

EFFICACY TRIALS OF THURICIDE 32LV
AGAINST
THE DOUGLAS-FIR TUSsock MoTH
1983

by

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by

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<u>Contents</u>	<u>Page</u>
Contents	i
Figures	ii
Tables	ii
Acknowledgements	iii
Abstract	iv
I. INTRODUCTION	1
II. METHODS	4
III. RESULTS AND DISCUSSION	7
IV. RECOMMENDATIONS	12
V. LITERATURE CITED	13

	<u>List of Figures</u>	<u>Page</u>
1.	Areas in British Columbia that have sustained one or more outbreaks since 1916.	2
2.	Location of Thuricide 32LV treatment area.	5
3.	Effect of ground application of Thuricide 32LV on Douglas-fir tussock moth survival at 8, 15, 22, 29 and 36 days post-treatment.	9

	<u>List of Tables</u>	<u>Page</u>
I.	Effects of Thuricide 32LV treatment on the survival of Douglas-fir tussock moth larvae in 1983.	8
II.	Loss of Douglas-fir foliage (current year: 1983; previous year: 1982).	11

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ABSTRACT

Thuricide 32LV^R (Bacillus thuringiensis Berliner var. Kurstaki) effectively controlled a Douglas-fir tussock moth (Orgyia pseudotsuga (McDunnough) infestation near Cache Creek, British Columbia. Two plots were treated using a commercial hydraulic ground spray system which delivered an application rate of 24.28 BIU/hectare. Larval population reduction reached a maximum of 99.12% by 15 days post-treatment. No new growth foliage protection could be attributed to the treatment; no substantial amount of old growth foliage protection could be attributed to the treatment.

I. INTRODUCTION

Outbreaks of the Douglas-fir tussock moth (DFTM), Orgyia pseudotsuga (McDunnough), have occurred periodically in the interior of British Columbia since 1916 (Canadian Forestry Service, 1980; Wood and Woensdregt, 1982)(Figure 1). These outbreaks occur mainly in dry belt Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) stands that contain a mixed component of ponderosa pine (Pinus ponderosa Law.) and Douglas-fir. In 1982 a total of 12 820 hectares were attacked by this forest pest; 9 743 hectares of this total being productive forest area (Ross and Taylor 1983). Ross and Taylor (1983) predicted that 6 514 hectares would be attacked in 1983; 4 944 hectares of this total being productive forest area.

These outbreaks are usually characterized by a rapid increase in insect numbers, 1 or 2 years of high densities during which conspicuous tree defoliation occurs and finally a collapse of the population (Mason 1980; Brookes et al 1978). Tree damage is caused through larval feeding. First- and second-instars feed on the underside of new needles turning the needles a reddish brown. Third to last instars feed on both new and old needles. The amount of tree mortality, top-kill, growth reduction and foliage recovery is directly related to the degree of defoliation (Brookes et al 1978; Wickman 1978, 1979).

