EVALUATION OF PINE OIL FOR PROTECTING WHITE SPRUCE FROM SPRUCE BEETLE (COLEOPTERA:SCOLYTIDAE) ATTACK[1]

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ABSTRACT

The effectiveness of two formulations of pine oil (Norpine 65 and BBR-2) in protecting white spruce from attacks by spruce beetles was tested in south-central Alaska. Fifty percent of the pheromone-baited trees were protected by Norpine 65 for 1 year after treatment whereas only 33% were protected by BBR-2. Baited trees sprayed with Norpine 65 and BBR-2 were attacked less frequently than were baited check trees and sustained a lower attack density per tree. The percentage of trees protected by Norpine 65 was 13% greater than those protected by BBR-2. Although 85% of the trees treated with Norpine 65 were attacked, the attack density was approximately half that of trees treated with BBR-2.

INTRODUCTION

The spruce beetle *(Dendroctonus rufipennis* [Kirby]) is the most destructive insect of white spruce *(Picea gluaca* [Moench] Voss) in south-central Alaska. Much of the timber loss during the past 10 yeasrs has been in areas with high-value trees, such as recreational and residential areas (Werner and Holsten 1983). Lindane is currently registered in the United States by the Environmental Protection Agency for spruce beetle control; however, forest resource managers and home owners are reluctant to use lindane because of its high toxicity to mammals and its persistent residues. For these and other reasons there is a need to develop methods for protecting high-value, individual white spruce trees from attack by spruce beetles—methods that are effective and acceptable to the public. A naturally occurring compound that appears to repel bark beetles is pine oil. This compound is a by-product of the sulphate pulping process and is a complex mixture of naturally occurring derived secondary and tertiary terpene alcohols and other terpene hydrocarbons.

Norpine 65[4] and BBR-2[5] are two compounds consisting of mixtures of terpene hydrocarbons that have been field tested against ambrosia beetles, *Trypodendron lineatum* Olivier, (Nijholt 1980) and *Dendroctonus* bark beetles (Nijholt and McMullen 1980, Nijholt *et al.* 1981, Richmond 1985, McMullen and Safranyik 1985). Neither compound is currently registered as an insecticide in the United States.

Nijholt *et al.* (1981) recorded a 67% reduction in spruce beetle attacks on white spruce trees treated with Norpine 65. Richmond (1985) reported that Norpine 65 provided 100% protection to lodgepole pine *(Pinus contorta* var. *latifolia* Engelm.) from attack by mountain pine beetle *(D. ponderosae* Hopkins). In comparison, BBR-2 protected 47% of the treated trees. BBR-2 and Norpine 65 protected lodgepole pine where mountain pine beetle populations were low, but the compounds were less effecitve when beetle pressure was high (McMullen and Safranyik 1985).

Field tests were conducted in south-central Alaska to test Norpine 65 and BBR-2 as sprays for protecting white spruce from attack by spruce beetle. The tests were conducted in 1983 and 1984 along Kenai Lake in the Seward Ranger District, Chugach National Forest.

MATERIALS AND METHODS

In 1983, 30 uninfested live white spruce trees with an average diameter at breast height (dbh) of 30.86 ± 6.65 cm and an average height of 17.6 ± 0.60 m were selected in a northeast aspect stand that was heavily interspersed with beetle-infested trees. Fifteen trees were randomly assigned to each of two treatments—BBR-2 and untreated checks. In 1984, 50 uninfested live white spruce were randomly selected in an area adjacent to the 1983 test site. Treatments consisted of 40 trees sprayed with Norpine 65 and 10 untreated check trees. Trees were located a minimum of 30 m from other treatment trees. BBR-2 and Norpine 65 were applied undiluted with a garden-type 8-1 pressure sprayer to the bark surface of the tree bole (2 l per tree) to a height of 3 m until the bark was thoroughly wet.

To test the effectiveness of the two pine oil formulations, treated and untreated check trees were baited with 1 ml of aggregation pheromone frontalin (Werner and Holsten 1984) for 60 days after treatment. The pheromone was dispersed from perforated polyethylene vials attached directly to the south side of the trees at breast height. A 20- by 50-cm piece of wire hardware cloth (mesh size 6.3 by 6.3 mm) coated with Stikem Special® was attached to the bole of each tree directly above the pheromone dispenser to compare the number of spruce beetles visiting the treated and untreated trees.

