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Ground spray applications of Virtuss®, a nuclear polyhedrosis virus, against White-marked Tussock Moth larvae at Bottom Brook, Newfoundland in 1986

R. J. West, J. C. Cunningham and W. J. Kaupp

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COVER PHOTO
Applying a ground spray of Virtuss® against larvae of the White-marked Tussock Moth, *Orgyia Leucostigma*.

GROUND SPRAY APPLICATIONS OF VIRTUSS®, A NUCLEAR POLYHEDROSIS VIRUS, AGAINST WHITE-MARKED TUSSOCK MOTH LARVAE AT BOTTOM BROOK, NEWFOUNDLAND IN 1986

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ABSTRACT

The efficacy of a ground spray application of a Douglas-fir tussock moth nuclear polyhedrosis virus product called Virtuss®, against a larval population of white-marked tussock moth (Orgyia leucostigma (J.E. Smith)) was tested in a mixed stand of balsam fir and white birch. Larvae were successfully infected and there was a general population reduction several weeks after treatment, but the amount of reduction varied with the type of sampling system used. The effects of the application did not include noticeable foliage protection in the year of treatment. However, a population collapse, indicated by an absence of egg masses in the study area, was attributed to a viral epizootic initiated by the application of Virtuss.

RÉSUMÉ

L'efficacité d'une pulvérisation au sol d'un virus de la polyédrose nucléaire de la chenille à houppes du Douglas commercialisé sous le nom de Virtuss® et destiné à réprimer une population larvaire de chenilles à houppes blanches (Orgyia leucostigma (J.E. Smith)) a été éprouvée dans un peuplement mixte de sapins baumiers et de bouleaux à papier. Des larves ont pu être infectées et une réduction générale des populations a été observée plusieurs semaines après le traitement, quoique l'ampleur de cette diminution variait selon la méthode d'échantillonnage utilisée. Le traitement n'a pas assuré une protection évidente du feuillage l'année où il a été effectué. L'effondrement des populations indiqué par l'absence de masses d'oeufs dans la région à l'étude a toutefois été attribué à l'épizootie virale déclenchée par l'application de Virtuss.

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INTRODUCTION

The white-marked tussock moth (WMTM)(*Orgyia leucostigma* (J.E. Smith)) occurs throughout eastern North America and feeds on a variety of hardwoods and softwoods including balsam fir (*Abies balsamea* (L.) Mill.), black spruce (*Picea mariana* (Mill.) B.S.P.), larch (*Larix laricina* (Du Roi) Koch.) and white birch (*Betula papyrifera* Marsh) (Drooz 1985). Infestations occur in urban areas and in forest plantations and have necessitated control actions (Rose and Lindquist 1982, Smith *et al.* 1983). Microbial control is an attractive method which has been tested in Newfoundland against the WMTM. In 1985, Dipel 132®, a commercial preparation of *Bacillus thuringiensis* var. *kurstaki*, was applied aerially against a localized infestation in a one-year old plantation of black spruce and larch located near Stephenville (Fig. 1) and the number of larvae dropped sharply after treatment (West and Durling 1986). In 1986, the infestation continued in an area adjacent to the plantation (Fig. 1) and presented an opportunity to test the effectiveness of Virtuss®, another microbial insecticide.

Virtuss is a nuclear polyhedrosis virus isolated from the Douglas-fir tussock moth (*Orgyia pseudotsugata* (McDunnough)) and propagated in WMTM larvae; it is a lyophilized, finely ground powder prepared from virus-infected larvae. Virtuss has been tested on infestations of the Douglas-fir tussock moth (Shepherd *et al.* 1984) and is registered in Canada for control of this species. It is hoped that this registration can be amended to include WMTM on the label.

This report describes the experiments testing the effectiveness of ground spray applications of Virtuss against the WMTM in Newfoundland in 1986.

