Forest Health Protection

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A TEST OF VERBENONE TO PROTECT INDIVIDUAL WHITEBARK PINE FROM MOUNTAIN PINE BEETLE ATTACK

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Abstract

In the Selkirk Mountains of northern Idaho, individual whitebark pine trees baited with an attractant pheromone were protected from mass attack by mountain pine beetles. Using either two or four verbenone pouches per tree, mass attacks on treated trees were significantly less than those on controls. This test provides strong evidence that individual trees can be protected from mountain pine beetle attack using verbenone.

Introduction

Whitebark pine (*Pinus albicaulis* Engelm.), one of a few species that grow in the subalpine community, plays a key role in survival and distribution of wildlife species, is important in watershed stabilization, and for recreation and aesthetic values. This key species is currently in rapid decline due to a variety of factors including the introduced white pine blister rust fungus, fire suppression, forest successional processes, and periodic outbreaks of mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (MPB) (Keane and Arno 1993).

The Selkirk Mountains contain the largest, most continuous whitebark pine population remaining in northern Idaho. Blister rust has been slowly killing or top killing trees there for many years and a current MPB outbreak has killed more than 64 percent of the remaining whitebark pine in some stands (Kegley et al. in prep). These whitebark pine forests are relatively dense with subalpine fir, spruce, and lodgepole pine as competing species (Kegley et al. 2001) (figure 1). Few openings exist for whitebark pine regeneration. The Bonners Ferry Ranger District is planning to create openings for regeneration with prescribed fire. In the meantime, there is a great need to protect remaining whitebark pine trees from MPB attack to ensure an adequate seed source for regeneration.

While individual, high-value trees can be protected from beetle attack with insecticides sprayed on tree boles with high-pressure spray equipment, this not practical in inaccessible areas or on a large scale. Verbenone (4,5,5-trimethylbicyclo [3.1.1] hept-3-en-2-one), a natural anti-aggregation pheromone of MPB,

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has been tested as a tree protectant in the past with inconsistent results (Amman et al. 1991, Amman and Lindgren 1995, Bentz et al. 1989, Gibson and others 1991, Shore et al. 1991). A new "pouch" formulation, releasing 10 times as much verbenone as past releasers, has recently been developed (Phero Tech Inc.), tested with promising results in lodgepole pine stands (Progar *In press*), and is currently registered for use against southern pine beetle (*D. frontalis* Zimmerman). It significantly reduced numbers of beetle-attacked trees in 1-acre treated blocks of lodgepole and whitebark pine (Bentz et al. 2002). Our objective for this experiment was to test the verbenone pouch as an individual tree protectant.

Methods

The test was conducted in the Selkirk Mountains, Bonners Ferry Ranger District, Idaho Panhandle National Forest. A total of 146 whitebark pine trees were randomly assigned one of the following treatments: 1) control, no verbenone, 2) 2 verbenone (2V) pouches on individual trees, or 3) 4 verbenone (4V) pouches on individual trees. Trees were located at least 130 feet apart. In addition to verbenone pouches, every tree in the test was baited with an attractant pheromone (MPB tree bait, Phero Tech, Inc.) to assure equal beetle pressure.

Figure 1. Whitebark pine killed by MPB in the Selkirk Mountains.

In September, following beetle flight, all treated trees were evaluated for presence of mass attacks, strip attacks, and pitchouts. Diameter at breast height (d.b.h.) and blister rust condition was also recorded for each tree. Blister rust information was recorded as low, when only old dead branches were observed; moderate on trees with current flagging; or severe when trees had bole cankers. Tree baits were stapled to the north side of trees. Verbenone pouches were stapled in the four cardinal directions on 4V-treated trees or on the east and west sides of 2V-treated trees. Because of an apparently long flight period of MPB in whitebark pine (Kegley et al. in prep), trees were selected and treated the first week in June; and verbenone pouches were replaced at the end of July. Due to the snow depth, initial pheromones were placed 10-15 feet high on tree boles. Replacements were about 7-8 feet high on tree boles (figure 2).

Figure 2. Vergbenone pouches stapled to a white bark pine tree.

Statistical Analysis

Numbers of trees with no beetle attack, mass attack, strip attack, and pitchouts were summarized by treatment. The Pearson Chi-Square test was used to test for significant differences in the type of MPB attack between treatments. Logistic regression analysis was used to determine the effect of d.b.h., presence of blister rust infection and degree or severity of blister rust on the probability of mass attack, strip attack, pitch out, or any of the above MPB attacks.

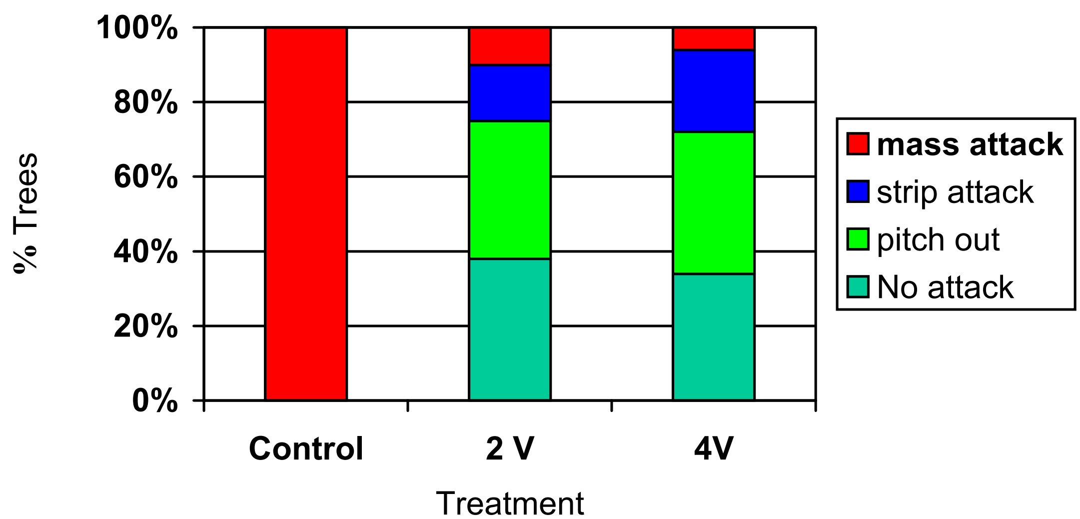
Results

Numbers and percent of trees by type of MPB attack are summarized in table 1 and figure 3. Significantly more mass attacks occurred in the control trees (Pearson chi-square test, $p < 0.001$) than either the 2V treatment or the 4V treatment. There was no significant difference between 2V and 4V treatments.

Table 1. Number and percent of trees with pitch outs, strip attacks, mass attacks, or no MPB attack by treatment.

Treatment/ MPB status	Control Number/percent		**2V treatment** Number/percent		**4V treatment** Number/percent	
No attack	0		18	38%	17	34%
Pitch out	0		18	38%	19	38%
Strip attack	0		7	15%	11	22%
Mass attack	48	100%	5	10%	3	6%
N (total)	48		48		50	

Figure 3. MPB attack by treatment



Average d.b.h. of all trees in this test was 20.3 inches and was not statistically different between treatments (Analysis of Variance F-test, $p>.08$) (table 2).

