EFFECTS OF SPRAYING 2,4-D AMINE ON COCCINELLID LARVAE[1]

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Abstract

When coccinellid larvae in six different age groups were sprayed with 2,4-D amine and then confined in glass vials, two main effects were seen: first, mortality was increased four times in all age groups; and secondly, the mean time to pupation increased in all age groups except the 1-day-old larvae.

Introduction

Widespread reports of abnormal numbers of aphids on grain in 1955 throughout Canada (5) brought attention to these pests. Extensive and costly insecticidal controls appeared to limit the pests although many acres of barley were reportedly destroyed. In 1956, T. C. Chiasson,[3] C. F. Everett,[4] M. E. MacGillivray,[5] and I examined grain fields in New Brunswick to determine the aphid conditions in fields not treated with insecticides. Among our observations we noted that early in the aphid infestation coccinellid adults and larvae became numerous and active (unpublished data). In 1958 again with the co-operation of Mr. Chiasson I examined grain fields to which herbicide had been applied. Coccinellid larvae collected from these areas died soon after collection but larvae handled in a similar manner from untreated fields survived. To explore the possible detrimental effect of herbicides on coccinellid larvae, I made the following investigation in 1959.

Material and Methods

Adult coccinellid beetles of three species (*Coccinella transversoguttata* Fald., *Hippodamia tredecimpunctata* (L.), and *Coccinella perplexa* Muls.) were collected from plots of oats on the Lincoln substation, Fredericton, during the first week in July. By far the greatest number of the beetles were of the species *Coccinella transversoguttata* Fald. The insects were sexed and mated. The females were then placed in glass vials, 3 in. × ¾ in., with cotton wool stoppers; strips of blotting paper were placed in the vials and most of the eggs were laid on these; the beetles were fed living aphids daily to satiation.

Due to the rabid cannibalism of the insects, egg masses (usually of 20 to 30 eggs) were removed as soon as possible. As with the adults it was necessary to isolate the young almost as soon as they hatched in order to minimize cannibalism. In this connection we noted that larval mortality was high if the young were removed before they had consumed the egg cases from which

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they had emerged. We handled all larvae with squirrel hair brushes and took particular care to do as little damage as possible.

To feed the larvae we used about 200,000 living aphids. During the first instar, which lasted about four days, a developing larva consumed fewer than 5 aphids per day; during the second and the third instars, each of about two days, the demand increased to 10 aphids per day; and in the final instar of about five days, the larva ate up to 25 aphids per day. We fed the larvae daily to satiation.

Treatments of 2,4-D amine[6] and water were applied to larvae in six age groups—a mixture of ages, and 1, 3, 6, 9, and 12 days. The 2,4-D amine was applied with a hand atomizer calibrated to apply spray at the rate of 8 oz of acid equivalent per acre. We examined 330 larvae; of these, 227 were treated with 2,4-D and 103 were reared unsprayed as controls. After treatment each insect was returned to the vial, and thence examined daily until death or emergence as an adult beetle. At each examination debris was removed from the vials and the larvae were given fresh food; obvious deformities were recorded. All tests were conducted in an insectary on the substation.

Results

In the first test in late July and early August with larvae in a mixed age group, 77 insects were sprayed with 2,4-D amine and 73 were left unsprayed as controls. Thirty-one of the sprayed larvae died before pupation compared to eight of the unsprayed insects. Larvae that survived developed at the same rate in both treatments.

TABLE I

The effect of spraying 2,4-D amine on coccinellid larvae of different ages in August and September, 1959 (based on 30 insects in each test)

	Checks (unsprayed larvae)	Age, in days, of sprayed larvae				
		1	3	6	9	12
Mean days to pupation	16	15	21	23	25	27
Mean days to maturity	20	20	30	28	29	35
% that died before pupating	7	27	40	43	50	57
% that died by end of experiment (larvae and pupae)	20	47	47	60	60	70

To determine if age of larvae made any difference to the effects of 2,4-D as noted in the mixed age group, we studied its effects on coccinellids in five separate age groups from the same egg assembly. These tests were started on August 22 and carried on until September 26. The results (Table I) show that there may be two kinds of effect, one on the rate of development and another on mortality. In the 1-day-old age group, as in the preliminary tests, we found that the development of treated and untreated larvae was the same;

[6]The 2,4-D amine (mixed amine salts of dichlorophenoxyacetic acid), brand name "Amsol" was purchased from Niagara Brand Chemical Company, Burlington, Ontario, and supplied for this experiment through the courtesy of the Field Crops Section, Research Station, Fredericton, N. B.

however, there was a lengthening of the development period of larvae treated when they were 3, 6, 9, and 12 days old. The effect on mortality in this test was essentially the same as found in the mixed age group. It was more than twice as great in the 2,4-D-treated larvae as in the untreated controls up to the time of pupation. Mortality during pupation was no greater in the sprayed than in the unsprayed groups.

Larvae whose development had been lengthened as a result of the 2,4-D sprays finally matured in the latter part of September. An examination of the temperatures that prevailed during this period showed that they were unusually low between September 14 and 18. These low temperatures may have contributed to the further lengthening of the development period and to the mortality of these larvae beyond that attributable to the 2,4-D sprays alone.

Records and observations of individual insects showed that deformity was more prevalent when larvae were sprayed in the later stages of their development; this might be explained on the basis that similarly affected younger stages died and the extent of deformity could not be determined. When they were treated at an early age, surviving treated larvae were often smaller as they approached maturity than untreated specimens at the same stage of development.

Discussion

In New Brunswick, herbicides for weed control in grain are usually applied when the crop is from 6 to 8 in. high. Studies on aphid development in grain fields not sprayed with herbicide show that aphids are present from the time grain is $2\frac{1}{2}$ in. high until it reaches a height of 30 in. (1). Closely associated with the appearance of these aphids is the presence and activity of their coccinellid predators. The first coccinellids noted have been adult beetles; the larval stage follows within 2 weeks. A slight delay in the application of the herbicide could make it coincide with the presence of coccinellid larvae with the lethal effects noted in this study. Such a delay is not uncommon since the application of herbicides, like most field practices, is dependent on favorable weather.

Aphid damage has been most generally reported from "late seeded grains". It is not known whether these areas were also late in receiving herbicide treatment but it seems likely. A setback such as we have found associated with the application of herbicides to coccinellid larvae gives the aphid population an unnatural advantage; this may account in part for a later season "upsurge" in population of the aphids thus freed from half of the early coccinellid predation.

In 1956 Ripper (7) reviewed in some detail the "effect of pesticides on balance of arthropod populations". By "pesticides" he referred to insecticides and fungicides; the effect of herbicides was not considered. The review emphasized, as have the studies of Pickett, Lord, and others (6, 4, 2), the disturbances of the balance of populations which can result from the continuous

and widespread use of chemicals as pest controls. Ripper also discussed the evidence that a pesticide could act either as a stimulant to a secondary pest or as a lethal factor, as it is in our case on the population of natural enemies, thus making possible a "resurgence" of insect populations within a treated area (8).

Carlson (3), in a study of the insecticidal control for lygus bugs, makes a statement that has equal application to herbicide practices when he says "data from field trials... showed that it was advisable to evaluate new treatments in terms of their effect on beneficial insects as well as on lygus bugs". Herbicides should be applied with the same care so that beneficial insects may not be sacrificed and pest conditions aggravated instead of improved.

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