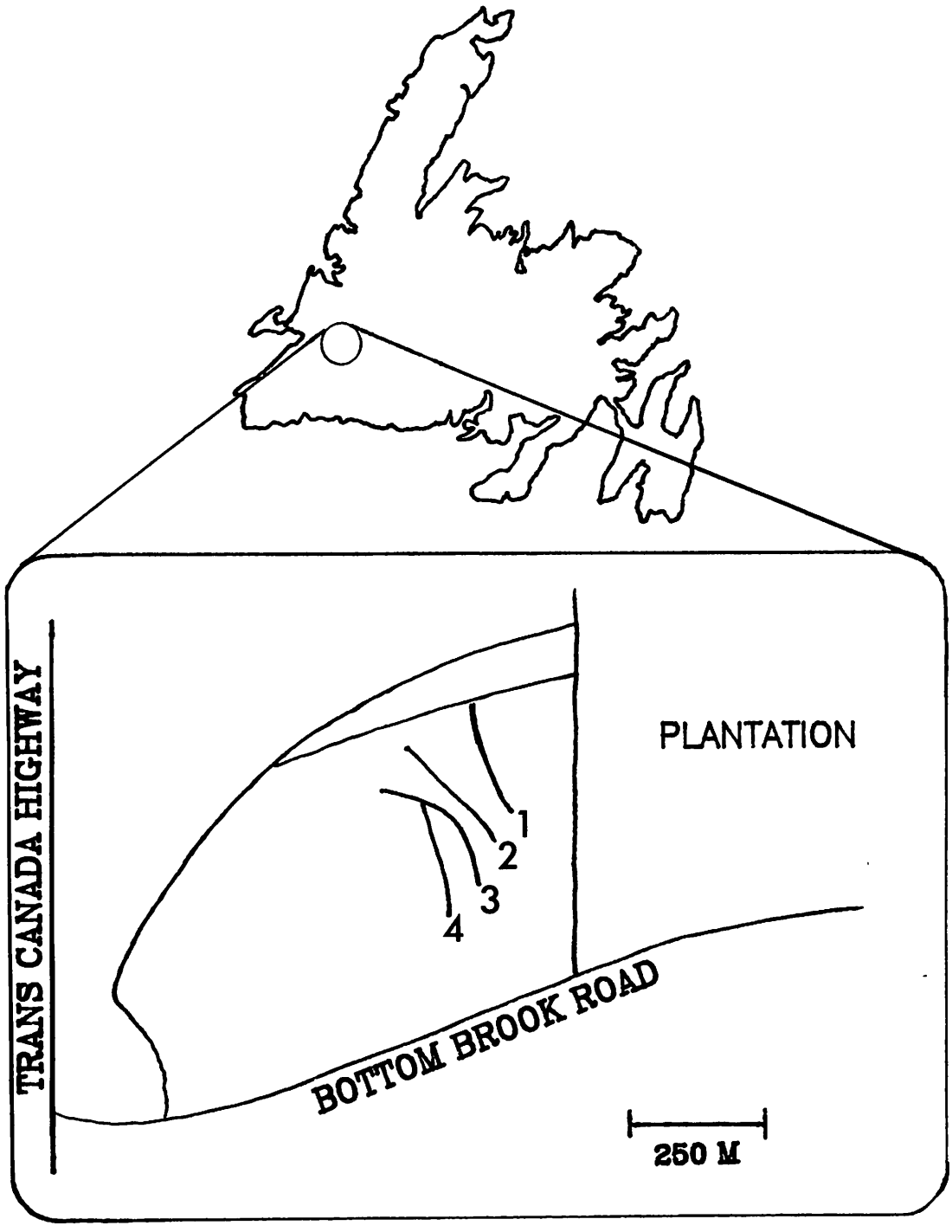

Figure 1. Location of study area and layout of treatment (1,2) and control (3,4) lines at Bottom Brook, Newfoundland in 1986. The plantation next to the study area was sprayed with Bacillus thuringiensis in 1985.

METHODS

Plot Layout

Four sampling lines were located on a south-facing slope in the white birch and balsam fir woods adjacent to the plantation at Bottom Brook in western Newfoundland to determine the effect of Virtuss against WMTM larvae (Fig. 1). Lines 1 and 2 were treated whereas lines 3 and 4 were untreated and used for controls. Each line was 120 m long with sampling stations located at 8 m intervals, for a total of 15 stations per line. The distance between neighbouring lines ranged from 30 m to 50 m.

