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Aerial application of virtuss®, a nuclear polyhedrosis virus, against whitemarked tussock moth larvae in Newfoundland in 1987

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

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Newfoundland and Labrador Region

AERIAL APPLICATION OF VIRTUSS[R], A NUCLEAR POLYHEDROSIS VIRUS, AGAINST WHITEMARKED TUSSOCK MOTH LARVAE IN NEWFOUNDLAND IN 1987

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ABSTRACT

The viral insecticide Virtuss^R, which contains a nuclear polyhedrosis virus (NPV), was aerially applied at a dosage of 2.5 x 10^{11} polyhedral inclusion bodies (PIB) per hectare against a larval population of whitemarked tussock moth larvae in a 25 ha plot containing white birch and balsam fir located near Bottom Brook, Newfoundland in 1987. The treatment was applied at a flow rate of 9.4 L/ha with a fixed-wing aircraft equipped with AU4000 Micronair rotary atomizers.

Three weeks after application, the incidence of larvae infected with NPV was 91% in the treated plot and 69% in the nearby check plot; after five weeks 100% of larvae in both plots were infected. The presence of NPV in the check plot and spread throughout the treated plot was attributed to secondary infection. Reductions in larval numbers due to treatment was 36% at 3 weeks post-spray and 93% at 5 weeks post-spray. The number of egg masses laid in the fall in the vicinity of the treated and check plots was low, but increased with distance from the sprayed area.

RÉSUMÉ

En 1987, la Virtuss^R, un insecticide viral qui contient un virus de la polyédrose nucléaire (VPN), a été appliqué par avion à un dosage de 2,5 x 10^{11} corps d'inclusion polyédraux (CIP) par hectare contre une population de larves de chenilles à houppes blanches au-dessus d'un lot de bouleaux à papier et de sapins baumiers de 25 hectares situé près de Bottom Brook (Terre-Neuve). Le traitement a été appliqué à un débit de 9,4 litres par hectare à partir d'un appareil à voilure fixe équipé de pulvérisateurs rotatifs Micronair AU4000.

Trois semaines après l'application, 91% des larves du lot traité et 69% des larves du lot-témoin adjacent étaient infectées; après cinq semaines, 100% des larves des deux lots étaient infectées. La présence de VPN dans le lot-témoin et sa diffusion dans le lot traité ont été attribuées à l'infection secondaire. A la suite du traitement, la réduction du nombre de larves attribuable à la pulvérisation était de 36% après trois semaines et de 93% après cinq semaines. À l'automne, seul un petit nombre de masses d'oeufs furent pondues aux environs du lot traité et du lot-témoin; mais on observa que leur quantité augmentait à mesure qu'on s'éloignait de la zone pulvérisée.

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INTRODUCTION

The whitemarked tussock moth (WMTM), Orgyia leucostigma (J.E. Smith) (Lepidoptera: Lymantriidae), sporadically infests coniferous plantations in eastern North America. Although the insect is primarily a pest of hardwoods, high populations can severely defoliate eastern larch, Larix laricina (Du Roi) Koch., spruce, Picea spp. and balsam fir, Abies balsamea (L.) Mill. This insect is also a nuisance as the larvae have urticating hairs that cause skin rashes on some individuals.

The market potential for a product to control the WMTM is limited because outbreaks are usually small and do not persist for extended periods because they collapse from naturally occurring viral diseases. Thus, it is unlikely that chemical agents will be developed due to a very expensive registration process and a low return on investment. Microbial control agents, however, can be registered at a lower cost. They are usually much more specific than chemical insecticides and for insects which cause localized outbreaks, such as the WMTM, they need to be produced only in small quantities.

Virtuss^R is a nuclear polyhedrosis virus (NPV) isolated from the Douglas-fir tussock moth, Orgyia pseudotsugata (McDunnough), and propagated in WMTM larvae; it is a lyopholized, finely-ground powder prepared from virus-infected larvae. Virtuss is fully registered for use against Douglas-fir tussock moth in Canada and efforts are underway to include WMTM as a targeted insect on the product label.

