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Effectiveness of Polyethylene Sheeting in Controlling Spruce Beetles (Coleoptera: Scolytidae) in Infested Stacks of Spruce Firewood in Alaska

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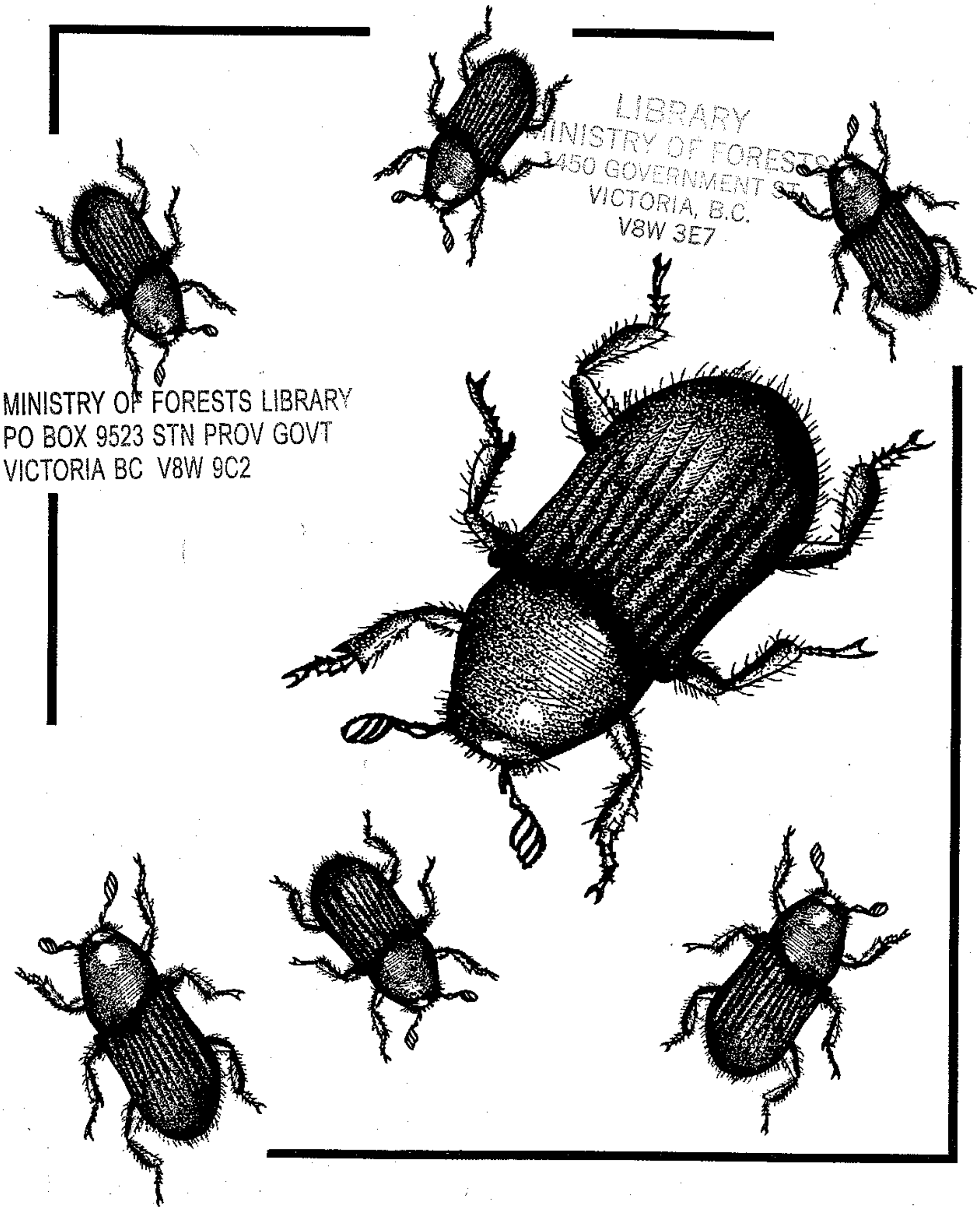

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Abstract

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Covering stacks of spruce firewood with either clear or black polyethylene sheeting does not raise log temperatures high enough to kill spruce beetle brood in the logs. Based on the results of this study, we do not recommend the use of polyethylene sheeting as a remedial measure for the reduction of spruce beetle brood in infested firewood or log decks in south-central Alaska.