Spray Formulation and Application

Virtuss was applied at a rate of 12.5 g containing 2×10^{10} polyhedral inclusion bodies (PIBs)/g in 20 ℓ of water/ha along each side of lines 1 and 2 on 13 July 1986 when most larvae were in the first instar. The rate used was 2.5×10^{11} PIBs/ha and is the dosage recommended on the label for Douglas-fir tussock moth control. The spray drift during application was judged to be 10 m for each side of the spray line. The area covered for each line was therefore 0.24 ha (2 x 120 m x 10 m). The application was delivered at full throttle from a Solo® backpack mist-blower on setting #2 while walking at a slow pace (cover photo).

Weather

Daily maximum/minimum temperatures and precipitation were monitored at the Stephenville Airport, 22 km from the treated area during July and August.

Infection Levels

One hundred larvae were collected from each line at 24 h pre-spray and at 1, 2, 3, 4, and 5 weeks post-spray, and sent to the Forest Pest Management Institute (FPMI) for examination. In this examination, larvae were smeared on glass slides and air-dried. Smears were stained for 5 minutes in Naphthalene black 12B at 40°C, rinsed in water and dried. This procedure stained PIBs a deep, blue-black. Stained preparations were examined under a compound microscope using oil-immersion optics at 1000x for the presence of PIBs, which confirms nuclear polyhedrosis virus (NPV) infection.

Effect of Treatment

Sampled trees were 2-4 m high for birch and 2-3 m high for balsam fir. Three sampling units were used to estimate larval populations at 24 h pre-spray and at 3 and 5 weeks post-spray at each of the 15 sampling stations for all four lines:

1) Birch beating sample and (2) Balsam fir beating sample:
   One m^3 of foliage (either birch or fir) was beaten with a 1 m stick to dislodge larvae onto a 1 x 1 m sheet, and larvae were then counted. For consistency, all beating samples were made by the same individual.
3) Balsam fir branch sample: One 45 cm mid-crown branch tip was removed and examined to determine the number of larvae present.

Population reduction due to treatment was determined using Abbott's (1925) formula modified by Fleming and Retnakaran (1985). Treatment lines were matched to the control line with the closest pre-spray population level.

Defoliation of birch was assessed along all lines from the ground at five weeks post-spray. Four mid-crown branches of balsam fir were sampled from each sample station for all lines in May 1987 and examined for the presence of egg masses.

RESULTS AND DISCUSSION

Weather

Heavy rains (16.2 mm) fell on 15 July two days after treatment and some spray deposit may have been washed from the foliage.

Infection Levels

A low pre-spray level of virus infection was present on all sample lines (Table 1). The impact of virus treatment was soon noticeable and, one week after treatment, infection levels in the treated lines at 23.5% and 31.0% were higher than in the control lines at 9.0% and 2.9%. Infection levels continued to increase for 5 weeks to over 60% in the treated lines. By the 5th week an epizootic had developed and the virus spread to the control lines thus increasing infection levels from 5 to 18% and 9 to 20% between the fourth and fifth week of sampling.

Effect of Treatment

Population reduction due to treatment varied with the treatment line and the method of sampling used (Table 2). Larval sampling by beating birch foliage in line 1 failed to indicate any population reduction. All other lines and sampling methods showed an overall population reduction by week three and a further reduction by week five. Reductions by week three ranged from 1.0% to 45.0% and from 50.6% to 83.5% by week five.

Table 1. Percent of white-marked tussock moth larvae infected with nuclear polyhedrosis virus in samples taken from Bottom Brook, Newfoundland in July and August 1986 following treatment with Virtuss. Samples of 100 larvae were taken at 24 h pre-spray and weekly for the 5-week post-spray period.

			Percent of Larvae Infected with NPV				
			Post-spray Week Number				
Treatment	Line	Pre-spray	1	2	3	4	5
Virtuss	1	1.2	23.5	24.0	28.4	47.3	62.4
Virtuss	2	1.9	31.0	22.0	46.2	74.4	68.9
Control	3	1.8	9.0	1.0	0.8	9.0	20.8
Control	4	0.9	2.9	0	0	4.9	18.3

The population reduction estimates for week five can be considered conservative because the level of infection had risen to 18-21% in the control lines (Table 1) causing some mortality. Mortality due to virus in the control lines would affect the post-spray counts and lead to lower estimates of population reduction due to treatment.

