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ASSESSMENT OF TWO PINE OIL TREATMENTS TO PROTECT STANDS OF LODGEPOLE PINE FROM ATTACK BY THE MOUNTAIN PINE BEETLE

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Abstract

Pine oil (Norpine-65) was evaluated as an infestation deterrent for the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, in a high hazard forest of lodgepole pine, *Pinus contorta* var. *latifolia* Engelmann. Two experimental treatments were tested, each in four, 9 ha, square blocks (replicates): 1) spraying trees in a grid at 50 m centres with 1.8 L of pine oil/tree, and 2) creating a "barrier" consisting of a double line of pine oil-sprayed trees, 25 m apart, 25 m within the block boundary. There were significantly-reduced ratios of newly-infested (green) trees to the previous year's infested (red) trees in both treatments compared to control blocks. However, neither treatment prevented beetles from attacking semiochemical-baited trees 75 m inside the block boundaries, and neither treatment is recommended for operational use. At maximum costs/ha of $22.04 and $43.39 (Can.) for grid and barrier treatments, respectively, the operational use of a repellent, or an insecticide would approach cost effectiveness if it reduced new infestations of *D. ponderosae* by 1 or 2 trees/ha, respectively.

INTRODUCTION

Pine oil is a commercially-available by-product of the pulp and paper industry. When sprayed on the boles of trees or on logs, it has repeatedly been shown completely or partially to deter attack by scolytid beetles (Nijholt 1980; Nijholt and McMullen 1980; Nijholt *et al.* 1981; Richmond 1985; McMullan and Safranyik 1985; Berisford *et al.* 1986; O'Donnell *et al.* 1986; Werner et al. 1986). Nijholt et al. (1981) reported that attack by the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, was deterred up to 10 m from pine oil-treated lodgepole pines, *Pinus contorta* var. *latifolia* Engelmann. This result suggested that pine oil might have potential in protecting large blocks of forest from attack by the beetles. However, McMullen and Safranyik (1985) did not induce such protection by affixing pine oil-impregnated fibre boards on trees or distributing them on the forest floor.[1]

Our objective was to test pine oil on an operational basis to determine if it could be used to protect high hazard stands from attack by the mountain pine beetle. Several criteria had to be met in such a program: 1) the stands had to have minimal infestations; 2) there had to be sufficient mountain pine beetle infestation in the adjacent forest to threaten each treated block; 3) the pine oil treatment had to be simple enough for regular forestry crews to carry out; 4) the pattern of treated trees had to be set up so that large blocks could be treated in a reasonably short time; and 5) the treatments had to be cost-effective.

[1] McMullen, L.H. and L. Safranyik. 1983. Effect of pine oil distributed in fibre board on the ground for protecting lodgepole pine from mountain pine beetle attack. Can. For. Serv., Pac. For. Res. Cen., Victoria, B.C.

METHODS AND MATERIALS

Twelve, 9 ha blocks, 300 x 300 m, were selected along the Ketchan Road, west of Summers Creek, approximately 25 - 35 km southeast of Merritt, B.C. in the Merritt Timber Supply Area. The stands were chosen on the basis of predominance of pine, age class 5 (81-100 years-old) or higher, and site quality (predominately medium to good). There was minimal infestation recorded in the area occupied by the blocks by B.C. Forest Service surveys, but the blocks were threatened by invasion of mountain pine beetles from a large infestation in the Summers Creek Valley and vigorous small infestations on the plateau where the blocks were situated.

Three treatments were selected (Fig. 1): 1) an untreated control; 2) a grid treatment, in which 36 lodgepole pines at 50 m centres within the block (4 trees per ha) were treated with pine oil; and 3) a "barrier" treatment in which there were 72 pine oil-treated trees in two lines, 25 m apart, with the outer line 25 m inside the block boundary.

From 9-17 May, 1984, the blocks were laid out and randomly assigned to treatment, all treatment trees were marked, their diameters at breast height (dbh) taken, and lines between trees marked with plastic flagging. (None of these procedures would be required in an operational program). The mean dbh ± S.E. of the trees marked for pine oil treatment in the grid blocks was 27.5 ± 0.5 cm, and in the barrier blocks 27.7 ± 0.4 cm.

Pine oil treatments were applied from 23 - 25 June, 1984. Marked trees were sprayed to run-off up to a height of 4.5 m with Norpine 65 (Northwest Petrochemical, Anacortes, Washington). Spraying was done with a hand-pressurized, backpack sprayer (Solo Klein-motoren GMbH, Sindelfingen, West Germany) fitted with a 1.2 m extension wand and a flat fan nozzle oriented vertically. A mean ± S.E. of 1.80 ± 0.03 L of pine oil was used/tree in the 8 treated blocks.

At a distance of 75 m from the boundaries of each block, 12 trees, 50 m apart (Fig. 1), were baited with mountain pine beetle tree baits (Phero Tech Inc., Vancouver, B.C.) comprised of myrcene, *trans*-verbenol and *exo*-brevicomin released at 17.6, 1.0 and 0.2 mg/24 h, respectively. A baited tree has a maximum range of approximately 50 m within a well-stocked stand[2] (personal observation).

Therefore, it was unlikely that these trees would attract beetles into the blocks, but rather that they would arrest beetles that flew through the pine oil barrier or grid, i.e., they measured the efficacy of the treatments. The mean dbh ± S.E. of baited trees in the control, grid and barrier blocks were 27.5 ± 0.8, 27.7 ± 1.0 and 28.8 ± 0.9 cm, respectively.

The efficacy of the treatments was assessed from 15 - 19 October, 1984. Every lodgepole pine tree in each 9 ha block was examined for attack by *D. ponderosae*. If a tree was attacked, the attack density was counted in two, 20 x 40 cm frames on opposite sides of the tree at eye level. The location of each attacked tree was plotted on a grid map.

RESULTS AND DISCUSSION

Efficacy

The pine oil applications, particularly the grid treatment, created a distinct odor throughout the treated blocks. This odor was still apparent to the human nose in temperatures <0° C in October, 1984, 4 mo after treatment. However, neither the barrier, nor the grid treatment deterred *D. ponderosae* from attacking many of the baited trees and those adjacent to them

[2] Heath, D. 1986. Assessment of operational pheromone-based containment programs for mountain pine beetle control in the Cariboo Forest Region. B.C. For. Serv. Int. Rept. PM-C-1.

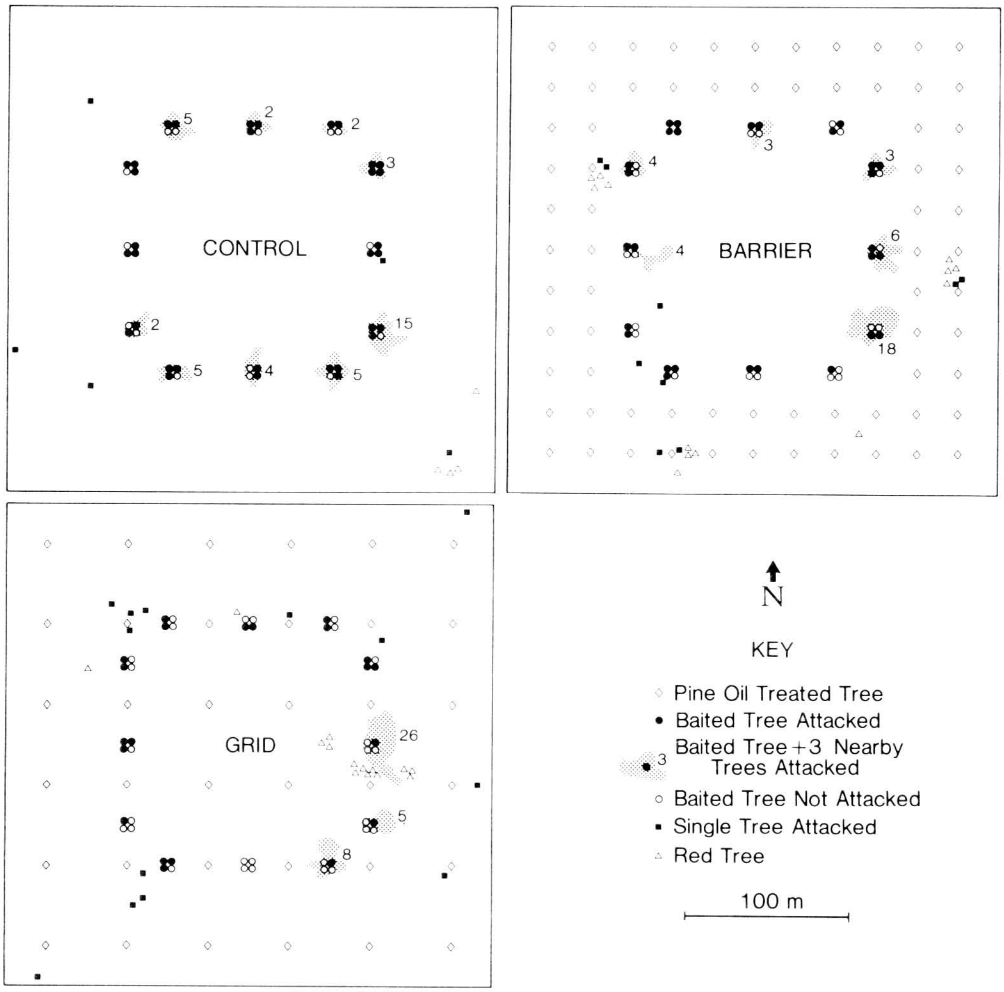

Fig. 1 Layout of 9 ha control blocks and barrier and grid pine oil treatment blocks, showing placement of pine oil-treated trees, semiochemical-baited trees, and attack by the mountain pine beetle (4 replicates superimposed for each treatment).

(Fig. 1), an attack pattern commonly observed in tree-baiting programs (Borden *et al.* 1986).

Although newly-attacked trees occurred as close as 4-5 m to trees treated with pine oil (Fig. 1) not one of the 432 pine oil-treated trees sustained a single attack by *D. ponderosae*. Thus, the treated trees were probably protected from the beetle, a result in keeping with those of other investigations with Norpine-65 (Nijholt *et al.* 1981; Richmond 1985; McMullen and Safranyik 1985).

There were no significant differences between treatments in the numbers of trees attacked or in attack densities on newly-infested, green trees (Table 1). However, in both the barrier and grid treatments, there were reduced green:red ratios, i.e., there were fewer newly-attacked, green trees for each tree with red-colored foliage attacked in the previous year (Table 1). Thus the treatments did appear to reduce the intensity of the infestation, compared to what it might have been. The supposition is that some of the beetles emerging from the few red trees were induced to leave the treated blocks, and that dispersing beetles either entered the treated blocks at a lesser rate than the control blocks, or were deterred from remaining within them.

Table 1 Numbers of trees attacked by *D. ponderosae*, attack density and ratios of newly-attacked (green) trees to previous year's (red) trees in 9 ha blocks untreated or subjected to one of two pine oil treatments. N=4 replicates per treatment.

Treatment	No. of trees attacked (all blocks combined)[a] Red	Green	Attack density on green trees ($\bar{x} \pm$ S.E.)[b]	Green: red ratios (all blocks combined)[c]
Control	4	81	58.9 ± 5.2	20.3 a
Barrier	13	76	58.2 ± 4.9	4.8 b
Grid	13	72	44.7 ± 4.9	5.5 b

[a]ANOVA P between treatment means >0.5 in both cases.

[b]ANOVA P = 0.15.

[c]Ratios followed by the same letter are not significantly different, Newman Keuls test modified for proportional data (Zar 1984), P < 0.05.

Operational Feasibility

The pine oil treatments and semiochemical baiting took three full days with a 5-person crew: two sprayers, two packers to replenish the spray tanks, and one person to bait trees and tag pine oil-treated trees as "pesticide treated" in accordance with B.C. Ministry of the Environment requirements. In an operational program, the latter person would be used in advance of the sprayers to compass, chain and flag the lines, to mark treatment trees and to pre-tag them as "pesticide treated."

Approximately 144 trees were treated/8 h day, not including travel to the area, but including travel between sites. On the actual blocks, a 36-tree grid required a mean of 95 min, i.e. 2.6 min/tree. The corresponding treatment time for a 72-tree barrier block was 145 min or 2.0 min/tree, somewhat less/tree than required for a grid block because of the shorter walking distances.

Table 2 Costs in Canadian dollars at 1987 rates for grid and barrier pine oil treatments on a per tree and per ha basis.

	Costs[a]			
Units and items evaluated	Grid Treatment		Barrier Treatment	
EXPENDITURES PER TREE				
Labor, incl. 35% benefits[b]				
Crew Chief	$ .77		$ .59	
Crew Members	2.48		1.92	
Subtotal		$3.25		$2.51
Pine Oil, 1.8 L per tree		1.38		1.38
Other materials, incl. flagging, tree-marking, paint and labels		.88		.63
Total cost per tree		$5.51		$4.52
EXPENDITURES PER HA				
5 ha		$22.04		$43.39
10 ha		$22.04		$36.16
20 ha		$22.04		$27.12

[a]Costs do not include capital outlay for such items as spray equipment and packing tanks. Costs for grid treatment on a per ha basis are constant because of a fixed density of 4 trees/ha. Costs for barrier treatment decline as area increases because there are 24, 40 and 60 trees for areas of 5, 10 and 20 ha, respectively.

[b]Based on B.C. Forest Service 1987 rates for Forestry Technician (FT)-3 (crew chief) and FT-1 (crew members).

At the above labor requirements and treatment times/tree, the cost of a grid treatment would be $5.51/tree or $22.04/ ha (Table 2). The barrier treatment would cost $4.52/tree; costs/ha would be higher, but decreasing as the size of the block increased (Table 2).

The lack of complete exclusion of attack with these pine oil treatments suggests that they will not be operationally implemented. However, the cost figures would apply equally well to a similar program which used a more effective repellent, or employed semiochemical-baited trees surface-treated with a toxic insecticide (Smith 1986). If implemented on a grid basis, the latter treatment might have considerable potential in reducing infestation levels within moderately-attacked stands. In either case as it costs a minimum of $20.00 to dispose of an attacked tree by felling and burning (P.M. Hall,[3] pers. comm.) prices of approximately $20.00 and $40.00 per ha would be cost effective if the treatment reduced the incidence of newly attacked, green trees by 1 or 2 trees per ha, respectively.

CONCLUSION

Although potentially cost-effective and operationally feasible, neither the grid nor the barrier treatments with pine oil met the objective of reducing *D. ponderosae* attacks below the critical level of 2.2 mass-attacked trees/ha which would require remedial treatment (Safranyik *et al.* 1974). Therefore, we conclude that pine oil as formulated and deployed by us should not be recommended for operational use in protecting high hazard stands of lodgepole pine. This limitation, however, does not preclude its use in protecting individual trees.

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[3] B.C. Forest Service, Protection Branch, 1450 Government St., Victoria, B.C. V8W 3E7