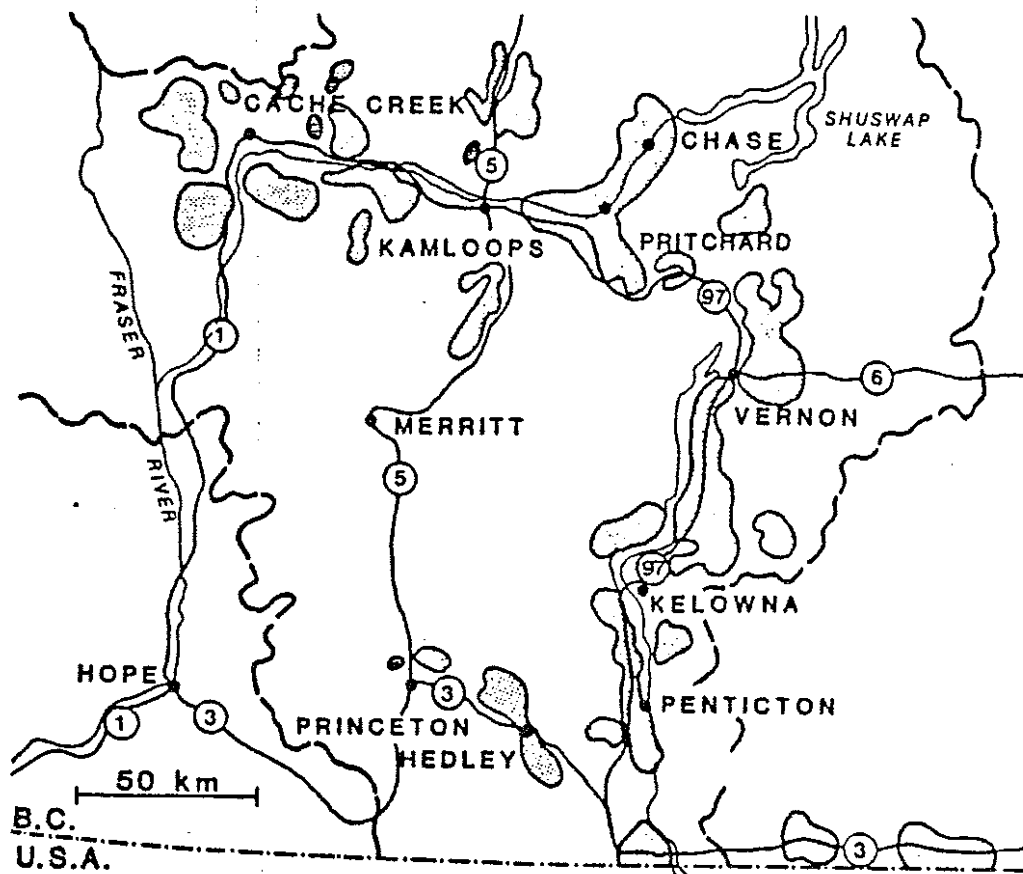


Figure 1: Areas that have sustained one or more DFTM outbreaks since 1916 (Source: Canadian Forestry Service report BC-X-201)

Management systems for the DFTM include chemical (insecticides or pheromones) or microbial (viral or bacterial) agents (Brookes et al 1978). Few of these materials are registered for the control of this pest in Canada. At present the microbial agent, Nucleopolyhedrosis virus (NPV) has minor registration for the control of DFTM in Canada¹.

Bacillus thuringiensis Berliner, an aerobic spore-forming bacterium, is toxic to many species of moths and butterflies, with no adverse effects on man, birds, mammals or fish (Falcon 1971). Formulations are marketed in the United States of America under the trade names of Thuricide^R, Dipel^R and Biotrol^R for use to control several insects on a variety of food and field crops, shade and ornamental trees, and forests (Harper 1974).

The control of DFTM infestations using chemical pesticides may be undersirable or prohibited. Though Bacillus thuringiensis is effective in aerial applications in the forests (Brookes et al 1978); there is a need to demonstrate its effectiveness with ground spraying equipment. The objective of this study is to determine the efficacy of Thuricide 32 LV^{R 2} (Bacillus thuringiensis Berliner variety Kurstaki) when applied by hydraulic ground sprayer, against a Douglas-fir tussock moth infestation.

1: J. Cunningham. C.F.S., F.P.M.I., Saulte Ste. Marie, Ontario.
2: Registered trade mark of Sandoz Inc., San Diego, California.

II. METHODS

In the Spring of 1983 representatives of the British Columbia Ministry of Forests conducted a sequential egg mass survey (Shepherd, Otvos and Chorney 1984) in the study area located east of Cache Creek, British Columbia (Figure 2). This survey indicated that severe defoliation could be expected in this area in 1983. The study area was divided into two treatment plots and two check plots.

