Forest Ecology and Management, 21 (1987) 231-235
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Effect of Systemic Pesticide Implants on the Level of Western Spruce Budworm Infestation: Treatment and Post-Treatment Years

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(Accepted 9 February 1987)

ABSTRACT

Hutto, R.L., 1987. Effect of systemic pesticide implants on the level of Western spruce budworm infestation: treatment and post-treatment years. *For. Ecol. Manage.*, 21: 231-235.

I recorded the mean density of Western spruce budworm (*Choristoneura occidentalis*) and all other arthropods on a group of Douglas-fir (*Pseudotsuga menziesii*) trees treated with systemic pesticide implants, and on a control group of untreated trees. Both budworm density and the density of other arthropods was significantly higher on the control trees. Conversely, cone mass was significantly greater on treated trees. During the year following treatment, budworm densities were no longer different between treatment and control groups. The long-term benefits of treatment for a single year are, therefore, uncertain.

INTRODUCTION

The Western spruce budworm, *Choristoneura occidentalis* Freeman, is the most widely distributed and destructive defoliator of Western coniferous forests (Carolin and Honing, 1972; Fellin and Dewey, 1982). The insect is also considered a serious pest of Douglas-fir (*Pseudotsuga menziesii* (Beissn.) Franco) cones in Montana (Dewey, 1970). The use of systemic insecticide implants has been suggested as a method to reduce foliage and cone crop loss (Reardon, 1984a), and has proven to be quite effective in controlled experiments (Reardon and Haskett, 1981; Stipe and Dewey, 1985), and in operational use (J. Dewey, USDA Forest Service, personal communication, 1986). In another study, however, 2 years of treatment were necessary to demonstrate a significant reduction in budworm density on Douglas-fir trees (Reardon, 1984b). On the basis of measured budworm densities on grand fir (*Abies grandis* (Dougl.) Lindl.) during treatment and post-treatment years, Reardon and Barrett (1984) found that the systemic implant method afforded protection

0378-1127/87/$03.50

only for the year of use. Moreover, the level of infestation was equal to or greater than control levels in the year following treatment.

To provide additional data on the effectiveness of ACECAP implants for Douglas-fir trees, I measured the level of budworm infestation in groups of treated and control Douglas-fir trees during the year of treatment and in the following year, when no trees were treated.

METHODS

A series of Douglas-fir trees was selected for experimentation by USDA Forest Service personnel associated with the Northern Region Cooperative Forestry and Pest Management Unit; 15 of those trees were randomly chosen for treatment with ACECAP implants (Reardon, 1984a). I collected branch samples from 14 of their treated trees, 12 of their untreated trees, and an additional 22 untreated trees that were interspersed with the rest. A total of 15 (four treated) trees were located in Lubrecht Experimental Forest of the University of Montana (46°52′N, 113°27′W) within mixed Douglas-fir forest and 33 (ten treated) were located on Champion International Paper Co. land (46°48′N, 113°33′W) on a pure Douglas-fir site that had been heavily thinned in 1980.

Trees were treated with implants on 18 April 1985, and I sampled for late-instar budworm larvae on 29 June 1985 and in the following year on 2 July 1986.

In 1985, I clipped three 45-cm terminal branch tips from the lower to middle crown of each tree using a 9-m pole pruner affixed with a collecting bag. The contents were emptied into plastic bags and transported to the laboratory where I sprayed the contents of each bag with a contact insecticide to reduce the activity of budworm larvae and, therefore, prevent their escape. The branch samples from each bag were placed on a large piece of white cardboard and all foliated tips were removed and counted. Foliage surface area was measured by compacting the foliage into the smallest single-layered space possible and measuring the length and width of the area to the nearest cm. The foliage was weighed to the nearest 0.1 g. Cones greater than 2.5 cm in length were removed from the branches, counted and weighed to the nearest 0.1 g. Budworm larvae and other arthropods were 'rinsed' from debris in a wash bowl containing 70% alcohol, dried on a paper towel, counted, and weighed on an electronic balance to the nearest 0.01 g.