Other factors also may have affected the population reduction estimates. Fleming and Retnakaran (1985) indicated that lower pre-spray numbers in the control than in the treatment plots (Table 2: lines 1 + 4 and 2 + 4 - beating fir samples; lines 1 + 4 and 2 + 4 - 45 cm fir tip samples) will result in overestimations of population reduction due to treatment. Conversely, higher pre-spray numbers in the control plots (i.e. lines 1 + 4 and 2 + 4 - beating birch samples) will lead to underestimations of population reduction.

Table 2. Effect of ground applications of Virtuss on larval populations of the white-marked tussock moth at Bottom Brook, Newfoundland in 1986 (Treatment = lines 1 and 2, Controls = lines 3 and 4).

Sampling method	Line No.	No. Samples	Total No. Larvae Sampled (± S.E. of mean) Pre-spray	3 weeks post-spray	5 weeks post-spray	Percent Population Reduction[1] 3 weeks post-spray	5 weeks post-spray
A) Beating 1 m^2 of birch	1	15	663 ± 4.7	775 ± 10.2	253 ± 2.0		
	4	15	883 ± 6.0	690 ± 5.2	242 ± 2.4	0	0
	2	15	777 ± 5.6	435 ± 2.3	105 ± 0.8		
	4	15	883 ± 6.0	690 ± 5.2	242 ± 2.4	28.3	50.6
B) Beating 1 m^2 of balsam fir	1	15	123 ± 1.2	48 ± 0.8	16 ± 0.3		
	4	15	100 ± 1.0	39 ± 0.7	32 ± 0.6	1.0	58.9
	2	15	140 ± 1.6	30 ± 0.5	10 ± 0.2		
	4	15	101 ± 1.0	39 ± 0.7	32 ± 0.6	44.5	77.5
C) 45 cm branch tip of balsam fir	1	15	53 ± 1.0	17 ± 0.3	4 ± 0.1		
	4	15	24 ± 0.4	14 ± 0.2	11 ± 0.2	45.0	83.5
	2	15	33 ± 0.5	18 ± 0.2	5 ± 0.1		
	4	15	24 ± 0.4	14 ± 0.2	11 ± 0.2	6.5	66.9

[1]Abbott's formula:

$$\% \text{ Population reduction} = \left[1 - \frac{\text{post-spray treatment pop.}}{\text{pre-spray treatment pop.}} \times \frac{\text{pre-spray control pop.}}{\text{post-spray control pop.}} \right] \times 100$$

Although application of Virtuss did increase infection levels, it did not immediately reduce population levels and greater than 50% population reduction generally did not occur until week five (Table 2). Possibly rain following the application may have diluted the virus on the foliage and delayed development of the epizootic. The slow speed of kill explains the lack of obvious differences in severity of defoliation between the treated and untreated lines; birch along all four lines was about 60% defoliated. Similar results have been observed following application of Virtuss on Douglas-fir tussock moth larvae (Shepherd et al. 1984).

Only one egg mass (line 1) was recovered from the mid-crown branch samples indicating that the WMTM population had collapsed in the study area. A second infestation of WMTM along Bottom Brook Road several kilometres southwest of the 1986 study area persisted in 1987. Only 3% of 200 larvae collected 9 July 1987 from this infestation were infected with naturally occurring NPV (W.J. Kaupp, unpublished data). We assume the population collapse in the study area was due to a virus epizootic initiated by the application of Virtuss and not to a naturally occurring NPV which was present at a low level in the WMTM population prior to spray application. The control and treatment lines were probably too close and virus infection in the control lines may have been due to spread from the treatment lines. Levels of virus-infected larvae were much higher in the treatment than in the control lines at five weeks post-spray and a second infestation of WMTM in the same general area did not collapse.

In conclusion, field applications of Virtuss against first-instar WMTM led to 60% infection of larvae and noticeable reduction in larval numbers after several weeks. Although this treatment failed to protect foliage in the year of treatment, the collapse of the population in the study area indicates that Virtuss may be effective in initiating an epizootic and providing foliage protection in the long-term. Further field trials of Virtuss against the WMTM are recommended and aerial applications should be attempted because this is the only feasible method of treating forested areas.

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