Fifteen trees, scattered throughout each of the treatment plots were selected and tagged as sample trees on the basis of full crown foliage and tree height (11-15 meters). The trees adjacent to the sample trees were tagged as buffer trees. In total 173 trees (30 sample and 143 buffer trees) were treated with Thuricide 32LV (B.t. var. Kurstaki, 8.4 BIU/Liter). Fifteen sample trees were selected and tagged in each of the check plots using the same criteria as above.

Egg hatch and larval dispersal were monitored prior to B.t. treatment. Treatment occurred when the majority of larvae were third instars.

A commercial hydraulic ground spraying system of B and W Agricultural Services Ltd. was used to apply the Thuricide 32LV. The system components were: two mixing tanks having a total capacity of 1134 liters, a mechanical agitator, and a spray gun system (Jet #2A: nozzle type AYHSS 60). The applications rates were 24.28 BIU/hectare and 26.41 BIU/hectare

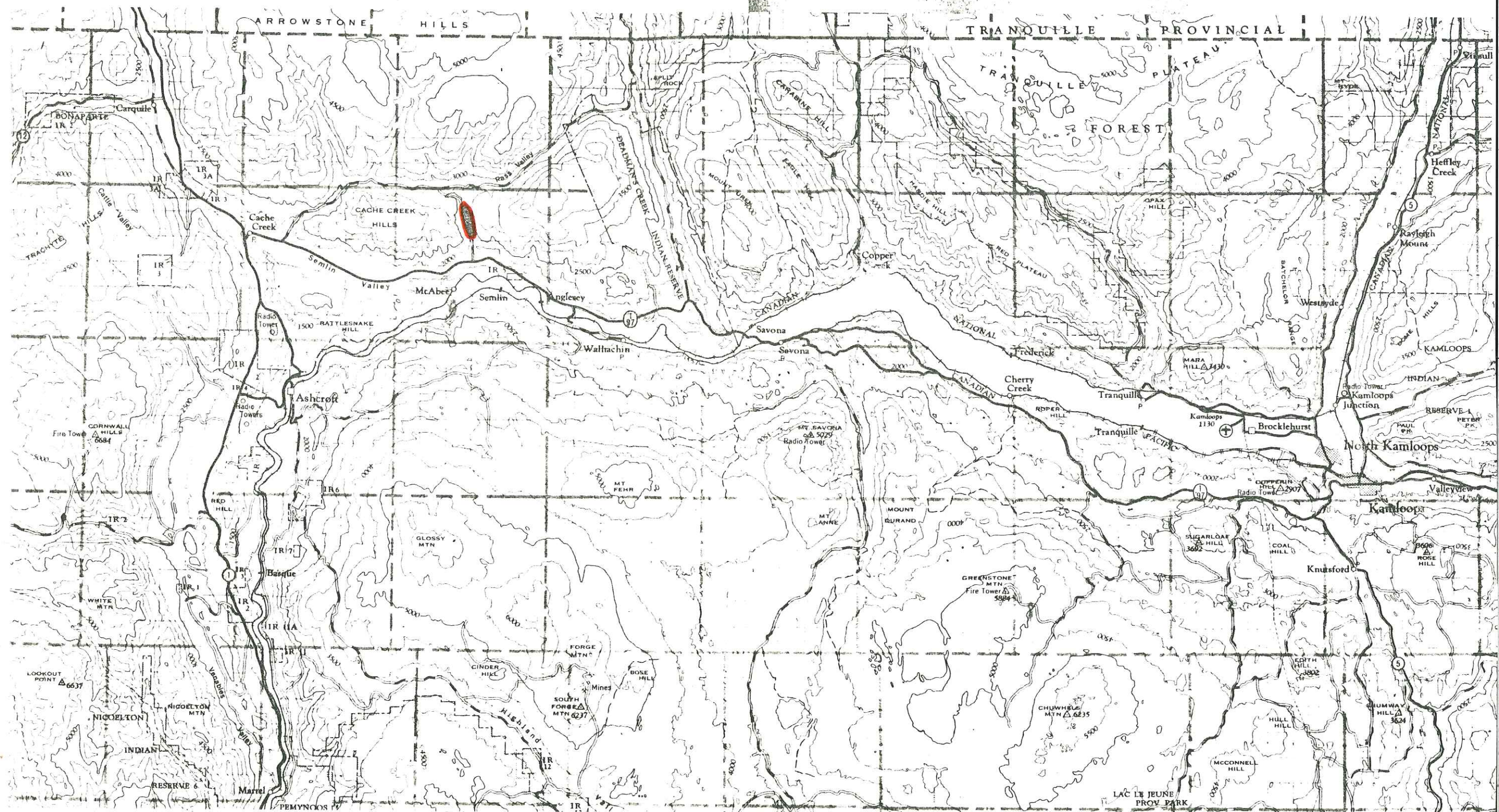


Figure 2: Location of Thuricide 32LV treatment area.

for plots one and two, respectively. Each sample tree and buffer tree was sprayed to drip point. No sun screen was added to the Thuricide. The treatment occurred in the early morning when meteorological conditions were ideal.

DFTM larval population density was monitored 7 days prior to treatment and 8, 15, 22, 29 and 36 days post-treatment. Monitoring consisted of clipping two 45 centimeter branch tips from the mid-crown section of each of the sample trees. A basket equipped pruning pole was used to reach and clip the branches. The foliated branch surface area was measured and the number of larvae counted and recorded for each branch. Abbott's formula (Abbott 1925) was applied to the population density data to eliminate population reduction due to natural causes.

Foliage protection was assessed by visually estimating the percentage of defoliation of new growth (1983) and older growth (1982) for each of the sample branches. This assessment was made at the pre-spray and each of the post-spray population density sampling times.

III RESULTS AND DISCUSSION

