PREVENTION OF RED TURPENTINE BEETLE ATTACK BY SERVIMOL AND DRAGNET

by Pavel Svihra

Abstract. A single application of Sevimol (carbaryl) to the basal 6 to 7 feet of *Pinus radiata* trees significantly reduced infestations of the red turpentine beetle, *Dendroctonus valens,* and protected trees for up to 98 days. In another field study, a single application of Dragnet (permethrin) also significantly reduced infestations of *D. valens* and protected trees for up to 147 days. This study has shown that Dragnet might be incorporated into a pine pest management program directed against *D. valens* because it protected trees for almost five months, allowing ample time for the arborist to implement cultural practices to improve the pine's vigor and defenses.

The red turpentine beetle (RTB), *Dendroctonus valens,* is the largest and most widely distributed bark beetle in North America. In California, the beetle attacks and sometimes kills Monterey pines, especially in Christmas tree farms or on sites disturbed by fire, logging, land clearing, landscape development, or soil compaction (1,6). RTB may be found in all the coniferous forests of the continental United States, southern Canada and Mexico (11). While it can attack other conifers (spruce, larch, true fir, and Douglas– fir), all serious damage by RTB has been to pines (*Pinus* spp.): red, lodgepole, and jack pines in the North; white, pitch, and shortleaf pines in the East; and Monterey, ponderosa, and sugar pines in the West (6). Forty–seven pine species are commonly planted as ornamentals in the California landscape (8). Any of them, if stressed, can be a target for RTB infestations (3). Yet records show that RTB rarely builds up populations to epidemic proportions (6).

D. valens attacks the basal 5 to 6 feet of the trunk portion of pines (*Pinus* spp.). The first infestations usually involve only a few beetles. If left unchecked, however, numbers may increase greatly, causing a rapid decline in the remaining vigor of the infested pine. In California, such a pine may then become the target of attack by the California fivespined ips, *Ips paraconfusus,* which then kills either the top or the whole tree. RTB infestation is an early indicator of the lack of pine defenses. If attack density is high enough, as can be estimated by numbers of pitch tubes or collection of granular material at or below points of beetle entry, preventive insecticidal sprays help to arrest beetle infestations in the early stages and reverse tree decline caused by the bark beetle. Insecticide spraying of the basal 6 feet of a trunk with lindane has been the only chemical option available for prevention of RTB attacks (1).

In California, this insect usually begins to infest pines at the end of February or the beginning of March, depending on temperature, and continues until early October, resulting in one or two generations per year (1). The RTB's search for a host is random (10), but it seems to prefer stressed trees and occasionally may attack apparently healthy ones (3). In a simplified sequence of events , the adult female bores through the outer bark into the phloem tissue, attracts the male and mates, excavates a patch–like gallery, deposits eggs, and emerges to repeat this sequence (10). The tree attempts to resist this penetration by producing pitch. Pitch tubes about 2 inches across on the bark surface, distributed in the basal 6 feet of the tree, are evidence of RTB attacks. When cold weather is approaching, the adults stay under the bark until spring, when they emerge, fly, and attack pines in the new growing season. Because of generation overlap the adults fly and may continuously attack stressed pines during the growing season.

An important consideration in selecting an insecticide and timing its application is its persistence on the bark surface. A lindane product (tested against attacks by the related bark beetles

D. brevicomis and *D. ponderosae*), combined with a 2% diesel oil, protected pine trunks for 36 months, while an aqueous emulsion of lindane alone was effective for only 22 months (5). These results were achieved when beetles were forced to attack logs cut from previously sprayed trees. In other experiments with southern pine beetles (*Dendroctonus* and *Ips*), lindane's efficacy was poor in remedial control (4) and erratic in efforts to suppress outbreaks (9).

Pressure to suspend lindane use in California prompted experiments to test carbaryl and permethrin as alternatives. The objective of these tests was to study the efficacy and durability of different formulations of carbaryl and permethrin after their application to the bark of uninfested Monterey pine landscape trees exposed to naturally attacking *D. valens* females.

