Toxicity of Insecticides to a Coccinellid Predator of the Cereal Leaf Beetle

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ABSTRACT

Laboratory tests of insecticides against the spotted lady beetle, *Coleomegilla maculata lengi* Timberlake, a predator of the cereal leaf beetle, *Oulema melanopa* (L.), indicated that carbaryl, Guthion® (*O,O*-dimethyl *S*-(4-oxo-1,2,3-benzotriazin-3(4*H*)-ylmethyl) phosphorodithioate), and malathion were highly toxic to the predator while Bayer 39007 (*o*-isopropoxyphenyl methylcarbamate) was moderately toxic. Dieldrin, endrin, and lindane were slightly or non-toxic to the insect. Carbaryl resulted in high mortality of both the cereal leaf beetle and the spotted lady beetle while dieldrin gave a high mortality of the cereal leaf beetle but only a moderate kill of the spotted lady beetle. The results obtained with granular and spray aplications of carbaryl and dieldrin were essentially the same.

The cereal leaf beetle, *Oulema melanopa* (L.) (Coleoptera, Chrysomelidae), a European pest of cereals, has become established in Michigan within the past decade. This pest has done considerable damage to oats, barley, and wheat in Berrien County during the past few years. Research on the control of the pest concentrated on the development of insecticides for the immediate control of the cereal leaf beetle. An important aspect of this research was the evaluation of the effects of the applications of insecticides on the natural enemies and other species associated with the cereal leaf beetle. The objective of this phase of research was to find insecticides that would adequately control the pest while causing the least possible damage to beneficial organisms. Several insecticides have been found to be effective against the cereal leaf beetle. The toxicity of these insecticides to an important predator of this pest is reported in this article.

During his studies of the biology on the cereal leaf beetle in Michigan in 1963, Mr. T. R. Castro (unpublished data) found that while the pest is attacked by several native predators, only the spotted lady beetle, *Coleomegilla maculata lengi* Timberlake, was sufficiently common to be considered of any importance in the reduction of the population of the cereal leaf beetle. The spotted lady beetle feeds on the eggs and larvae of this insect pest. Aphids are the common prey of the spotted lady beetle but it is recorded as feeding on the eggs and larvae of several lepidopterous pests of corn and cotton; on its own eggs, larvae, and pupae and of those of other coccinellids; on the eggs of the Colorado potato beetle, *Leptinotarsa decimlineata* (Say); on the larvae of the asparagus beetle, *Crioceris asparagi* (L.), and on the cottonwood leaf beetle, *Chrysomela scripta* F.; and on the eggs and larvae of the Mexican bean beetle, *Epilachna varivestis* Mulsant (Bravo 1957, Conrad 1959). The spotted lady beetle overwinters in aggregations of adults in forest duff. It emerges with the first warm days of spring, and moves to fields of grains and grasses, where it feeds on aphids and other soft-bodied, slow-moving insects. The cereal leaf beetle adults emerge from hibernation at about the same time and move into the same fields as does the spotted lady beetle. Thus, the eggs and larvae of the cereal leaf beetle are exposed to predation by the coccinellid. The adults and larvae of the predators were frequently observed feeding on the young stages of the cereal leaf beetle by the authors and others during 1963. The coccinellid was particularly effective against the pest in the early spring when the aphids were scarce. When the aphid populations increased later in the season, the spotted lady beetle fed heavily on the aphids and only occasionally on the cereal leaf beetle.

During the early spring, the adults of the cereal leaf beetle are sufficiently numerous in some fields to justify an insecticide spray for their control. Carbaryl, dieldrin, endrin, Guthion® (*O,O*-dimethyl *S*-(4-oxo-1,2,3-benzotriazin-3(4*H*)-ylmethyl) phosphorodithioate), lindane, and malathion proved to be the most effective of the insecticides tested for the control of the cereal leaf beetle in field tests during 1963 (Ruppel and Yun[3]). The experimental insecticide Bayer 39007 (*o*-isopropoxyphenyl methylcarbamate) also showed promise against this pest in both aerial and ground applications (Wilson and Toba 1964, Ruppel and Wilson[4]). The effect of these insecticides on the spotted lady beetle was little known. Campbell and Hutchins (1952) found that endrin was moderately toxic to this insect in a laboratory test and that dieldrin was slightly toxic to it in the laboratory and had little effect on it in the field. Harries and Volcarce (1955) found that malathion was highly toxic and that dieldrin was slightly toxic to the spotted lady beetle. Their results indicated that endrin was only slightly toxic to the spotted lady beetle in contrast to the heavier kill of the species obtained with endrin reported by Campbell and Hutchins. The toxicities of Bayer 39007, carbaryl, Guthion, and lindane to this predator were not known.

In a recent article, Bartlett (1963) tested many insecticides against 6 species of coccinellids, but not the spotted lady beetle. He found that carbaryl, Guthion, and malathion were highly toxic to all 6 species; that endrin was moderately to highly toxic; and that dieldrin was not toxic or only moderately toxic. His results with lindane varied from no effect to highly toxic depending on the species. He noted differences in the effectiveness of lindane from different manu-

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[3] Ruppel, R. F. and Y. M. Yun. 1964. Ground sprays of insecticides against the cereal leaf beetle. Manuscript in preparation.