Treatment efficacy was computed by recording the number of attacks on the lower 3 m of the bole and the number of trees that died after treatment. Trees were examined at 3 months after treatment to record trap catch and attack densities in the sticky traps; tree mortality was recorded at 13 months. Successful attacks were characterized by pitch tubes or entrance holes (Hard *et al.* 1983). Live trees with no attacks or < 10 attacks/3 m of lower bole were considered to be protected by the treatment. Analysis of variance and Waller and Duncan's Bayes LSD test (Duncan 1975) were used to compare beetle attack means and sticky trap catch means.

[1]This article reports the results of research only. Mention of a proprietary product or pesticide does not constitute an endorsement or a recommendation for use by the U.S. Department of Agriculture, nor does it imply registration under FIRFRA, as amended.

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TABLE 1. Effectiveness of pine oil formulations in protecting white spruce from attack by spruce beetle in Alaska.

	BBR-2 (1983)				Norpine-65 (1984)			
	Check		Treated		Check		Treated	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
No. trees[1]	14	1	10	5	9	1	20	20
No. trees attacked	14	0	10	1	9	1	20	14
Mean No. beetles/trap[2]	70 ± 38d	15 ± 0b	54 ± 36c	6 ± 5a	83 ± 71d	10 ± 2a	16 ± 12b	4 ± 2a
Mean No. attacks/tree[2]	45 ± 8c	0a	41 ± 15c	0.5 ± 0.9a	48 ± 7c	3 ± 1a	21 ± 11b	4 ± 5a
Percent mortality	93	-	67	-	89	-	50	-

[1]Tree mortality assessed 13 months after treatment.

[2]Mean number of attacks on the lower 3 m of the tree bole. Values followed by the same letter within rows are not significantly different ($P > 0.05$; Waller and Duncan's Bayes LSD (Duncan 1975)).

RESULTS AND DISCUSSION

Spruce beetle populations were extremely high in the study areas during 1983 and 1984. Eleven of the BBR-2-treated trees (or 73%) were attacked compared to 14 (93%) of the untreated check trees. Sixty-seven percent of the treated trees died within 1 year after treatment compared to 93% of the check trees. Thirty-four or 85% of the Norpine 65-treated trees were attacked compared to 10 or 100% of the check trees. Fifty percent of the treated trees died compared to 90% of the check trees. Although significantly more trees treated with Norpine 65 were attacked than those treated with BBR-2, the severity of attack was less. There was no difference between treatments in the percentage of check trees attacked. Those check trees that lived apparently had little beetle pressure as few beetles were caught in traps and beetle attack density was < 3 per 3 m of the lower bole.

Trees treated with Norpine 65 caught significantly fewer beetles and sustained fewer attacks than untreated checks; trees treated with BBR-2 caught fewer beetles than checks but had as many beetle attacks (Table 1). Norpine 65-treated trees that died caught fewer beetles and had fewer attacks than trees that died in the BBR-2 treatment. There was no difference in the number of beetles caught and attack densities between trees treated with Norpine 65 and BBR-2 and that were still living 13 months after treatment.

Norpine 65 provided more protection to white spruce from attack by spruce beetles than did BBR-2. The mode of action of pine oil is unknown but evidence suggests it acts as an olfactory or gustatory repellent. It remains questionable whether phytotoxicity occurs in some species of conifer; phytotoxicity was not evident in this study. Although both Norpine 65 and BBR-2 provided some protection to white spruce from beetle attack, the composition and concentration of active ingredients was unknown. In addition, variation of active ingredients probably occurs among batches of pine oil obtained from different pulping runs, and until the active ingredients are known and bioassayed, care must be taken in interpreting field test results.

ACKNOWLEDGEMENTS

We thank John Hard, Danny Lyon, and Ken Zogas, USDA Forest Service, Fairbanks and Anchorage, Alaska, for their assistance in collecting field data, and George Hudak of the Seward Ranger District, Chugach National Forest, for providing a site for the study. We are also grateful to Dave Duncan, Northwest Petrochemical Corporation, for supplying the Norpine 65 and assisting in the application.

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