Materials and Methods

The Olema Ranch Campground, Point Reyes–Olema, California, a 15–acre area sparsely planted with more than 600 Monterey pines 30 to 40 years old and 15 to 25 in. DBH, was selected for these studies. It is heavily used by tourists during the summer. Since 1989, the landowner had been annually removing 10 to 15 pines that had been killed by RTB alone or by RTB and *Ips* bark beetles. This high rate of tree loss mostly occurred close to sites frequented by campers. The RTB attack density on surviving pines was also heavy. The landowner hired a pest control company to spray with lindane those pines having a high density of RTB pitch tubes (> 10 pitch tubes per tree). No spraying of lindane was done during 1992 and 1993. To keep the turf green, the campground was irrigated bi–weekly during the summer and fall with randomly positioned rotating cannon sprinkling heads attached to hoses, throwing water a distance of 20 or 30 feet. Thus, the basal trunks of trees selected for experiments were irregularly blasted with water. No rain occurred during the test period in 1992, while in 1993 a day–long shower occurred 46 days after treatments were applied.

In 1992 a study was conducted to determine the duration of effectiveness of three formulations of Sevin (carbaryl) (Rhone–Poulenc Ag Company, Research Triangle Park, N.C.) in preventing attacks of the red turpentine beetle on Monterey pines at Olema Ranch Campground. The formulations and dosages used were:

a. Sevin 90 DF, 7.92 lb. a.i. per 100 gallons water
b. Sevin 80 WSP, 8.0 lb. a.i. per 100 gallons water
c. Sevimol 4, 8.0 lb. a.i. per 100 gallons water.

In 1993 Sevimol 4 was compared with permethrin [Dragnet, FT Termiticide (FMC Corporation, Agricultural Chemical Group, Philadelphia, PA)]. Its finished emulsion contained 4.0 lb. a.i. per 96 gal. water.

The basal 6 to 7 feet of each Monterey pine were sprayed to runoff with the assigned insecticidal material using a pressure hydraulic sprayer. An average of 1.5 gal. of finished spray was applied to each test tree (Fig.1). Materials were applied at a slanted angle toward the bark in both clockwise and counterclockwise directions. Spraying was finished within a 6 hour period during a windless day with air temperatures of 70° to 78° F in both years.

Experiment in 1992. Twenty-four groups of four uninfested Monterey pines each were selected on May 26. The distance between trees within a

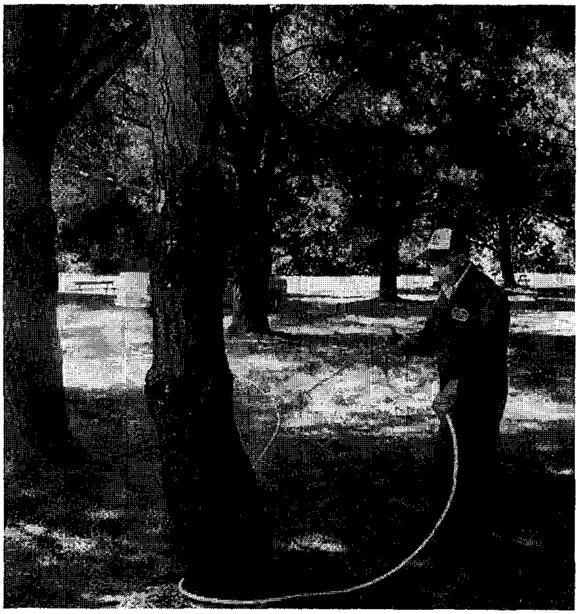

Figure 1. Application of chemical to the pine bole with a hydraulic sprayer.

group was not more than 30 to 40 feet and between groups, 40 to 100 feet. Within each group, insecticide treatments were assigned at random: a. Sevin 90 DF, b. Sevin 80 WSP, c. Sevimol 4, and d. untreated. Treatments were arranged in a randomized complete block design and replicated 24 times.