Keywords: Insects, spruce beetle, *Dendroctonus rufipennis, Picea* spp., firewood, polyethylene sheeting, lethal temperatures, Alaska (south-central).

Summary

The objective of this study was to evaluate the effectiveness of clear and black polyethylene sheeting in raising the temperature of stacks of beetle-infested spruce firewood to kill spruce beetle brood. Ambient temperature and temperatures of the bark surface and inner bark of logs on the top, outside middle, and inside middle of the stacks of firewood were compared for stacks with and without polyethylene. Higher bark surface temperatures were obtained under the clear polyethylene sheeting (36 °C) than under the black sheeting (27 °C) or in the uncovered check stacks (30 °C). The highest inner bark temperature of 30 °C was from the uncovered check stack; however, this was not lethal to spruce beetle brood.

Contents

Introduction

The spruce beetle (*Dendroctonus rufipennis* (Kirby) (Coleoptera: Scolytidae) has infested more than 1 320 000 ha of spruce (*Picea* spp.) in Alaska forests during the last 20 years (Holsten 1990). Forest pest outbreaks throughout the United States seem to have increased in both frequency and severity during the last 20 years, and Alaska is no exception. More than 200 000 ha of infested spruce were detected in aerial surveys in 1992; one of the highest levels of spruce beetle activity on record (U.S. Department of Agriculture 1993). One major effect of these outbreaks is the increased hazard of wildfire in stands along the wildland-urban interface and the degradation of aesthetic, recreational, and wood fiber values in forested areas and urban landscapes (Werner and others 1977).

Several management strategies are available to the land manager that can reduce the impact of spruce beetles in south-central Alaska. These include silvicultural techniques such as thinning and pruning (Hard 1992; Hard and Holsten 1985, 1991; Holsten and others 1991), preventive and remedial insecticide applications (Werner and others 1985, 1986; Werner and Holsten 1992), and the use of semiochemicals such as attractants and antiaggregants (Holsten and others 1991, Werner and others 1988).

In some urban and suburban areas of south-central Alaska, spruce frequently are killed by spruce beetles and these beetles then are transported in infested firewood obtained from the Kenai Peninsula. Firewood often contains spruce beetle larvae, which complete their development, emerge, attack, and kill nearby live spruce.

Chemical treatment of infested firewood is one way to reduce the number of emerging spruce beetle adults. A 2-percent solution of Sevin SL[1] provides remedial control of emerging adults (Werner and Holsten 1992). The use of insecticides in some high-use recreation areas and urban settings is not always advisable, however. Debarking or fire-scorching of infested spruce will destroy developing larvae (U.S. Department of Agriculture 1992), but such techniques are time-consuming and sometimes not appropriate because of public concern with smoke and air quality. One possible way to control spruce beetles in infested firewood is to subject the insects to lethal temperatures. Keen (1952) reports that bark temperatures of 48 °C are fatal to the western pine beetle (*D. brevicomis* Hopkins). Mitchell and Schmid (1973) note that solar treatment of infested spruce cull logs in clearcuts provides >90 percent mortality of *D. rufipennis* on the top surface of logs but does not significantly increase mortality on the sides. They found, in the laboratory, that inner bark temperatures of 49 °C for 30 minutes cause 92 percent mortality of beetles in infested logs. The ambient temperatures, cloudless skies, and minimum wind speed necessary to produce these high temperatures in inner bark rarely occur in south-central Alaska. The use of polyethylene sheeting to control *Ips* beetles by covering logging slash in Arizona was investigated by Buffam and Lucht (1968). They report that an average mortality of 89 percent of *Ips* larvae was obtained with clear polyethylene, the use of which provided significantly higher inner bark temperatures than occurred in the untreated checks (57 °C vs. 39 °C, respectively). The use of clear polyethylene for the control of bark beetles in wood residue and firewood is a recommended technique in California (Sanborn 1991).

