots sprayed with the two experimental compounds. But the difference was, in fact, far greater than the figures suggest. That was because, first, the amount of active ingredient applied per acre was twice as great in the DDT plots as in the Sevin or Ethion plots. Second, as the outcome of codling moth infestation, at least half of the fruits had fallen from the DDT-treated trees before harvest; these were not assessed for codling moth injury. Virtually none of the dropped fruits in the other plots showed codling moth injury.

This experiment demonstrated in the field what had been suggested in the laboratory, and what had been the experience of the owner of the property; in this orchard the codling moth can no longer be controlled with DDT.

TABLE III—Codling Moth Infestation in Harvested Fruit (5,000 Fruits Each Plot Including Duplicates)

Plot	Machine	Material	Amount per acre, lb.	Apple variety	Fruits % stung	% wormy
1	Turbo-mist	DDT 50%	12	McIntosh	3.2	14.1
1A				McIntosh	4.8	39.0
1A				Delicious	7.2	41.2
2	Turbo-mist	Sevin 50%	6	McIntosh	1.8	0.6
2A				McIntosh	3.4	2.0
2A				Delicious	1.6	2.3
3	Expt. Mark II	Sevin 50%	6	McIntosh	2.1	0.4
3A				McIntosh	2.5	0.4
3A				Delicious	1.2	0.5
4	Swanson	Sevin 50%	6	McIntosh	1.8	0.9
4A				McIntosh	1.0	0.1
4A				Delicious	1.3	0.5
5	Turbo-Mist	Ethion 25%	12	McIntosh	3.3	2.2
5A				McIntosh	0.6	0.1
5A				Delicious	1.7	0.9
6	Expt. Mark II	Ethion 25%	12	McIntosh	7.4	4.3
6A				McIntosh	2.0	0.6
6A				Delicious	1.7	1.1
7	Swanson	Ethion 25%	12	McIntosh	6.6	3.8
7A				McIntosh	1.7	0.3
7A				Delicious	2.0	1.3

What then of the experimental chemicals? Of the two, Sevin, as applied with the Turbo-mist sprayer in plot 2, undoubtedly was subjected to heavier codling moth attack than Ethion because, in both of the experimental blocks, plot 2 immediately adjoined the DDT plot. So plot 2, doubtless, was heavily invaded by second generation moths that had developed due to the failure of DDT. That is probably the explanation for the slightly heavier infestation in plot 2 than in the other plots, (3 and 4), that were sprayed with Sevin. The over-all performance of Sevin, in this orchard experiment, shows that this material was evidently about as effective against DDT-resistant codling moths as was DDT against non-resistant codling moths when the later insecticide was introduced into British Columbia 15 years ago.

To judge from the records of infestation alone, Ethion, although apparently less effective against DDT-resistant codling moth than Sevin, is nevertheless a promising material. There is, however, another consideration; about a month before harvest some defoliation occurred on Delicious trees that had been sprayed with Ethion. On the other hand, Sevin gave no evidence of phytotoxicity in this orchard, but experience elsewhere indicates that Sevin may have a thinning effect if applied to fruitlets shortly after petal fall.

The experimental effects of Sevin and Ethion on orchard pests other than the codling moth may be summarized in a few words. Five applications of Sevin gave adequate control of the green aphid, *Aphis pomi* DeG., but resulted in a heavy infestation of the mite, *Tetranychus mcdanieli* McG. Ethion, on the other hand, gave good control of the mite, but not of the aphid.

Summary

1. Against a codling moth population highly resistant to DDT, the carbamate Sevin and the organo-phosphate Ethion gave good control.

2. Sevin gave adequate control of the green aphid, *Aphis pomi* DeG., but resulted in a heavy infestation of the mite, *Tetranychus mcdanieli* McG. Ethion had the opposite effect.

3. On apples, Sevin left a less persistent deposit than DDT, and Ethion a more persistent deposit.

4. Ethion caused some defoliation of Delicious apple trees a month before harvest. Sevin caused no phytotoxic effects either on McIntosh or on Delicious.

References

1. Marshall, J. Resistance to DDT in the codling moth in British Columbia. Proc. Ent. Soc. Brit. Columbia 56: 59-63. 1959.
2. McMechan, A. D., and K. Williams. A new and compact orchard concentrate sprayer. In preparation.

A BREEDING PLACE OF XESTOBIUM ABIETIS FISHER (Coleoptera: Anobiidae)

In his check-list of the Coleoptera of North America, Charles Leng records only 2 species of the anobiid genus *Xestobium, X. rufovillosum* (DeG.) the notorious deathwatch beetle of Europe which Leng records from New England, Illinois and Indiana, and *X. affine* Lec. from Vancouver and California.

In mid-February, 1960, Professor K. Graham gave me 2 chunks of very punky wood taken from a rotten top branch of a broad-leafed maple *Acer macrophyllum* Pursh. at Langley Prairie in the lower Fraser Valley and a couple of beetle grubs which he had dug out of the wood. I dug out another grub and put the wood into a plastic bag. In a few days time 2 beetles emerged which keyed out to genus *Xestobium* but were definitely not *rufovillosum* of which I have several specimens sent to me for reference from the government laboratory at Princes Risborough, England. My specimens have exactly the same type of markings consisting of scattered patches of pale golden-yellow recumbent hairs on a black background, but are only 4/5 the length and 1/3 the breadth, of *rufovillosum*.

I sent the specimens to Mr. Gordon Stace Smith of Creston who replied: "I have spent a lot of time with your *Xestobium;* it was your host record that puzzled me. I collected a type series of 4 specimens, extracting them from pupal cells in a dry tree of *Abies grandis* Lindl, the white fir. No other specimen is known until yours so it must be regarded as very rare. Fisher who described the species retained 2 and I have 2 paratypes".

The wood from which my beetles emerged and (August, 1960) are still emerging is so rotten that one can easily stick a finger into it; it is white with the dry rot fungus *Poria* which Dr. R. J. Bandoni of the Department of Botany at the University tells me is either *Poria ferrea* or *P. ferruginosa,* both of which cause white rot. Emergence records of the 10 specimens that I retained are Feb. 26, 2; March 1, 2; March 5, 2; March 26, 3; August 4, 1.

I kept some of the beetles alive in a glass jar for 2 weeks where they did not seem to feed on anything, not even on the brown mycelium of the *Poria* but they periodically drank water sprayed into the jar. Some mated and went through the motions of laying eggs in bits of fungus-covered wood so I hope to raise another generation. On bright days they were very active but on dull overcast days they were quiescent, hiding under trash.

Note

On 26 August I received this note from Mr. W. J. Brown, coleopterist of the Science Service *"Xestobium abietis* Fisher. The habitat seems wrong but I can make it nothing else. Our specimens are from long-dead, standing fir."

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