Experiment in 1993. On March 22 eighty groups of three uninfested Monterey pines (not treated in 1992) were selected by a method similar to that used in 1992. In each group, the treatment was assigned at random: a. Sevimol 4, b. Dragnet, and c. untreated. Thus each treatment was replicated 80 times in a randomized complete block design.

Experimental trees were monitored, beginning one week after application and at weekly intervals thereafter, for any occurrence of pitch tubes or granular material on the bark and near the base. Insecticide persistence was determined according to the time that elapsed from the chemical application to the forming of the first pitch tube(s) or granular material. Attack sites were marked with a grease pencil, counted and recorded. Monitoring of trees terminated six weeks after recording the last attack on all treatments. Data were analyzed by using analysis of variance with a p value of less than 0.05 being considered as significant.

Results and Discussion

In 1992 *D. valens* attacked 14 untreated trees and only 4 treated with Sevimol and 5 each of those treated with Sevin 90 DF or Sevin 80 WSP (Table 1). There was a significant difference in the average number of pitch tubes per tree trunk in untreated control tree groups compared with all treated ones. On average 9.4 pitch tubes occurred in untreated pines compared with only 1.4 pitch tubes in Sevimol treated trees — a number slightly but not significantly lower than those in the Sevin 90 DF and Sevin 80 WSP treatments (Table 1). Sevimol was much more persistent than Sevin 90 DF and Sevin 80 WSP. For 84 days, RTB was unable to bore successfully through the bark of Sevimol–treated pines, while both Sevin formulations were effective for only about half as long (42

Table 1. Prevention of red turpentine beetle attacks on Monterey pines at Point Reyes-Olema, California in 1992 and 1993.

Year	Treatment	No. of trees		Duration of tree protection (days)	Cumulative no. of attacks in infested trees	No. of attacks per tree ($\bar{x}$)
		Treated	Infested			
1992	Sevimol 4	24	4	84	15	1.4 [a]
	Sevin 90 DF	24	5	42	24	2.2 [a]
	Sevin 80 WSP	24	5	49	29	2.6 [a]
	Control	24	14	14	136	9.4 [b]
1993	Sevimol 4	80	7	98	16	0.9 [a]
	Dragnet	80	1	147	3	0.3 [a]
	Control	80	27	28	154	6.7 [b]

a,b Values for number of attacks per tree followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

to 49 days). These results appear to demonstrate that there were differential effects in carbaryl formulation longevity and, from a practical point of view, Sevimol 4 was the most effective.

In the tests conducted in 1993 (Table 1) both Sevimol and Dragnet had a pronounced effect on the number of attacked trees and pitch tube density. A significantly higher density of pitch tubes occurred on untreated pines than on those treated with Sevimol or Dragnet. The difference in pitch tube density between Sevimol and Dragnet was not significant. Sevimol denied RTB penetration for 14 days longer in 1993 than in 1992 (Table 1). No rain occurred in 1992 during the evaluation of Sevimol effectiveness, whereas the longer efficacy (98 days) in 1993 was recorded in spite of a day–long rainfall 46 days after application. There is considerable evidence that rain, sunlight, ultraviolet light, and wind affect the persistence of insecticides on the bark surface (7). Persistence of chemicals in Olema could also have been affected by ground irrigation under these conditions. Dragnet still had sufficient residual activity to prevent RTB attack for 49 days longer (147 days) than Sevimol.

These data show that Sevimol 4 prevented RTB attacks for about three months, while Dragnet persisted much longer (for about five months). Dragnet could be used almost as effectively as lindane in a preventive program since the current lindane label recommends 2 to 3 sprays of lindane during the growing season against the borers. Its use would provide enough time for the arborist to focus on cultural practices, such as watering, root aeration, and fertilization to improve the pine's vigor and defenses. The question is when to recommend an insecticidal application, especially if pines are stressed but not attacked, or the numbers of pitch tubes at the tree base are low and thus insufficient to overcome tree defenses.

Further work is required to find out if a combination of Dragnet with horticultural oils prolongs persistence on the bark as has been demonstrated with lindane (5).

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