United States Department of Agriculture

Forest Service

Pacific Northwest Region

Westside Forest Insect and Disease Service Center

Sandy, Oregon

WFIDSC-01-11

July, 2011

Testing Commercial Pheromones for Trapping *Dioryctria abietivorella* (Grote) in Western White Pine and Douglas-fir Seed Orchards

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by

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Introduction

Coneworms, *Dioryctria abietivorella*, periodically cause cone and seed damage in western white pine (*Pinus monticola*) and Douglas-fir (*Psuedotsuga menziesii*) seed orchards. These seed orchards provide valuable seed that is resistant to the introduced pathogen, white pine blister rust (*Cronartium ribicola*), and seed for reforestation and restoration activities. Until recently, monitoring for coneworms was conducted by periodic cone inspections. However, coneworm damage is most often noticed by frass accumulating on the outside of cones after damage already occurs. This makes it difficult to accurately time insecticide treatments to protect cones. Pheromones have been tested for trapping coneworm adult moths for many years but only recently has an effective, optimized formulation been developed (Strong et al. 2008). An effective pheromone trapping system would allow seed orchard managers more timely information on coneworm populations for management considerations. The objective for this study was to test the efficacy of two commercial pheromone formulations for trapping coneworm adults in western white pine and Douglas-fir seed orchards.

Methods

Coneworm pheromone lures from AlphaScents, Inc.™ and Synergy Semiochemicals Corp. were tested in diamond sticky traps purchased from Contech Enterprises, Inc. A western white pine seed orchard in Coeur d'Alene, Idaho (2400 ft elevation) and a Douglas-fir seed orchard (Beaver Creek) near Philomath, Oregon (580 ft elevation) (Fig. 1) were the locations used in this study. In each orchard, three treatments were randomly assigned to 30 traps placed 100 feet apart. Treatments were: 10 traps with AlphaScents™ lure, 10 traps with Synergy lure, and 10 traps with no pheromone (controls). Lures were set upright in the sticky adhesive on the floor of each trap (Fig. 2).

Figure 1. Beaver Creek Douglas-fir seed orchard near Philomath, Oregon.

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Figure 2. *Dioryctria* pheromone lure and captured male moths in a diamond sticky trap.

Traps were placed June 22, 2009 (Idaho) and June 29, 2009 (Oregon) and hung on branches as high as we could reach with a cone hook. Traps were monitored weekly or biweekly and any moths caught were counted and removed. Lures and traps were replaced monthly, with any excessively dirty traps being replaced as needed throughout the study. Traps were removed on September 21 (Idaho) and October 5 (Oregon).

Due to various sampling frequencies, the data were summarized and analyzed by two-week time periods. Because the control treatment was so much different than the two lure treatments and we were mainly interested in detecting differences between the two lures, analysis was performed both with and without the control. The data were analyzed in SAS (SAS 2007) using a generalized estimation equation (GEE) methodology with a Poisson response distribution, a log link function and exchangeable working correlation among the response data. The GEE (Liang and Zeger 1986) is a method of dealing with correlated discrete data (such as those collected in repeat measurement studies) that can be modeled as a generalized linear model. The exchangeable working correlation allows for a correlation between the number of insects collected in the same trap in adjacent time periods and is recommended by Agresti (2002). We used a Type 3 GEE Analysis using a scoring method based upon Pan (2001) to test for significance among the predictor variables.

Results

A total of 1300 and 1159 moths were caught at Beaver Creek and Coeur d'Alene, respectively (Table 1). Only 1 moth was caught in control traps, a total of 1178 moths in Alpha Scents™ lure traps, and 1280 moths in Synergy lure traps.

Table 1. *Dioryctria abietivorella* pheromone trap catch by treatment and location during 2009.

Seed Orchard	*Number of Time Periods*	*Treatment Number of Moths*		
		Control	AlphaScents™	Synergy
Beaver Creek	7.0	1	630	669
Coeur d'Alene	6.5	0	548	611
Total		1	1178	1280

Moths were caught immediately after trap deployment in late June, and were continually caught through September or October. Peak flight periods varied by site (Fig. 3).