The efficacy of a ground spray application of Virtuss on WMTM larvae was assessed in an infested area of the Bottom Brook Valley in western Newfoundland in 1986 (West et al. 1987). Larvae were successfully infected and there was a localized population collapse attributed to a viral epizootic initiated by the application. The infestation continued in 1987 in an area about 7 km from the location of the 1986 ground application (Fig. 1) and presented an opportunity to test the efficacy of an aerial application of Virtuss against the WMTM.

METHODS

Plot Layout

The treated plot, 250 m by 1000 m (25 ha), was located along a south-facing slope in a mixed forest of white birch, Betula papyrifera Marsh; balsam fir, Abies balsamea (L.) Mill.; red maple, Acer rubrum L.; black spruce, Picea mariana (Mill.) B.S.P.; and white spruce, Picea glauca (Moench) Voss. An untreated area 90 m south of the treated plot was used as a check plot (Fig. 1). Trees were about 25 years old in the check plot and in the first 100 m along the bottom of the slope of the treated plot. Older birch dominated and created an overstory further up the treated slope.

Spray Formulation and Application

Virtuss was mixed in water with the addition of 6% (w/v) Orzan LS[R], a lignosulphate used as a protectant against ultraviolet light,

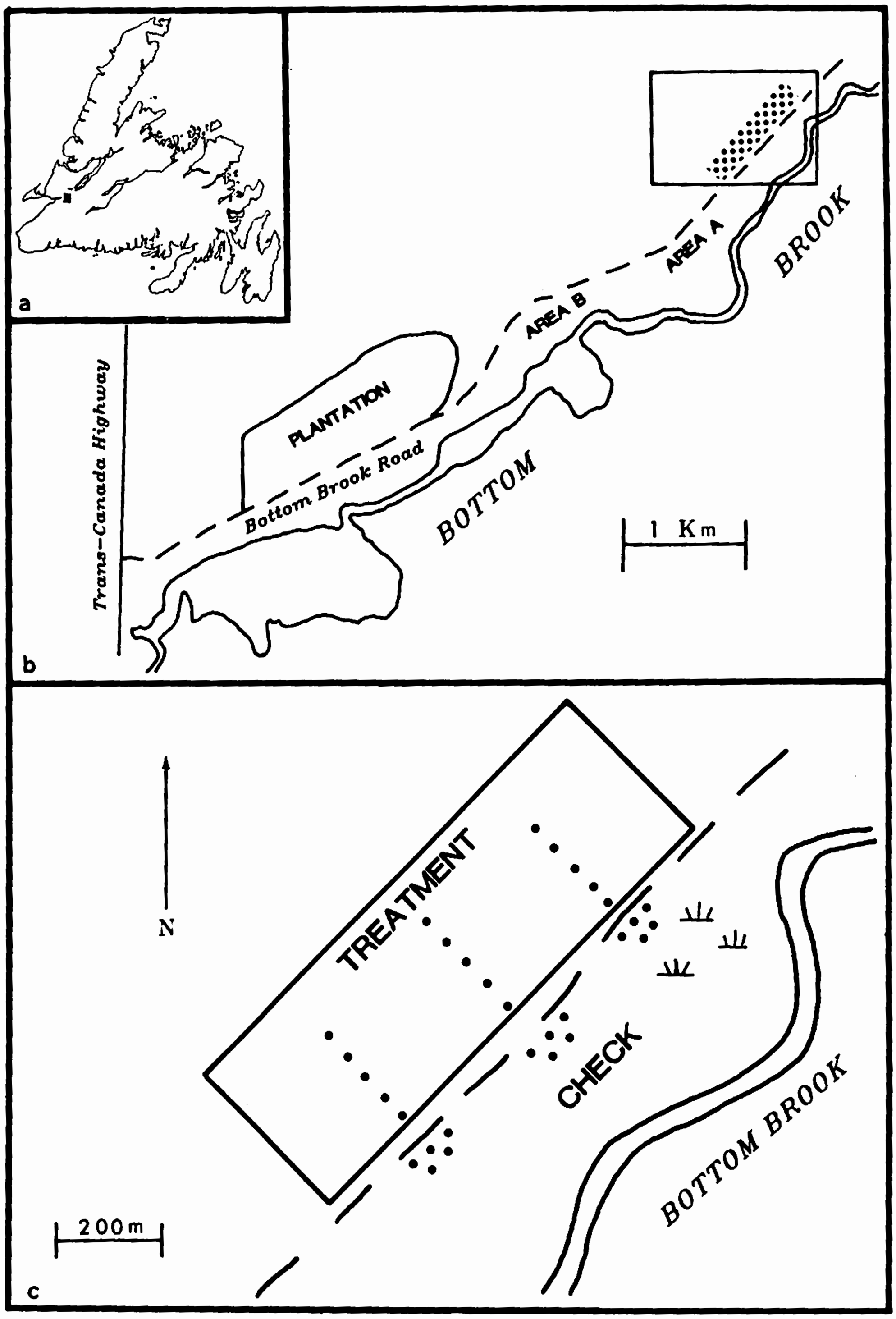

Figure 1. Location of study site and plot layout for aerial application of Virtuss against the whitemarked tussock moth in Newfoundland in 1987. a = location in Newfoundland; b = location in Bottom Brook area, stipple = area sprayed with Virtuss; c = enlargement of area framed in b, dots = sample points.

and applied at a rate of 2.5 x 10^{11} polyhedral inclusion bodies (PIB) in 9.4 L/ha at 2000 h on 12 July 1987 with a Piper Pawnee aircraft. The plane was equipped with six AU4000 Micronair^{R} rotary atomizers and flew at 140 km/h in swaths 30 m apart at an altitude of 20 m above the treetops. Swaths were flown from east to west. The application was videotaped at ground level from the southwest boundary of the plot. Larvae were in the second or third instar at the time of application.

Weather

Records of daily maximum/minimum temperatures and precipitation at the Stephenville Airport, 28 km from the treated area, were available for the entire study period.

Infection Levels

Samples of larvae were examined microscopically for the presence of PIBs (West et al. 1987). At least 50 larvae were examined per plot for the pre-spray (8-9 July) and first post-spray (4 August) sample, but this was not possible for the second post-spray sample (18 August) when population densities were very low.

Population Assessment

Larvae were counted at 15 sampling points each in the treated plot and in the check plot (Fig. 1) on 8-9 July (pre-spray), 4 August (first post-spray) and 18 August (second post-spray). At each sampling point, six 1-m long branch tips were removed from a birch tree at mid-crown and beaten individually with a stick over a 1 m^2 beating sheet to dislodge larvae for counting. The six branches represented one sample unit. Population reduction due to treatment was calculated using a modified Abbott's (1925) formula (Fleming and Retnakaran 1985). Sample lines in the treated plot were matched with lines in the check plot which had similar pre-spray population densities.

For egg-mass counts, four 45 cm long mid-crown branches were removed from balsam fir trees at the sample points in each plot in October 1987 and examined. In May 1988, additional balsam fir trees were sampled similarly in unsprayed areas 0 to 1 km and 3 to 4 km west of the treated plot (Fig. 1; Area A, Area B).

Defoliation Assessment

A cursory assessment of white birch defoliation was made from the ground five weeks after the application of Virtuss.

RESULTS AND DISCUSSION

Weather and Application

It was 20°C, hazy and humid with a southwest wind of 10-12 km/h during the application. The spray cloud drifted onto the slope of the treated plot, but not into the check plot. A light rain (0.2 mm) fell 3 days after the application and this was followed the next day with an accumulation of 5.4 mm.

Infection Levels

Less than 3% of the larvae collected from the treated and check plots before the application were infected with NPV. The first post-spray sample showed that 79% of the larvae in the west sample line, 96%

in the centre line and 98% in the east line in the treated plot were infected and 69% were infected in the check plot. The lower incidence of infected larvae on the west line of the treated plot might be explained by a lower deposit caused by an west to east spray drift. All larvae examined from the second post-spray sample of both the treated and check plots were infected with NPV. The high infection levels indicated good spray coverage and possibly some spray drift into the check plot, although this was not directly observed. A viral epizootic similar to the one that developed following ground sprays in 1986 (West et al. 1987) also would account for spread of the virus into the check plot after three weeks and infection of all remaining larvae in both plots after five weeks.

The incidence of NPV-infected larvae following the aerial application was much higher than those recorded for the 1986 ground application at the same post-spray intervals.