[4] Ruppel, R. F. and M. C. Wilson. 1964. Aerial applications of insecticides to control spring infestations of the cereal leaf beetle in small grains. Manuscript in preparation.

facturers and regarded his own results with this insecticide as questionable. In view of the incompleteness and disagreement of the knowledge on the effects of these materials on the spotted lady beetle, tests on their toxicities to this insect were made in the laboratories at Michigan State University during 1963.

Two tests using essentially the same methods were made. Seedling plants of the oat variety "Clintland 60" were used. The insecticides were fresh, standardized formulations obtained directly from the manufacturer. The sprays were applied to the plants by means of an experimental sprayer that applied the sprays at a rate equivalent to 65 gal of finished spray per acre (see Yun and Ruppel 1964, for more detail on this sprayer). The granular formulations were applied by sprinkling measured amounts of the granules over the plants. Thirty adults of the cereal leaf beetle or of the spotted lady beetle were placed on the plants within an hour after the plants had been treated. Untreated plants were used as checks and 3 replications, arranged in a randomized block design, were used in both tests. Counts of the number of living and dead beetles were made at predetermined intervals after the insects had been placed on the plants. Statistical analyses were made to determine the significance of observed differences between treatments.

In the first test, all 7 of the selected insecticides were tried against active adults of the spotted lady beetle that had been collected in grain fields near East Lansing. The insecticides were applied at a dosage for each that was thought to be minimal for the effective control of the cereal leaf beetle. After the lady beetles had been placed on the plants, the latter were held in a growth chamber that was set at 80°F, 65% RH, and a 16-hr photoperiod. Carbaryl caused a rapid kill of the spotted lady beetle, all of them dying within 48 hr. Guthion also killed the coccinellids rapidly and caused 97% mortality 48 hr, and 100% 72 hr following treatment. The kill obtained with malathion was slower than with either of the first 2 insecticides, but it still caused 87% mortality of the coccinellid at the end of 48 hr and 97% at 72 hr. Bayer 39007 was moderately effective against the spotted lady beetle and caused only 7% mortality at the end of 24 hr, 30% at the end of 48 hr, and 41% at the end of 72 hr. The 3 chlorinated hydrocarbon insecticides were much less toxic to the coccinellid. Dieldrin resulted in a 3% kill at the end of 72 hr and neither endrin nor lindane showed any effect. The results of this test are summarized in Table 1.

It was evident from the first test that the chlorinated hydrocarbons were the least, and that carbaryl was the most toxic to the spotted lady beetle. A second test comparing spray and granular applications of carbaryl and dieldrin against the cereal leaf beetle and the spotted lady beetle was made to determine if the method of application would affect the selectivity of the insecticides. The dosages for the sprays used in this test were those that were determined to be effective in previous field trials. The dosages for the granular applications were increased slightly over the dosages used in the sprays as it was thought that the insects would have less contact with the granules than with the spray deposits and a higher dosage would be needed. Adults of both the cereal leaf beetle and the spotted lady beetle were placed together on the treated plants. The adults of the cereal leaf beetle were obtained from a laboratory culture and the adults of the spotted lady beetle were collected in an over-wintering aggregation near Standish, Mich., in October 1963. The plants were held in a growth chamber that was set at 55°F, 80% RH, and a 16-hr photoperiod after the insects had been placed on them. The low temperature was used to approximate the conditions when the insecticides would be applied in the field.

The mortality of both insects obtained with all treatments was slow and incomplete because of the low temperature. Carbaryl killed 90% to 93% of the cereal leaf beetle adults and 81% to 85% of the spotted lady beetle at the end of 5 days. At the end of this same period, dieldrin had killed 69% to 86% of the cereal leaf beetles but only 31% to 50% of the coccinellids. The differences in the selective killing of the 2 species by the 2 insecticides were statistically highly significant. The granular formulations were somewhat slower in obtaining a kill of the insects, but these differences were not statistically significant. There were no significant differences in mortality of the 2 insects obtained by the different formulations

Table 1.—Mortality of adult spotted lady beetle obtained with insecticides that are effective against the cereal leaf beetle.

Insecticide	Formulation	Dosage[a] lb/acre	Percent mortalities 1 hr	8 hr	24 hr	48 hr	72 hr
Carbaryl	85 WP	1.00	20	50	83	100	100
Guthion	2.0 EC[b]	0.38	0	23	40	97	97
Malathion	8.0 EC	1.00	0	0	20	87	41
Bayer 39007	1.5 EC	0.50	0	0	7	30	33
Dieldrin	1.5 EC	.25	0	0	0	3	3
Endrin	1.6 EC	.12	0	0	0	0	0
Lindane	1.65 EC	.25	0	0	0	0	0

[a] The dosages are expressed as weight of actual toxicant applied per acre.
[b] The emulsifiable concentrate formulations are given as pounds of active insecticide per gallon.

