PROTECTION OF INDIVIDUAL TREES IN PINE SEED ORCHARDS FROM ATTACKS BY CONE AND SEED INSECTS

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Abstract: Two approaches for protecting individual trees are presented. A Single Tree Spray System consisting of irrigation spray nozzles permanently mounted on PVC pipes was used to apply insecticides in two seed orchards. White pine cone beetles, and the leaffooted and shieldbacked pine seedbugs were controlled by Asana XL®, esfenvalerate, in an eastern white pine seed orchard in western North Carolina. A second installation of the Single Tree Spray System was used to apply Guthion®, azinphosmethyl, which also reduced cone attacks by webbing coneworms on loblolly pines in a seed orchard in eastern North Carolina. Trunk implants of Orthene®, acephate, a systemic insecticide, protected individual loblolly pines from attacks by coneworms and seedbugs in a loblolly pine seed orchard in central Georgia. Criteria such as controlled breeding operations, genetic value, cone crop size, and inherent susceptibility to attacks can affect the need for protection and the allocation of control efforts for cone and seed insect pests on individual orchard trees.

Keywords: *Conophthorus coniperda, Dioryctria* spp., *Leptoglossus corculus, Pinus strobus* L., *Pinus taeda* L., *Tetyra bipunctata,* acephate, Asana XL®, esfenvalerate, Guthion®, azinphosmethyl.

INTRODUCTION

As advanced generation seed orchards become productive, older orchards are less intensively managed. However, orchard managers often continue to harvest seed or make expensive controlled pollination's on ramets of the best clones in older orchards. Such situations create a dilemma for orchard managers trying to protect a few selected trees from attacks by cone and seed insects. Aerial applications of registered insecticides will protect these scattered trees, but this approach is costly and inefficient. Individual trees can be protected by applying insecticides with conventional ground equipment (Nord et al. 1984), but good spray coverage on tall trees is often difficult or impossible to achieve. Our objective was to evaluate the efficacy of two alternative approaches to protecting individual trees: 1) a Single Tree Spray System using permanently mounted spray nozzles on PVC pipes; 2) a single annual implant of the systemic insecticide, Orthene®.

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MATERIALS AND METHODS

Single Tree Spray System The Single Tree Spray System was installed at two seed orchards. Installation and operation of the system is described in detail by Kilroy et al. (1996). The first installation was on eastern white pines, *Pinus strobus* L., at the USFS Beech Creek seed orchard near Murphy, NC. Thirty trees 45-50 ft. in height were selected for the study. Two treatments (sprayed or unsprayed) were randomly assigned to pairs of ramets from 15 clones. Ten sample branches with a total of 100 or more cones were tagged on each tree in late March, 1995. Each tree was sprayed with five gallons of 0.025% AI Asana XL® on March 16, April 6, and June 6. The number of healthy cones, cones killed by the white pine cone beetle, *Conophthorus coniperda* (Schwarz), and cones infested by the white pine coneborer, *Eucosma tocullionana* Heinrich, were counted on the sample branches in June. Ten apparently healthy cones were collected from each study tree in August. The seed were extracted, x-rayed, and the numbers of seed bug-aborted seed and seed bug-damaged caused by the southern pine seed bug, *Leptoglossus corculus* L., and the shieldbacked pine seed bug, *Tetyra bipunctata (H.-S),* were counted on the radiographs.

The second Single Tree Spray System installation was on loblolly pines, *Pinus taeda* L., at the Weyerhaeuser seed orchard near Washington, NC. Forty-five trees 50-60 ft. in height were used for the study. Three treatments (sprayed 1995, sprayed 1995 & 1996, and unsprayed) were randomly assigned to ramets from 15 clones. Each tree was sprayed with 5 gal. of 0.2 % Guthion® on April 21 and June 1, 1995 and 10 gal. on April 19 and June 5, 1996. Peak pollen shed occurred on April 10, 1995 and April 12 and 13, 1996. The nuinber of cones killed by the webbing coneworm, *Dioryctria disclusa* Heinrich, or other *Dioryctria* spp., and number of healthy cones on the south 1/2 of each tree crown were counted during June of each year. Spraying was discontinued in 1996 because of severe damage to the trees and the Single Tree Spray System caused by hurricane Fran.