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[1]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

The objective of this study was to evaluate the effectiveness of both clear and black polyethylene sheeting in eliminating or reducing spruce beetle brood in infested spruce bolts.

Materials and Methods

A field test was conducted in May 1991 in a cleared, open, unshaded area near Kenai Lake, Chugach National Forest, 150 kilometers south of Anchorage, Alaska. Five Lutz spruce (*P.* ×*lutzii* Little) naturally infested with 2-year-cycle spruce beetle brood were selected at random. Trees infested with 2-year-brood were selected for the study because such trees have apparent foliage discoloration and easily can be identified as dead by firewood cutters. Each tree was cut into 0.5-m-long bolts. The number of beetle brood including larvae, pupae, and unemerged adults was estimated for each bolt from two 20-cm^2 circular bark disks removed from opposite sides of the large end of the bolt. Fifteen bolts were assigned randomly to one of three treatments. One group of bolts was covered with 4-mil clear polyethylene, the second group was covered with 4-mil black polyethylene, and the third group was left uncovered to serve as a check. Each group of 15 bolts was stacked in the following manner: six bolts on the bottom tier, five bolts in the middle tier, and four bolts on the top tier. Bark surface and inner bark temperatures were recorded from six bolts in each treatment. A Grant recorder with attached thermocouples was used to record temperatures at 1-hour intervals from the following locations on the bolts in each treatment: the bark surface of two logs in the top tier, the inner bark of each end log of the middle tier, and the inner bark of two interior logs within the middle tier. Ambient air temperature was recorded hourly by a remote automated weather station (RAWS) less than 30 m from the three stacks of bolts.

On August 13, four 100-cm^2 circular bark samples were taken from the midsection of each bolt (one from the top, bottom, and each side). The number of beetle brood (live and dead larvae, pupae, and unemerged adults) was recorded.

An analysis of variance was done for two variables: (1) the number of pretreatment progeny for each stack of bolts, and (2) number of posttreatment brood. Bonferroni's multiple comparison test (Dunn and Clark 1987) was used to compare treatments at $P = 0.05$.

Results and Discussion

There were no significant differences in numbers of live spruce beetle brood among bolts before treatment (table 1). The use of clear and black polyethylene sheeting to kill beetles within bolts had no significant effect on number of spruce beetle brood (table 1). Although not significantly different, there was a trend toward more brood within those bolts covered with sheeting than within the uncovered check bolts (table 1). During the posttreatment evaluation, it seemed that the moisture content of the inner bark environment was higher than it was in the untreated checks, which possibly increased brood survival. Relative humidity was not recorded, however.

Higher bark surface temperatures were obtained under the clear polyethylene treatment (36 °C) than in either the black polyethylene treatment (27 °C) or the untreated checks (30 °C) (figs. 1, 2, and 3). The highest inner bark temperature obtained was 30°C from the uncovered check (fig. 3). As previously mentioned, an inner bark temperature of about 49 °C is needed to produce significant spruce beetle mortality (Mitchell and Schmid 1973).

Table 1—Mean number ± SD of spruce beetle progeny in stacks of spruce bolts with and without polyethylene sheeting, Kenai Peninsula, Alaska, 1991

Treatment	N	Pretreatment[a]	Posttreatment[a]
		Number	
Black polyethylene	15	43.5 ± 34.0a	22.6 ± 17.5a
Clear polyethylene	15	54.1 ± 34.5a	27.0 ± 21.4a
Check (no polyethylene)	15	42.2 ± 35.0a	18.6 ± 10.3a

[a]Means followed by the same letter are not significantly different ($P < 0.05$; Bonferroni multiple comparison test [Dunn and Clark 1987]).

