AERIAL SPRAYING FOR CONTROL OF THE SPIRAL SPRUCE-CONE BORER, *HYLEMYA ANTHRICINA* (DIPTERA: ANTHOMYIIDAE)

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RÉSUMÉ

On a arrosé l'Epinette blanche *(Picea glauca* (Moench) Voss) avec l'insecticide dimethoate; en deux stations, les arbres ont été traités individuellement avec deux types de rampes d'arrosage tandis qu'en une troisième station, un arrosage à la volée a été appliqué. Les faibles densités de population de la Mineuse des cônes de l'Epinette, *Hylemya anthracina* (Czerny) ont été réduites de 87% et de 100% par les arrosages individuels et de 68% par l'arrosage à la volée. L'augmentation de production de graines par cône a été de 43% dans les cônes des arbres aroses individuellement et de 22% dans ceux des arbres arrosés à la volée.

ABSTRACT

White spruce *(Picea glauca* (Moench) Voss) trees were sprayed with dimenthoate; at two sites, trees were treated individually with different types of booms; at a third site, a broadcast spray was applied. The low population densities of the spiral spruce-cone borer, *Hylemya anthracina* (Czerny), were reduced by 87% and 100% with individual tree sprays and by 68% with a broadcast spray. Increased seed yields were 43% per cones from individually sprayed trees and 22% per cone from the broadcast application.

INTRODUCTION

The spiral spruce-cone borer, *Hylemya anthracina* (Czerny) (Diptera: Anthomyiidae), is a major pest limiting white spruce, *Picea glauca* (Moench) Voss, seed production in British Columbia (Hedlin 1973, 1975). Seed lost to this insect varies with year and site, and seed crops may be completely destroyed.

Aerial broadcast sprays for control of cone and seed insects have resulted in variable success. Uneven distribution of spray deposit in tree crowns is a major problem (Johnson 1963). Most aerial applications have tested contact insecticides but few have tested systemic insecticides. It is necessary to spray cones and surrounding foliage thoroughly to achieve good control with systemic insecticides (Hedlin 1966; Johnson and Zing 1967). Dimethoate, a purported systemic insecticide, has been effective against spruce cone and seed insects (Haig and McPhee 1969; Hedlin 1973), primarily as a larvicide. Few aerial application techniques, other than broadcast applications, have been tested.

The objective of this study was to determine the effectiveness of three aerial application techniques, a broadcast application and two individual tree treatments with different types of booms, for control of spiral spruce-cone borer.

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MATERIALS AND METHODS

Aerial applications of dimethoate (Cygon® 4-E) were made with a helicopter (Bell 206-B-Jetranger) at three sites near Prince George, British Columbia in June, 1979. At two sites, Willow River and Everett Creek, individual trees were treated, and a broadcast application was made at the third site, Evans Creek. White spruce made up 80% of the stand at Willow River, 85% of the stand at Everett Creek and 70% of the stand at Evans Creek. The trees were 29 m tall at Willow River, 27-37 m at Everett Creek and 24-37 m at Evans Creek. All the stand were of medium density.

Trees to be treated and sampled were tagged with numbered cards on wire hoops placed over the tree tops before spraying. At Willow River and Everett Creek, 20 trees were tagged for treatment and 20 as controls (no treatment). At Evans Creek, two 3.64 ha (8-acre) blocks, one for treatment and the other for control, were marked with ribboned rubber hoops placed over the tops of trees at the corners of the blocks and 25 trees within each block were tagged. At all sites, only the tallest trees were used because tagging and sampling were carried out manually from a helicopter. At the time when the sprays were applied, cone development at all 3 sites ranged from megastrobili closed and turning to just past the horizontal position.

At Evans Creek, 2% dimethoate was broadcast at a rate of 83.46 1/ha (10 US gal/acre) at 240 KPa on 21 June. The spray solution was dyed with Erio Red® . The spray-boom was 9.14 m long, with 48 nozzles. The nozzles used

were raindrop nozzles designed to emit droplets near 1200μ mean diameter. The air speed of the helicopter was 48 km/h. the helicopter was about 3 m above the tallest trees while spraying. Kromekote® cards were used to monitor the spray deposits at the tops of the 25 sample trees as well as at ground level underneath these trees. However, these cards could not be analyzed quantitatively because the large droplet sizes resulted in streaking.

The trees at Everett Creek were sprayed on 19 June with 0.8% dimethoate at 205 KPa with a 0.5 m horizontal, 5-nozzle boom (the broadcast boom without the extension arms). The same nozzles used on the full broadcast boom were used on this boom. The helicopter hovered above each tree while spraying, each tree receiving 12.3 1. Only 17 trees were treated because the spray solution was depleated at this time.

The spray-boom used at Willow River was a fabricated "A"-frame (Fig. 1), each arm of which was lined with 6 nozzles. The nozzles were flat fans (8015) designed to emit droplets of 300 μ mean diameter. On 9 June, the treatment trees were sprayed with 0.8% dimethoate at 240 KPa. The helicopter hovered above ech tree and sprayed for 10 sec, each tree receiving 2.28 1. The boom was damaged while approaching tree 11, resulting in only 10 trees being treated.

Cones of the tagged trees were hand-picked from the helicopter at 3 different times: just prior to spraying; on 20 July (4 to 6 weeks after spraying), and at cone harvest, 5 September (10 to 12 weeks after spraying). A sample consisted of four cones from each of five branches taken from the top 1.53 m of the tree. Unfortunately, no samples were taken on 5 September at Willow River and the numbers of trees sampled at the other sites were reduced considerably because some tagged trees were harvested before the samples could be taken.

Cones taken in the first two collections were dissected and the numbers of eggs and larvae of *H. anthracina* were counted. Cones taken in the third collection were dried and the seeds extracted and dissected to determine the numbers of filled, extractable seeds. The results were analyzed for each site individually by an analysis of variance after a correction for heterogeneity of variance by a log $10_{10}(x + 1)$ transformation and the differences between means were tested by the Student-Neuman-Keuls' test (Sokal and Rohlf 1969).

RESULTS AND DISC USSION

The pre-spray samples indicated low *H. anthracina* population densities (Table 1). The densities increased between the pre-spray and the first post-spray samples, as expected, since oviposition occurs during this period (Hedlin 1973). No significant differences in numbers of *H. anthracina* were found between treatment and control trees in the pre-spray samples (Table 1), indicating similar rates of infestation.

There were significant differences in numbers of *H. anthricina* between sprayed and unsprayed cones in the first post-spray samples at all sites. Spraying resulted in *H. anthracina* population reductions of 87% at Willow River, 100% at Everett Creek and 68% at Evans Creek. The reductions could be due to the larvicidal action

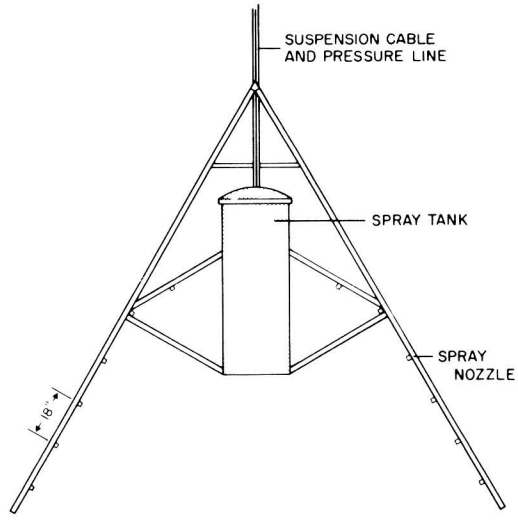

Fig. 1. Diagram of the "A"-frame spray-boom used at the Willow River site.

TABLE 1. Numbers of *H. anthracina* per cone in pre- and post-spray samples of dimethoate-sprayed and non-sprayed white spruce cones (non-transformed data).

Site	Treatment	Pre-spray No. trees	Pre-spray $\bar{x}$*	Post-spray No. trees	Post-spray $\bar{x}$*
Evans Creek	Non-sprayed	25	0.12a	25	0.34a
Broadcast	Sprayed	25	0.16a	25	0.11b
Everett Creek	Non-sprayed	20	0.06a	20	0.49a
Individual tree (5-nozzle)	Sprayed	20	0.14a	17	0.00b
Willow River	Non-sprayed	20	0.36a	20	0.70a
Individual tree ("A"- frame)	Sprayed	20	0.41a	10	0.09b

* Means in the same sampling period at each site significantly different if followed by different letter, Student-Newman-Keuls' test, $P \leq 0.05$.

of the dimethoate or to the knockdown of ovipositing females, or both, depending on the state of development of the target population.

The differences in numbers of filled seeds from cone samples taken in the third collection were significant at Everett Creek and Evans Creek (Table 2). The percentage increase was 43% at Everett Creek and 22% at Evans Creek, corresponding to the reductions in infestation levels.

This study shows that *H. anthracina* numbers and damage can be reduced by aerial applications of dimethoate and that both individual tree treatment and broadcast applications can be effective.

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TABLE 2. Numbers of filled seeds per cone extracted from dimethoate-sprayed and non-sprayed white spruce cones (non-transformed data).

Site	Block	No. Trees	$\bar{x}$*
Everett Creek	Non-sprayed	7	23.84a
	Sprayed	11	34.04b
Evans Creek	Non-sprayed	18	25.75a
	Sprayed	9	31.43b

* Means at each site are significantly different if followed by a different letter, Student-Newman-Keuls' test, $P \leq 0.05$.

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