PRE-EMERGENCE INSECTICIDE APPLICATIONS FOR CONTROL OF THE MOUNTAIN PINE BEETLE, *DENDROCTONUS PONDEROSAE* (COLEOPTERA:SCOLYTIDAE).[1]

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ABSTRACT

An experiment was set up near Princeton, British Columbia to investigate the efficacy of carbaryl (Sevin SL) and chlorpyrifos and (Dursban 4E) at 1% and 2% a.i. in water, to prevent the successful emergence of mountain pine beetles, *Dendroctonus ponderosae* Hopkins, from infested lodgepole pines, *Pinus contorta* var. *latifolia* Engelmann. All treatments were effective in killing the emerging beetles outright. Mortality ranged from 83.3% for 1% Sevin to 94.9% for 2% Dursban, compared with 6.1% mortality of beetles emerging from water-treated control trees. Living emergent beetles from all treatments suffered >50 and >90% mortality after 1 and 5 days, respectively, compared with 5 and 10 days, respectively, for beetles from control treatments.

INTRODUCTION

Various insecticides applied to the bark of infested trees are effective in preventing or reducing the successful emergence of bark beetles. Examples are: lindane against the western pine beetle, *Dendroctonus brevicomis* LeConte (Swezey and Dahlsten 1983), and lindane, chlorpyrifos, fenitrothion (and several other insecticides) against the southern pine beetle, *Dendroctonus frontalis* Zimmerman (Brady *et al.* 1980; Jones *et al.* 1980).

As lindane is in disfavor because of environmental concerns, it was judged necessary to evaluate additional materials for remedial use on the mountain pine beetle, *Dendroctonus ponderosae* Hopkins. Integrated pest management using semiochemicals (Conn *et al.* 1983; Borden *et al.* 1983) and insecticides for the eradication of small infestations from lodgepole pine, *Pinus contorta* var. *latifolia* Engelmann is of particular concern. Toward this end, this paper describes the evaluation of 2 insecticides, Sevin SL[3] (carbaryl) and Dursban 4E[4] (chlorpyrifos).

MATERIALS AND METHODS

Thirty lodgepole pines infested by *D. ponderosae* in 1981 were selected in the spring of 1982 and in the Summers Creek area approximately 25 km NE of Princeton, B.C. The timber type and the ecological classification is uniform throughout the area. All trees were >26 cm diameter at breast height (dbh) ($\bar{x} = 32.3$ cm) and the mean dbh's between treatment groups did not differ significantly (F test, $p > 0.05$). To minimize potential problems with insecticide drift and contamination, 6 replicates (trees) for each of 5 insecticide treatments were randomly chosen as same-treatment groups. The control group was located approximately 400 m away from the nearest insecticide-treated trees.

On 6 July, 1982, the trees were sprayed to the drip point with 2-3 L of water or insecticide for-

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mulation in water. A backpack sprayer (Solo 425, Solo Kleinmotoren GMBH, Sindelfingen, FDR) was used, allowing coverage of the basal 3 m of the bole. The 5 treatments were: Sevin at 1% a.i., 2% Sevin, 1% Dursban, 2% Dursban, and water.

On 8 July, prior to beetle emergence, all 30 trees were felled. The first 0.8 m of each tree above the 0.3 m high stump was cut and transported to a B.C. Forest Service fire suppression camp approximately 5 km E of Princeton. There they were bagged in muslin and kept in a shaded area. Emergent beetles were collected every 2-3 days. Dead beetles were counted; live or moribund beetles (those unable to move normally) were held at room temperature in petri dishes with moist filter paper and checked daily for longevity.

The data were transformed by $\log_{10}(x+1)$ if necessary and subjected to analysis of variance and the Newman Keuls test.

RESULTS AND DISCUSSION

Emergence of *D. ponderosae* was first noted on 17 July. The first major peak of emergence occurred during a warm period from 23-29 July, 17-23 days after the insecticide treatment. Subsequent peaks of comparable magnitude occurred from 5-9 and 15-27 August and 31 August - 4 September.

There were no significant differences in total emergence between treatment groups, despite the very low emergence rate of 309.3/m² from the logs treated with 2% Dursban (Table 1). A possible fumigant effect of Dursban may account for this low emergence. L. H. McMullen[5] found 2% Dursban to be as effective as or better than 1% Lindane and recommended its use to kill *D. ponderosae* brood under the bark. R. S. Hodgkinson[6] obtained similar results with 2.4% Dursban in diesel oil for the spruce beetle, *Dendroctonus rufipennis* Kirby.

The most striking effects of the insecticide treatments were the significantly small numbers of healthy beetles that emerged, especially for 2% Dursban, and the significantly greater numbers of dead and moribund beetles for all treatments except 2% Dursban (Table 1). This apparent anomaly can be explained by the low numbers of emergent beetles from logs treated with 2% Dursban, and is offset by the fact that this treatment resulted in the highest percentage (94.9%) of dead and moribund emergent beetles.

Beetles emerging alive from logs treated with 2% Dursban suffered 96.5% mortality after 24 h (Fig. 1). Beetles emerging from logs treated with 1% Dursban or Sevin at both concentrations sustained less, but still severe mortality (>50% after 24 h), while only 4.1% of beetles emerging from the control logs were dead after 24 h. Over 90% of the beetles emerging alive from treated logs were dead

[5]Unpublished report, 1980, Pacific Forest Research Centre, Victoria, B.C.

[6]Internal Report PM-PG-2. 1983. B.C. Forest Service, Prince George, B.C.

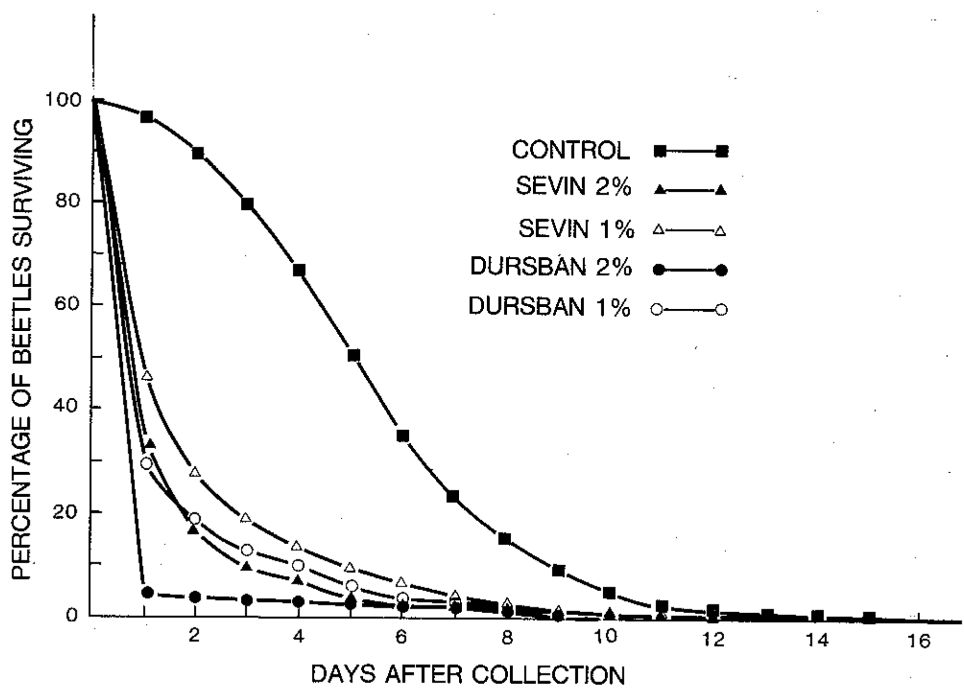

Fig. 1. Survival of *D. ponderosae* held at room temperature and 100% RH after emergence from logs subjected to various insecticide treatments.

TABLE 1. Numbers of emergent **D. ponderosae** and their condition following different pre-emergence insecticide treatments on infested trees. Summers Creek, near Princeton, B.C., 1982, N = 6 Replicates.

Treatment	$\bar{X}$ ± SE of Beetles in Each Category[a]										
									Number Dead and Moribund		
	Total Emerged/m^2		Number Dead/m^2		No. Moribund/m^2		No. Healthy/m^2 [b]		Total		%
Control (Water)	1109.0 ± 509.2	a	57.3 ± 77.2	a	15.7 ± 18.6	a	1036.0 ± 517.0	a	73.0 ± 94.6	a	6.1
Sevin SL, 1%	1227.8 ± 847.9	a	588.5 ± 397.6	ab	386.5 ± 284.3	b	252.7 ± 201.4	b	975.0 ± 655.6	b	83.3
Sevin SL, 2%	999.8 ± 573.2	a	484.5 ± 356.3	ab	385.2 ± 250.2	b	130.2 ± 71.4	b	869.8 ± 552.0	b	85.8
Dursban 4E, 1%	1006.3 ± 518.7	a	776.2 ± 444.6	b	114.2 ± 70.0	b	116.0 ± 145.1	b	890.2 ± 501.1	b	88.8
Dursban 4E, 2%	309.3 ± 359.6	a	255.3 ± 295.9	ab	36.5 ± 44.0	a	17.7 ± 21.3	c	291.8 ± 339.1	ab	94.9

[a] Means within a column followed by the same letter are not significantly different, Newman Keuls' test, $P < .01$

[b] Data transformed by $\log_{10}(x + 1)$ prior to analysis of variance.

within 5 days, while >50% of those from control logs survived 5 or more days.

Thus, Dursban 4E appears to be slightly more effective than Sevin SL, but only at a concentration of no less than 2%. These encouraging results with water-based formulations indicate that a diluent such as diesel oil need not be transported to target areas that have an adequate source of nearby water.

The effectiveness of both insecticides for remedial treatments (Table 1, Fig. 1), and their efficacy in preventing attack by *Dendroctonus* spp. (Hall *et al.* 1982; McCambridge 1982) suggests that they may reliably replace lindane for direct suppression of the mountain pine beetle in lodgepole pine.

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