This study was conducted in a characteristically windy site, which may explain the relatively low inner bark temperatures of the uncovered check bolts. Mitchell and Schmid (1973) report that wind is an especially important temperature-moderating factor. Bark temperatures in Colorado were consistently reduced by moderate winds (>8 km per hour), even though air temperatures were adequate to produce lethal inner bark temperatures. In this study, bark temperatures exceeded ambient temperatures (as recorded by the RAWS) only in the clear polyethylene treatment (fig. 1). Contrary to our initial expectations, inner bark temperatures did not exceed bark surface temperatures in the clear and black polyethylene treatments (fig. 1 and 2).

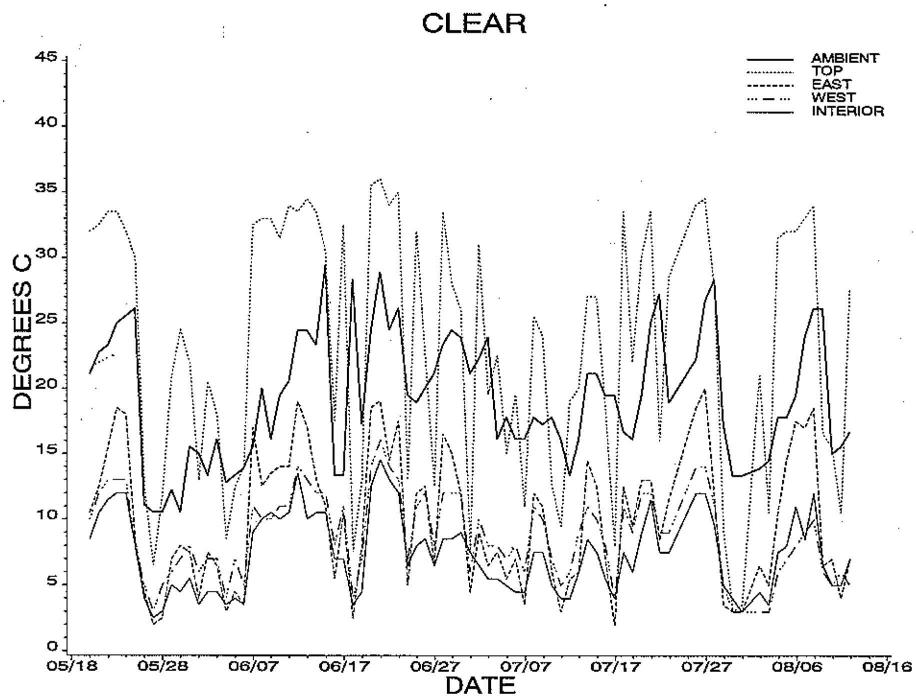

Figure 1—Ambient air, surface, and inner bark temperatures of stacks of logs under clear polyethylene sheeting.