Thuricide 32LV^R was effective operationally at 24.28 BIU/hectare, when it was applied with a commercial hydraulic ground spray system. Within 8 days of application treatment plot two had an 88.8% reduction in its DFTM larval population. By 15 days post-treatment population reduction was 84.03% and 99.12% respectively for treatment plots one and two (Table I). These levels of population reduction are sufficient to control a DFTM infestation.

Plotting the larval survival ratio¹ against days post-spray demonstrated that the Thuricide 32LV^R substantially decreased the DFTM populations in each of the treatment plots (Figure 3). The initial decrease in larval density within 8 days of treatment reflects the quick effect of the B. thuringiensis. With other lepidopterous larvae cessation of feeding may occur from one half hour to two hours after initial contact, with death following. Larvae could remain on the foliage for 3-5 days before death without any further foliage damage (Sandoz Inc. 1983). Also, under normal field conditions Thuricide 32LV^R normally retains residual effectiveness for 4-10 days. This could account for the low survival ratios of 0.26 and 0.09 respectively for treatment plots one and two which occurred at 8 days post-spray.

1: the post-spray mean larval density per square meter of foliage divided by the pre-spray mean larval density per square meter of foliage.

TABLE I. Effects of Thuricide 32LV treatment on the survival of Douglas-fir tussock moth larvae in 1983.

Treatment (Plot)	Population Density ¹				
	Pre-spray. (8 day)	Post-spray. (15 day)	Post-spray. (22 day)	Post-spray. (29 day)	Post-spray. (36 day)
Thuricide 32LV (1)	191.38	50.65 (0.264) ^a	83.72 (0.437)	51.80 (0.271)	115.90 (0.605)
Thuricide 32LV (2)	102.56	9.86 (0.096)	2.47 (0.024)	3.39 (0.033)	6.89 (0.067)
Check (1)	186.70	23.46 (0.125)	66.60 (0.357)	30.26 (0.162)	49.89 (0.261)
Check (2)	146.83	126.04 (0.858)	402.12 (2.738)	166.91 (1.136)	222.07 (1.512)
100					
Treatment (Plot)	Percent population reduction due to treatment ²				
	Pre-spray. (8 day)	Post-spray. (15 day)	Post-spray. (22 day)	Post-spray. (29 day)	Post-spray. (36 day)
Thuricide 32LV (1)	-	69.17	84.03	76.19	59.95
Thuricide 32LV (2)	-	88.80	99.12	97.09	95.56
Checks (1 and 2)	-	-	-	-	-

1: number of tussock moth larvae per square meter of foliage.