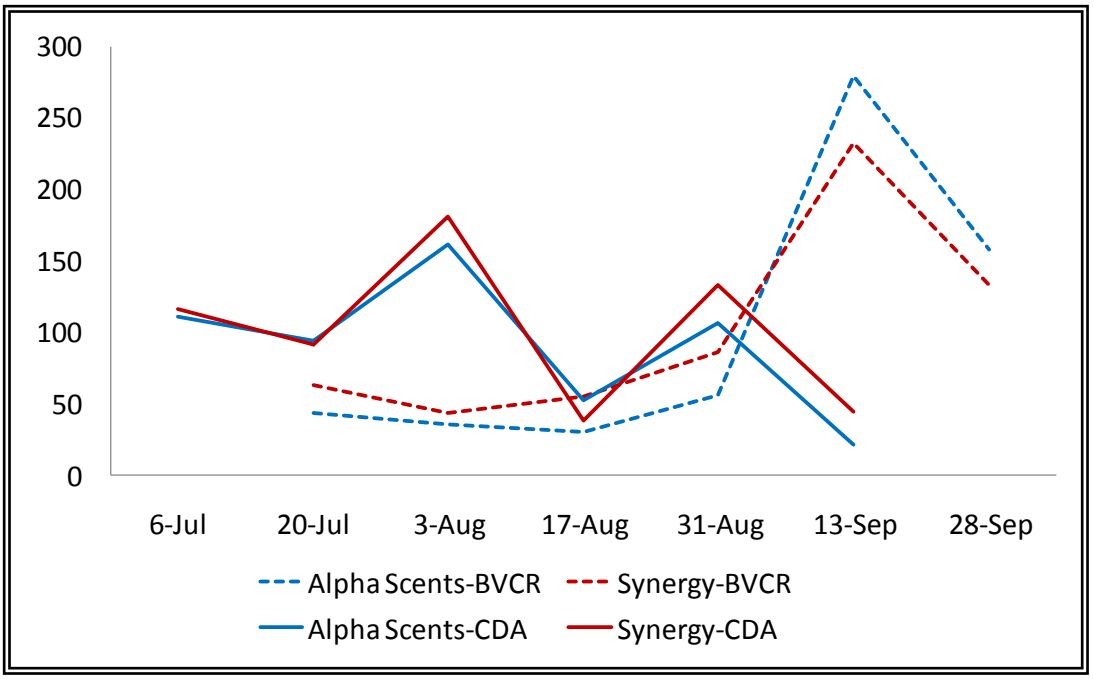

Figure 3. Number of *Dioryctria abietivorella* moths caught by date, lure, and location.

The difference in number of captures between the two commercial lures was slightly significant (p<.05) (Table 2), while the difference in numbers of moths caught in the control compared to the two lure treatments was highly significant (p<.0001). Differences among the two-week sample time periods were also highly significant (p<.001) (Table 2). In addition, we found a highly significant difference (p<.001) between sites based on a three-way interaction among trap captures, site, and time period (Table 2).

Table 2. Score Statistics for Type 3 GEE analysis.

Source	DF	Chi-Square	PR>ChiSq
Site	1	3.80	0.0513
Time Period	6	24.05	0.0005[1]
Treatment	1	3.88	0.0487[2]
Treatment*Site	1	0.02	0.8853
Treatment*Period	6	3.15	0.7901
Treatment*Period*Site	12	35.43	0.0004[1]

[1]Significant at <.001 level, [2]Significant at <.05 level.

Discussion

Two main peak flight periods were observed in Idaho during the study period (Fig. 3). These occurred during late July/early August and late August. In Oregon, one peak flight

occurred in early September. Differences in flight peaks between locations are likely due to differences in elevation, weather, and host tree species in the two seed orchards. Even though we could not check the traps every week, there was never a time period when traps were filled to capacity. If there was any scavenging of moth bodies by predators, it was adequately accounted for by counting imprints. Therefore, it is unlikely that two-week analysis periods changed the outcome of the test.

Both lures were highly effective in attracting moths. Our results suggest the Synergy lure may be somewhat more effective, as we found a slightly significant difference between the number of moths captured in traps baited with the AlphaScents, Inc.™ and Synergy Semiochemical Corp. lures. However, we feel this slight statistical difference is of little practical importance when monitoring for presence or flight period. There was only a 102 moth difference out of thousands caught (Table 1).

Managers can feel comfortable using either lure for monitoring coneworm populations for presence or flight periods, and the decision might logically be based on availability or price differences. In 2009, the cost of AlphaScents™ lure was $3.30 each and Synergy lure was $3.41 each. In conducting studies to follow the flight period of coneworm adults, users should be aware that the lures are not completely interchangeable, and lures from only one of the two companies should be used during the entire season.

Acknowledgements

We'd like to thank Stu Johnston, Siuslaw NF, Even Evensen, manager of USFS Beaver Creek Seed Orchard, and Dave Foushee, manager of the Coeur d'Alene Forest Service western white pine seed orchard, for allowing this study in their orchards; additional thanks to Von Helmuth, Denise Hardesty, and Mark Willhite for valuable field assistance. We are very grateful for the statistical help of Carol Apple.

References

Agresti, A. 2002. Categorical Data Analysis. John Wiley & Sons, Inc., