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Sensitivity of Selected Nontarget Insects[1] to the Carrier of Dipel 4L® in the Laboratory[2]

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ABSTRACT

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A mixture of water and the carrier of Dipel 4L® (3:1) was applied to selected insect predators and a parasite in a controlled laboratory environment. Corrected mortality from the 9.4-liter/ha application never exceeded 2.1% for any species. The 18.7-liter/ha rate resulted in a statistically significant increase in mortality for *Chrysopa carnea* Stephens and *Hippodamia convergens* Guérin and Méneville adults 3 and 7 days after treatment, but not for *C. carnea* larvae or *Aphytis melinus* De Bach adults. Corrected mortality for the higher application rate never exceeded 13.4% for any species.

The microbial insecticide, *Bacillus thuringiensis* var. *kurstaki* Berliner, is highly pathenogenic for lepidopterous larvae. Recently, Abbott Laboratories developed Dipel 4L®, a nonaqueous, emulsifiable suspension of *B. thuringiensis*. Because aqueous suspensions of the bacterium are considered environmentally safe, the change to a nonaqueous, oil formulation created concern about the safety of the product to nontarget insects.

Since Dipel 4L® has been registered for aerial application to suppress populations of the western spruce budworm, *Choristoneura occidentalis* Freeman, and the spruce budworm, *C. fumiferana* (Clemens), it became necessary to determine if this new formulation would adversely affect nontarget insects. The objective of this study was to evaluate the effects of the carrier of Dipel 4L® at excessive application rates to selected insect predators and a parasite, in a controlled laboratory environment.

Materials and Methods

Insects

Three species of insects were used: the common green lacewing, *Chrysopa carnea* Stephens; the convergent lady beetle, *Hippodamia convergens* Guérin and Méneville; and an aphelinid, *Aphytis melinus* De Bach. All insects were purchased from Rincon-Vitova Insectaries, Inc., Ventura, Calif. About 200 *C. carnea* eggs were placed in 0.45-kg coffee cans between several sheets of tissue paper. Frozen *Sitotroga* spp. eggs were supplied as food. *Chrysopa* larvae were collected when they were 8 to 10 days old. *Chrysopa* pupae were held at room temperature (22° C), and adults were collected 1 to 3 days after eclosion. *Hippodamia* adults of unknown age were shipped from Ventura to Berkeley and held at 10° C. California red scale, *Aonidiella aurantii* (Maskell), parasitized by *A. melinus* De Bach, were shipped from Ventura to Berkeley, and held at room temperature (22° C). Adult *A. melinus* were collected as they emerged.

Bioassay Procedures

Three aerosol spray treatments were evaluated: 1, water only; 2, carrier and water (1:3); and 3, carrier and water (1:3) at twice the volume of treatment 2. All treatments were formulated immediately before treatment. Sprays were applied to insects in petri dishes with the Moellman spray chamber (Robertson et al. 1979). Parameters of application were: 0.25 ml volume (0.5 ml for treatment 3) expelled through the nozzle at 704 g/cm^2, 60-sec exposure of insects, and an average spray deposit volume of 9.4 liters/ha (18.7 liters/ha for treatment 3).

With the exception of *H. convergens*, treated insects were of a fairly uniform age. *Chrysopa* larvae were 8 to 10 days old, *C. carnea* adults were 1 to 3 days old, and *A. melinus* adults were 1 day old. *Hippodamia* adults had been collected by Rincon-Vitova and were a mixture of individuals of unknown age. They were lightly anesthetized with CO_2 (except that *H. convergens* were immobilized by placing the holding container in an ice bath), placed in a 9-cm petri dish lined with filter paper, treated, and held for up to 7 days postspray. Mortality was assessed at 3 and 7 days, except for *A. melinus* adults, which normally do not live as long as 7 days.

The different species or developmental stages were treated as they became available. After treatment, *H. convergens* and *C. carnea* adults were kept in new filter-paper-lined, 9-cm petri dishes with a mixture of water, sucrose, and Formula 57® (1:1:1) streaked on the lid as a source of food. To avoid cannibalism, *C. carnea* larvae were held individually in no. 0 gelatin capsules and provided frozen *Sitotroga* eggs for food. *Aphytis* adults were held in 5-cm tight-seal petri dishes and provided streaks of honey for food.

Experimental Design and Data Analysis

A completely randomized design was used in the experiment. Each treatment was applied to 20 in-

[1] *Hippodamia convergens* Guérin and Méneville (Coleoptera: Coccinellidae); *Chrysopa carnea* Stephens (Neuroptera: Chrysopidae); and *Aphytis melinus* De Bach (Hymenoptera: Alphelinidae).

[2] Received for publication 12 February 1981. Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the USDA is implied.

Table 1.—Mortality of predators and a parasite after spraying with a dilution of the Dipel 4L® carrier

Insect	Water only		Dipel 4L® and water (1:3)					
			9.4 liters/ha			18.7 liters/ha		
	n	%	*n*	%	Corrected[a] %	*n*	%	Corrected %
			3 days postspray					
C. carnea								
Larvae	267	6.4	296	7.4	1.1	297	9.4	3.2
Adults	404	2.5	413	2.2	0.0	411	6.1[b]	3.7
A. melinus								
Adults	180	8.3	256	4.7	0.0	166	10.2	2.1
H. convergens								
Adults	397	9.8	402	11.2	1.6	403	15.9[b]	6.8
			7 days postspray					
C. carnea								
Larvae	267	11.6	296	13.5	2.1	297	17.5	6.7
Adults	404	3.7	413	5.6	2.0	411	8.8[b]	5.3
H. convergens								
Adults	397	33.5	402	29.1	0.0	403	42.4[b]	13.4

[a] Corrected mortality = $\frac{\%T - \%C}{100 - \%C} \times 100$, where %T = percent treatment mortality and %C = percent control mortality.

[b] Percent mortality significantly different ($\alpha = 0.05$) from water-only treatment.

sects per replication with up to 20 replications per treatment. For each species or life stage, differences between the water-only check and either of the carrier treatments were evaluated with a 2 × 2 contingency table (Steel and Torrie 1960) and tested for significance ($\alpha = 0.05$). For illustrative purposes, mortality was corrected by Abbott's formula.

Results and Discussion

The concentrations of the two treatments selected are representative of the optimal and maximum rates of Dipel 4L® aerially applied in forests. The amount of formulation that actually reaches or impinges on the test insects in the Moellman spray chamber is at least four times more than that which would be expected to reach insects when applied in a forest.

The 9.4-liter/ha rate did not result in a significant increase in mortality for any of the species tested for up to 7 days postspray (Table 1). Corrected mortality or mortality that resulted solely from the carrier never exceeded 2.1% for any species tested. The 18.7-liter/ha rate resulted in a statistically significant increase in mortality for *C. carnea* and *H. convergens* adults 3 and 7 days after treatment, but not for *C. carnea* larvae or *A. melinus* adults. When treatment mortalities were corrected for mortality in the water-only check, mortality resulting from the 18.7-liter treatment never exceeded 13.4%.

The amount of Dipel 4L® carrier impinging on the test insects from the higher application rate used in this study is at least eight times the amount insects are likely to contact if Dipel 4L® is mixed 1:1 with water and applied at the rate of 9.4 liters/ha over a forest (unpublished data). Results suggest that the carrier in Dipel 4L® could cause slight increases in mortality to nontarget insects only when applied in excessive amounts. Any potential disadvantages from increased mortality are outweighed by the benefits of having a microbial insecticide, such as *B. thuringiensis*, for control of forest defoliators.

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