2: adjusted by Abbott's formula.

a: survival ratio= post-spray population density/pre-spray population density.

Check plot two, approximately 50 meters from treatment plot two, became contaminated through spray drift during the application of B. thuringiensis. This resulted in larval survival ratios which were very similar to those of the treated plots (Figure 3). Therefore this plot is not used to evaluate the efficacy of Thuricide 32LV^R.

The larval survival ratio of both the check and treated plots fluctuated with time (Figure 3). These fluctuations were more pronounced in check plot two than in either of the treated plots. It is the re-distribution of larvae throughout the crown of the tree which causes these larval density fluctuations. Young larvae generally migrate to the tops of the trees where there is an abundance of new foliage. Larvae initially feed on new foliage. When this is depleted they start feeding on older foliage. They typically drop or crawl down to the lower crown levels to feed on the new growth.

Fluctuations of larval populations in the treated plots was less than that of check plot two. This was likely due to the cessation of feeding caused by B. thuringiensis.

There was no substantial difference in the amount of defoliation in the check plots and the treated plots (Table II). By 15 days post-spray nearly 100 percent of the new (1983) foliage was defoliated in all plots. Defoliation of older (1982) foliage in the treated plots ranged from 33.5% to 41.3%. Defoliation in check plot two was 53.7%. By 36 days post-spray 100% of the new foliage was defoliated in all plots. Defoliation of the older growth ranged from 27.7% to 60.0% in the treated

TABLE II. Loss of Douglas-fir foliage (current year: 1983; previous year: 1982)

Year	Percent Defoliation					
	Pre-spray	Post-spray	Post-spray	Post-spray	Post-spray	Post-spray
	1983 (1982)	(8 day) 1983 (1982)	(15 day) 1983 (1982)	(22 day) 1983 (1982)	(29 day) 1983 (1982)	(36 day) 1983 (1982)
Treatment (Plot)						
Thuricide 32LV (1)	6.2 (ND) ¹	5.7 (ND)	100 (33.5)	93.7(67.5)	100 (39.2)	100 (27.7)
Thuricide 32LV (2)	ND	6.0 (ND)	100 (41.3)	92.0(65.7)	100 (74.3)	100 (60.0)
Check (1)	ND	5.0 (ND)	99.0(36.5)	97.0(68.7)	100 (51.6)	100 (59.3)
Check (2)	5.3 (ND)	5.6 (ND)	100 (53.7)	99.3(74.6)	100 (62.5)	100 (70.4)

1: No data collected

plots and was 70.4% in check plot two.

IV. RECOMMENDATIONS

The results of this study indicate that Thuricide 32LV^R is effective at 24.28 BIU/hectare, in substantially reducing DFTM larval density, when applied with a commercial hydraulic ground spray system. It is therefore recommended that Thuricide 32LV^R be considered for minor registration for ground application control of the Douglas-fir tussock moth.

Application rates less than 24.28 BIU/hectare may be just as effective in reducing the DFTM larval density of an infestation. It is therefore recommended that further studies be undertaken to ascertain the lower limit at which Thuricide 32LV^R is effective as a control agent of the DFTM.

Finally, Thuricide 32LV^R does not appear to substantially reduce foliage loss on Douglas-fir trees due to feeding by the DFTM. Further studies are needed with respect to the timing of the Thuricide 32LV^R application and DFTM instar development.