Effect of Treatment

The change in larval numbers varied between treated lines three weeks after treatment (Table 1). In the west line, numbers dropped slightly but a large (51%) reduction was calculated because counts in the matched check rose substantially. In the centre line there was a major decrease in larval numbers while the matched control had a slight increase in the number of larvae. A sizeable reduction of 62% was calculated for this line, but according to Fleming and Retnakaran (1985) should be considered an over estimation because pre-spray counts were

Table 1. Effect of an aerial application of Virtuss on larval populations of the whitemarked tussock moth at Bottom Brook, Newfoundland in 1987. Five sample units each consisting of six 1-m long birch branch tips were examined for each line.

		No. larvae/sample unit ($\bar{x}$ ± S.E.)			Post-spray population reduction (%)	
Treatment	Line	Pre-spray	3 weeks Post-spray	5 weeks Post-spray	3 weeks	5 weeks
Virtuss	West	53.2 ± 16.3	48.6 ± 4.5	0	50.8	100
Check		70.4 ± 12.4	130.8 ± 18.1	2.2 ± 1.4		
Virtuss	Central	36.2 ± 27.4	59.4 ± 12.7	0.4 ± 0.4	61.5	93.3
Check		95.4 ± 11.6	108.0 ± 17.8	4.2 ± 1.2		
Virtuss	East	87.4 ± 14.8	97.0 ± 10.1	0.2 ± 0.2	0	89.4
Check		92.6 ± 34.1	61.4 ± 8.9	2.0 ± 0.7		
Virtuss	Plot average	92.3 ± 12.2	68.3 7.6	0.2 ± 0.1	36.3	93.3
Check		86.1 ± 12.1	100.1 ± 11.3	2.8 ± 0.7		

lower in the matched check line. No reduction was observed in the east line where larval numbers increased slightly in the treated area but decreased in the check area. The reason for this is not clear, perhaps there was more movement of larvae into the treated line than into the check line. For the whole treated area three weeks post-spray, a 36% reduction was calculated. This calculation is reasonable considering that pre-spray counts were similar in the check and treatment plots.

The number of larvae five weeks after treatment were less than 5/sample unit for the check plot and 0.4 or less/sample unit for the treatment plot (Table 1). The sharp decline in larval numbers between the third and fifth week following application indicated spread of the virus within the treated plot and into the check plot. This secondary infection is due to horizontal transmission of NPV released from virus-killed larvae and ingested by larvae which avoided receiving a lethal dose at the time Virtuss was applied.

The number of egg masses recovered from balsam fir branches was low in samples from the treated plot (2/60 branches) but increased with the distance from the treated plot (Table 2). Therefore population reduction and secondary infection was localized following an application of Virtuss against WMTM larvae. However, the low numbers of egg masses

Table 2. Number of whitemarked tussock moth egg masses laid in 1987 and found on balsam fir foliage sampled at Bottom Brook, Newfoundland in the vicinity of the area treated with Virtuss in 1987. Area A, 0 to 1 km west of treated plot; Area B, 3 to 4 km west of treated plot.

Location	No. sample points	No. branches/ sample point	Total no. egg masses	No. egg masses/ 45 cm branch tip
Virtuss plot	15	4	2	0.03
Check plot	15	4	7	0.12
Area A	15	4	9	0.15
Area B	11	3	11	0.33

found in samples in unsprayed areas nearest the treated plot (Table 2) suggest that the effects of treatment went beyond the sprayed area. These observations and the apparent spread of NPV infection to larvae in the check plot support a strategy of spraying alternate swaths when treating infested stands. This strategy, also recommended for control of the Douglas-fir tussock moth (Otvos *et al.* 1987), would utilize limited supplies of Virtuss more efficiently.

There was no evidence of reduced defoliation in the treated plot; defoliation was about 20% on white birch in both the treatment and check plots. Disease spread into the check plot may account for the apparent lack of foliage protection in the treated plot. Fifth and sixth instar larvae cause the greatest amount of defoliation, but few were found in either the check plot or the treated plot at the time of the second post-spray sample.

The use of Virtuss is a viable control option against the whitemarked tussock moth, especially during the initial stages of an outbreak. Our results support the addition of *Orgyia leucostisma* to the registration label of Virtuss for minor use purposes.

ACKNOWLEDGMENTS

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