In 1986, three branches were clipped from each tree, as in 1985, but the branch samples were then placed into a large plastic bag and each branch was shaken vigorously to dislodge larvae. The 'beating' method has been found to be nearly 100% accurate in terms of counting budworm larvae (Foltz and Torgersen, 1985). The larvae were then removed and counted, and the coneless branches weighed to the nearest 0.1 g. The only measure of budworm density

TABLE 1

A comparison of the mean values of several measures of budworm density, the density of other arthropods, and cone characteristics between systemically treated trees and control trees

Measure	N	Untreated trees	N	Treated trees	U[a]	P
1985						
# budworms per m^2	34	135.5	14	36.7	58	0.00
# budworms per tip ($\times 100$)	33	7.87	14	3.13	82	0.00
# budworms per g ($\times 100$)	33	6.19	14	2.04	59	0.00
budworm mass (g)	34	0.03	12	0.03	188	0.68
# other arthropods per m^2	34	48.29	14	18.96	143	0.03
# cones per m^2	33	36.59	13	80.96	179	0.37
cone mass (g)	20	3.77	8	5.33	26	0.01
1986						
# budworms per g ($\times 100$)	33	2.44	14	2.31	202	0.49

[a]Mann-Whitney U statistic.

in 1986 was number counted per g foliage. Nonetheless, my 1985 data showed this measure to be well correlated ($r=0.99$) with the number per m^2 foliage and with the number of budworm per foliated branch tip ($r=0.94$).

RESULTS

All three measures of budworm larval density were significantly different between treatment and control trees in 1985, although the mean mass of an individual budworm larva was no different (Table 1). Other arthropod species were also significantly more abundant on control than on treated trees. Although the number of cones per m^2 was no different between the experimental groups, cone mass was significantly greater on the treated trees (Table 1).

In 1986, budworm density was no longer different between groups (Table 1), and budworm density in 1985 was not correlated with density on the same tree in 1986 ($r=0.08$, $N=47$, $P=0.30$). Budworm density declined significantly on the untreated control trees ($U=174$, $P<0.001$) from 1985 to 1986, while increasing (nonsignificantly) on the treated trees ($U=89$, $P=0.68$).

DISCUSSION

Although an earlier study of the effect of systemic implants on populations of Western spruce budworm infesting Douglas-fir trees revealed a significant reduction in budworm densities on treated trees (Reardon and Haskett, 1981), two later studies (Reardon, 1984b; Reardon and Barrett, 1984) revealed no such effect, possibly because of low budworm densities during the later studies.

It is clear from the results reported herein and from those of Stipe and Dewey (1985) that the level of budworm infestation on Douglas-fir can be greatly reduced with the use of systemic implants. Consequently, cone mass can also be increased substantially as a result of treatment.

As was the case with grand fir (Reardon and Barrett, 1984), however, treated trees may suffer disproportionate damage in the year(s) following the cessation of treatment. This relative increase in budworm larval density on trees that were released from protection by the pesticide implants makes the long-term consequences of short-term treatment equivocal, especially for trees in urban parks or in cone- and seed-production areas.

The reasons for the disproportionate increase in larval density on treated vs. control trees during the year following treatment are unknown, but presumably involve selection of the relatively healthy trees as oviposition sites by adult females, or possibly an increased survival of larvae on those trees after a slow recruitment of predatory arthropods (spiders and ants; Campbell and Torgersen, 1982, 1983; Campbell et al., 1983) which were also reduced in abundance due to emigration or death during the treatment year (Table 1).

ACKNOWLEDGEMENTS

I am grateful to Jed Dewey and Larry Stipe for letting me tie into their work the effects of systemic treatments, and for their loan of tree-pruning equipment. Jed Dewey and anonymous reviewers provided helpful comments on the manuscript. Hank Goetz granted permission to work in Lubrecht Forest and John Mandzak granted permission to work on Champion International land. I thank Sue Reel for help with the budworm sampling and counting. This work was funded by NSF-MONTS during the second year of study.

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