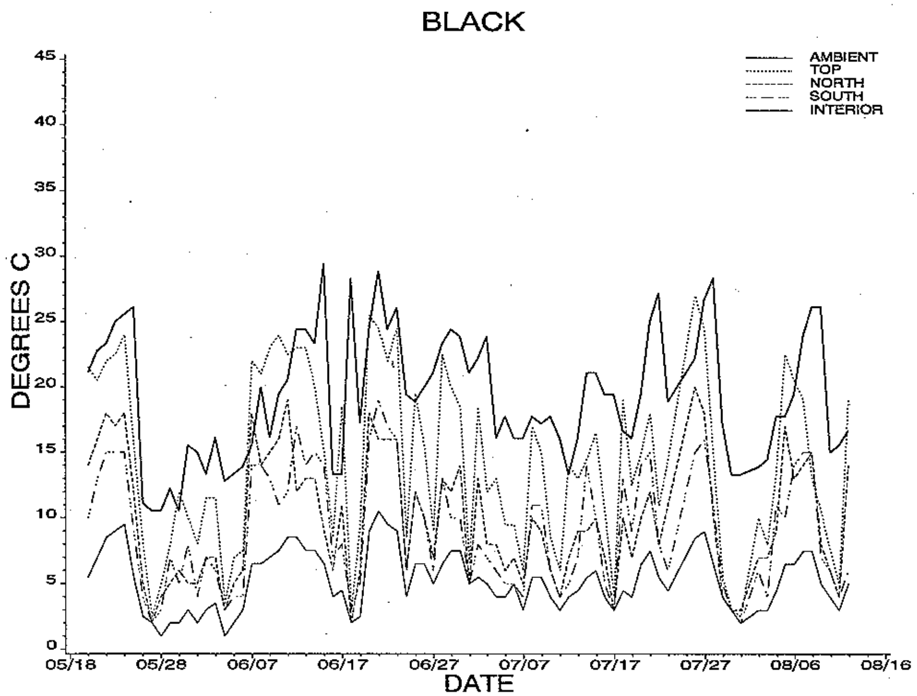

Figure 2—Ambient air, surface, and inner bark temperatures of stacks of logs under black polyethylene sheeting.

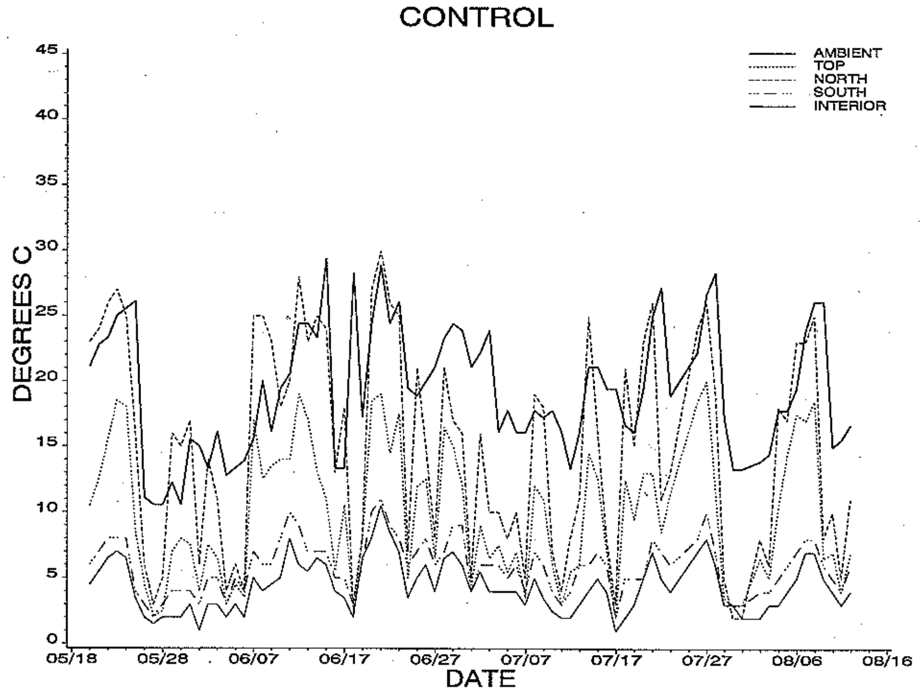

Figure 3—Ambient air, surface, and inner bark temperatures of stacks of logs not covered by polyethylene sheeting.

Inner bark temperatures were much lower within the stacks of bolts regardless of treatment (figs. 1, 2, and 3). Even if lethal inner bark temperatures occurred in the bolts on the upper tier, such temperatures probably would not occur within the stack or from the bottom bolts.

Conclusions

Clear and black polyethylene sheeting did not raise surface and inner bark temperatures high enough to reduce or kill populations of spruce beetles in covered stacks of spruce firewood when compared to stacks of uncovered firewood. Based on the results of this study, we do not recommend the use of polyethylene sheeting as a remedial measure for the reduction of spruce beetle brood in infested firewood in south-central Alaska.

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Metric Equivalents

1 millimeter (mm) = 0.039 inch

1 centimeter (cm) = 0.39 inch

1 square centimeter (cm^2) = 0.155 square inch

1 meter (m) = 3.28 feet

1 kilometer (km) = 0.62 mile

1 hectare (ha) = 2.47 acres

degrees Celsius (°C) = (degrees Fahrenheit = 32)/1.8

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