Orthene® Implants Implants of Orthene® systemic insecticide were made at the Weyerhaeuser seed orchard near Lyons, GA. Thirty loblolly pines 40-45 ft. in height were selected for the study. Three treatments (Orthene® - Feb., Orthene® - April, or unsprayed) were randomly assigned to ramets from 10 clones. Holes ca. 4 inches deep and 1/2 inch in dia. were drilled at a spacing of 5 inches around the circumference of the bole of each tree at a height of about 4 ft. above ground line. Each hole was filled with 1/3 fl. oz. (10 ml) of a saturated water solution containing 604 g of dissolved Orthene® 75S per liter. Implants were made on February 22 and April 22, 1996. Holes were drilled in untreated trees and filled with distilled water. Numbers of cones killed by *Dioryctria* spp. in the spring (small dead cones) and the summer (large dead or infested cones), and the number of healthy cones were counted on the south 1/2 of each tree crown during September. Seed extracted from ten apparently healthy cones per tree were x-rayed, and the number of filled, empty, seed bug-aborted, and seed bug-damaged seed were counted on the radiographs.

All data were analyzed by the GLM procedure and Dunnett's or Duncan's tests were used to detect significant differences among treatments at the $\alpha = 0.10$ probability level (SAS 1988). Percentage data were transformed using the arcsine $\sqrt{\%}$ or the log (x+1) transformations.

RESULTS AND DISCUSSION

Single Tree Spray System Eastern white pines protected by Asana® applied with the Single Tree Spray System had significantly fewer cones killed by the white pine cone beetle, cones infested by coneborers, and more healthy cones (Table 1). Previous attempts to control the white pine cone beetle by spraying insecticides have failed (DeBarr et al. 1982). This the first demonstration of successful control of the white pine cone beetle by spraying insecticides.

Table 1. Mean percentage of cone beetle-killed, coneborer-infested, and healthy cones on eastern white pines protected with ASANA XL® applied with the Single Tree Spray system, Beech Creek Seed Orchard, Murphy, NC, June 1995.

	Treatment	
Cone condition	Unsprayed	Sprayed
Killed by cone beetles	36.5a	19.7b
Infested by coneborers	1.5a	0.6b
Healthy	62.0a	79.7b

Means followed by the same letter are not significantly different (a=0.1) Dunnett's one-tailed t-test (SAS 1988).

Seed samples from sprayed eastern white pines had lower percentages empty seed, seed bug-damaged seed, and aborted seed caused by seed bugs than unsprayed trees (Table 2). Cones from sprayed trees also had higher percentages of filled seed and yielded significantly more filled seed per cone.

Loblolly pines protected by Guthion® applied with the Single Tree Spray System had significantly lower percentages of cones killed by the webbing coneworm than unsprayed trees in 1996 (Table 3). Peak pollen shed occurred on April 12 and 13 during 1996 and the trees were sprayed on April 19. This application date is within the 7 day "window of opportunity" for killing webbing coneworm larvae as they exit the pollen catkins and attack cones (G. L. DeBarr and L. R. Barber -- unpublished data). The April 21, 1995 application in date was 11 days after peak pollen shed and cone attacks by the webbing coneworm larvae had already occurred. Trees sprayed both years had significantly higher percentages of healthy cones than unsprayed trees.

Table 2. Average seed quality and yield per cone on eastern white pines protected with ASANA XL® applied with the Single Tree Spray System, Beech Creek Seed Orchard, June 1995.

	Seed quality				Seed yields
Treatment	% Filled	%Empty	% Seed bug-aborted	% Seed bug-damaged	No. filled seed/cone
Unsprayed	73.0a	18.8a	1.6a	5.0a	37.6a
Sprayed	88.5b	8.7b	0.5b	1.4b	53.5b

Means followed by the same letter are not significantly different (a=0.1) Dunnett's one-tailed t-test (SAS 1988).