Table 2.—Effect of sprays and granules of carbaryl and dieldrin on adults of the cereal leaf beetle and the spotted lady beetle.

Insect	Hours after treatment	Percent Mortality: Carbaryl Granules[a]	Carbaryl Spray[b]	Dieldrin Granules[c]	Dieldrin Spray[d]
Cereal leaf beetle	24	13	30	7	0
	48	33	53	13	23
	72	53	57	20	53
	96	83	67	47	80
	120	90	93	69	86
Spotted lady beetle	24	10	53	7	17
	48	30	63	10	27
	72	37	63	17	30
	96	50	64	11	32
	120	81	84	31	50

[a] 10% granules applied at a dosage equivalent to 1.5 lb of active insecticide per acre.
[b] 85% wettable powder applied at a dosage equivalent to 1.0 lb of active insecticide per acre.
[c] 5% granules applied at a dosage equivalent to 0.5 lb of active insecticide per acre.
[d] An emulsifiable concentrate containing 1.5 lb/gal applied at a dosage equivalent 0.38 lb of active insecticide per acre.

of the insecticides. The results of this test are summarized in Table 2.

The results of the first test (Table 1) clearly show that, at the dosages of each that were used, carbaryl, Guthion, and malathion are highly toxic; Bayer 39007 is moderately toxic; and dieldrin, endrin, and lindane have a low order of toxicity to the spotted lady beetle. These results coincide, in general, with results obtained against lady beetles with these same insecticides (Campbell and Hutchins 1952, Harries and Volcarce 1955, Bartlett 1963). The exception to this agreement of results is that of endrin. The reason for this lack of agreement is not clear. Dosages, means of application, time of counting, and environmental conditions varied in the different tests and may have influenced the results with endrin to the point that they are not comparable.

The results of the second test (Table 2) corroborate the results of the first test in that dieldrin was again less effective against the spotted lady beetle than was carbaryl. Both of these insecticides were highly toxic to the adults of the cereal leaf beetle. The differences between the granular and spray applications were minimal, and the use of granules in place of sprays seems to offer little advantage. The use of an insecticide such as dieldrin for the control of the cereal leaf beetle early in the spring appears to allow an adequate control of the pest with a minimal loss of the coccinellid predator.

There may be an additional benefit to the saving of the coccinellid as a predator of the cereal leaf beetle. As was noted previously, the spotted lady beetle feeds primarily on aphids. Both Wilson and Toba (1964) and Ruppel and Yun[3] found that aphids, identified as predominantly *Rhopalosiphum fitchii* (Sanderson) and *Macrosiphum granarium* (Kirby) by M. C. Wilson, increased in numbers in the plots that were sprayed with carbaryl. Both of these aphids are vectors of barley yellow dwarf virus. Wilson noted that this disease was present in his plots and caused loss of yield. As carbaryl is highly effective against the coccinellids and ineffectual against the aphids, part of this increase in the aphid populations may be caused by the kill of the predator without a compensating kill of the aphids. The use of a selective insecticide could result in an adequate control of the cereal leaf beetle without reducing the effectiveness of the spotted lady beetle against both the cereal leaf beetle and the aphids. This, in turn, could result in a lessening of the barley yellow dwarf. Field tests of insecticides that take these factors into consideration are needed.

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Egg Parasites of the Elm Spanworm in the Southern Appalachian Mountains[1]

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ABSTRACT

Large numbers of an egg parasite, *Telenomus alsophilae* Viereck, were recovered from egg masses of the elm spanworm, *Ennomos subsignarius* (Hübner), over the current outbreak area in the southern Appalachian Mountains. Overall level of parasitism averaged 57%. Accompanying the high incidence of egg parasitism was marked reduction in infested area and intensity of damage.

The elm spanworm, *Ennomos subsignarius* (Hübner), a hardwood defoliator, has been epidemic in the southern Appalachian Mountains since 1954. Egg parasites were first collected from this outbreak in 1961 when 1 *Anagrus* sp. (Hymenoptera: Mymaridae) and 41 specimens of *Telenomus alsophilae* Viereck (Hymenoptera: Scelionidae), a common egg parasite of the fall cankerworm, *Alsophila pometaria* (Harris), were recovered (Ciesla 1964). These were taken from 6 egg-masses collected during late April and early May in Macon County, N. C. Egg parasites were not recovered the following year, although similar collections were made. This is the second recorded occurrence of egg parasites of *E. subsignarius,* the first being reported by Knull (1932), who collected *Telenomus* n. sp. from elm spanworm egg-masses in Pennsylvania.

Egg hatch observations during 1963, which were designed to time application of aerial sprays for the control of *E. subsignarius* in recreation areas in western North Carolina, indicated that only a small proportion of eggs had hatched by mid-May. When egg-masses, containing unhatched eggs, were brought into the laboratory for study, large numbers of the egg parasite *T. alsophilae,*[3] emerged. Because *T. alsophi-*

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[3] Determined by C. F. W. Muesebeck.