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DFIM SURVIVAL THURICIDE 32LV TREATMENT

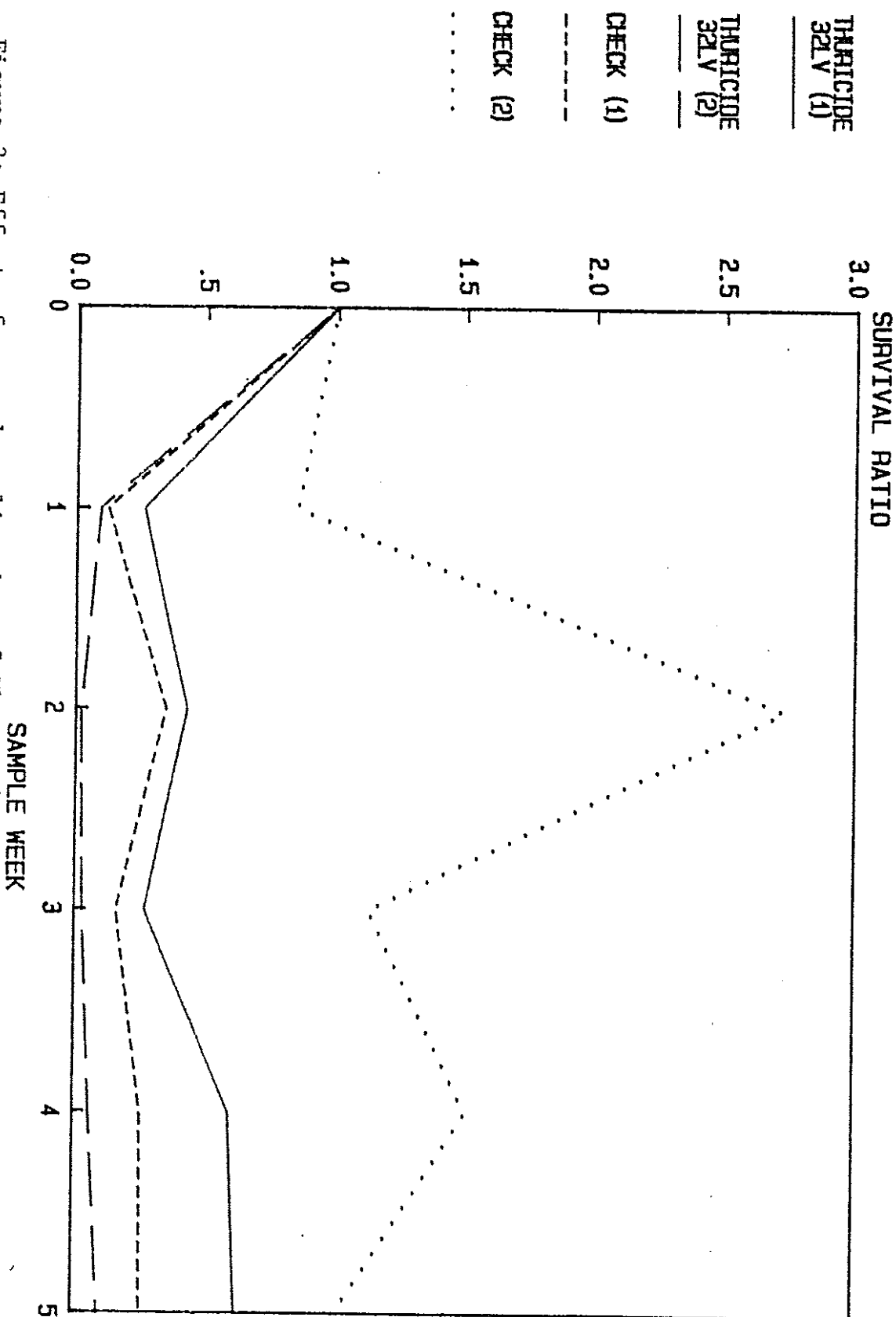


Figure 3: Effect of ground application of Thuricide 32 LV on Douglas-fir tussock moth survival at 8, 15, 22, 29 and 36 days post-treatment.