Table 3. Mean percentages of webbing coneworm-killed and healthy cones on loblolly pines protected by ASANA XL® applied with the Single Tree Spray System, Weyerhaeuser Seed Orchard, Washington, NC, June 1995.

	Treatment		
Cone condition	Unsprayed	Sprayed 1996	Sprayed 1995 & 1996
Killed by webbing coneworm	6.9a	2.7b	2.3b
Healthy	88.9a	92 Oab	95.6b

Means followed by the same letter are not significantly different (a=0.1) Duncan's Multiple Range Test (SAS 1988).

Orthene® Implants Loblolly pines protected with implants of Orthene® made in February or April had significantly lower percentages of spring and early summer attacks by *Dioryctria* spp. than unsprayed trees (Table 4). However, only the April implants of Orthene® had significantly lower percentages of late summer attacks than unsprayed trees. This suggests that the February implants were too early to provide protection from coneworms for the entire summer.

The numbers of seed bug-aborted seed in cones from trees implanted with Orthene® in February or April were significantly lower than those in cones from unsprayed trees (Table 5). However, the implants did not significantly reduce the numbers of seed bug-damaged seed. Seed bug aborted seed are caused by the leaffooted pine seed bug feeding on developing seed in cones during late May through June. In contrast, seed bug-damaged seed detectable on the radiographs are caused by leaffooted and shieldbacked pine seed bugs feeding on maturing seed in August and early September. These results suggest that implants of Orthene® provided control of seed bugs during the spring and early summer, but were ineffective in preventing late summer damage.

Table 4. Mean percentages of cones killed by coneworms on loblolly pines protected with trunk implants of Orthene® systemic insecticide, Weyerhaeuser Seed Orchard, Lyons, GA, 1996.

	Treatment		
Attack period	Unsprayed	Orthene® (Feb.)	Orthene® (Apr.)
Spring & early summer	2.9a	0.8b	0.7b
Late summer	7.3a	6 . 5ab	3.6b
Totals	10.2a	7.3 ab	4.3b

Means followed by the same letter are not significantly different (a=0.1) Duncan's Multiple Range Test (SAS 1988).

Table 5. Mean numbers of seed bug-aborted seed and seed bug-damaged per cone on loblolly pines protected with trunk implants of Orthene® systemic insecticide, Weyerhaeuser Seed Orchard, Lyons, GA, 1996.

	Treatment		
Seed condition	Unsprayed	Orthene® (Feb.)	Orthene® (Apr.)
Seed bug-aborted	3 .4a	0.9b	0.5b
Seed bug-damaged	6.0ab	4.1a	8. lb

Means followed by the same letter are not significantly different (a=0.1) Duncan's Multiple Range Test (SAS 1988).

The idea of using fixed-pipe sprayers to control cone and seed insects in tall trees is not new. Early workers (Grigsby 1964, Ciesla and McConnell 1965, Ciesla et al. 1967), tried to control cone and seed insects on southern pines using fixed-pipe systems. More recently this technique was tried on conifers in the western United States (Personal Communication with Dr. Nancy Rappaport, USFS, Pacific S.W. Res. Sta., Davis, CA). However, our tests are the first to demonstrate efficacy of a Single Tree Spray System. This approached can be used by orchard managers to apply any of the insecticides currently registered for use in seed orchards. The feasibility of using systemic implants for cone and seed insect control was also demonstrated many years ago (Merkel and DeBarr 1974). Our results suggest that Orthene® implants have potential for cone and seed insect control on loblolly pines. However, this insecticide use pattern must be registered by EPA before it can be used operationally.

DeBarr (1971) suggested that managers consider protecting individual trees in seed orchards. However, in the past such an approach was unacceptable to mangers because all the seed from operational orchards had value and were harvested. Today there are situations where the protection of individual trees is desirable. Criteria such as controlled breeding operations, genetic value, cone crop size, and inherent susceptibility to attacks can affect the need for protection and the allocation of control efforts for cone and seed insect pests on individual orchard trees.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of S. Ausbon and F. Brantley, Weyerhaeuser Company, and D. Barrett, G. Beaver, M. Cody, C. Crowe, and C. Logan, USFS.

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