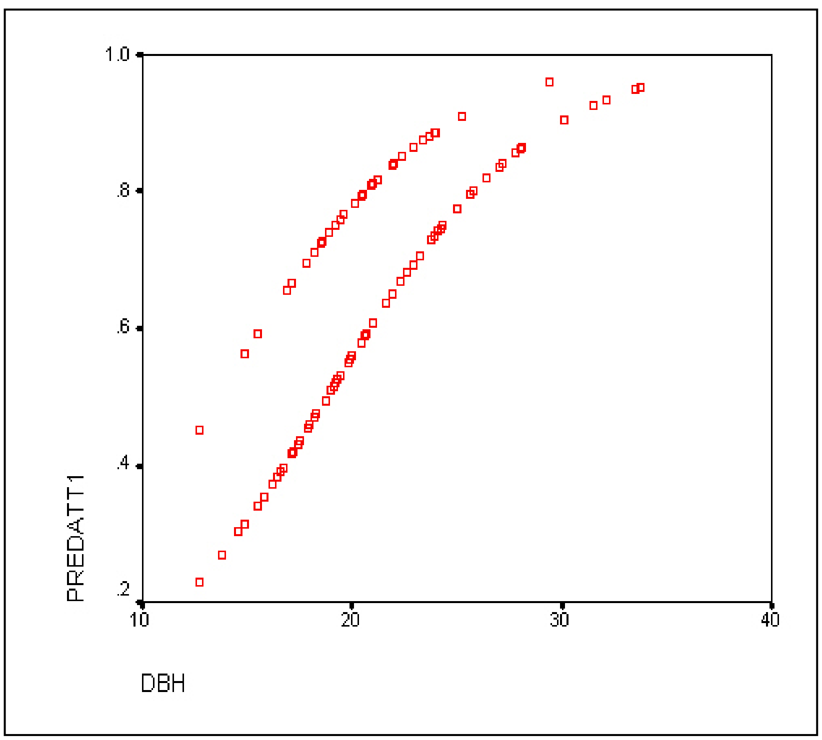
Table 2. Average d.b.h. by treatment

Treatment	Average tree diameter
C	19.1
2V	20.8
4V	20.9

Because all control trees were mass-attacked, only trees treated with verbenone were analyzed for relationship between MPB attack and d.b.h., and between MPB and incidence and severity of blister rust. This reduced our sample size from 146 trees to 98 trees for this analysis.

Logistic regression was used to model the type of attack by MPB as a function of d.b.h., the degree of blister rust infection, and the presence of blister rust. Diameter at breast height and the presence of blister rust were found to be significant in the prediction of any MPB attack. The probability of attack by MPB increased as d.b.h. increased (Wald test of coefficients, $p< .001$) and was significantly greater on uninfected trees than on trees with blister rust infection (Wald test of coefficients, $p< .05$) (figure 4). However, no significance was found when the type of beetle attack or intensity of rust infection was defined in more detail (mass attack, strip attack, pitchout, or light, moderate, severe rust infection)

Figure 4. Prediction of MPB attack based on d.b.h. PREDATT1=probability of any MPB attack. Upper line is the prediction of MPB attack on trees with no blister rust. The lower line is the prediction on trees infected with any blister rust (branch or bole cankers).



Discussion and Conclusions

This test provides strong evidence that verbenone can protect individual whitebark pine trees from MPB attack, even when trees are baited with an attractant pheromone. Although verbenone pouches show great promise in protecting individual trees, further testing in different areas is needed before the product registration is extended to include MPB and can be recommended for operational use.

The probability of attack by MPB increases as d.b.h. increases. Beetles also appear to prefer trees that are not infected with blister rust, although this relationship should be tested further. It is not likely that a blister rust branch canker on a large tree would have any affect on MPB behavior. But it is logical that a bole canker resulting in top-kill may predispose trees to MPB attack, especially when MPB populations are low. However, we found no significant relationship between severely infected trees and MPB attack in our test. In a study in Montana, MPB did prefer whitebark pine trees with higher blister rust infection levels (Adams and Six 2002). The use of pheromones in our study may have influenced the relationship, but all the trees we analyzed for rust and MPB interactions were treated similarly--with both verbenone and an attractant pheromone. No clear relationship was found between blister rust and MPB in other whitebark stands surveyed in northern Idaho that were not involved in the use of pheromones (Kegley et al. 2001). It is also possible that the influence of blister rust on MPB attack may be different when MPB populations are at low levels than at outbreak levels. More data is needed to clearly define any relationship between MPB and blister rust in whitebark pine.

Acknowledgements

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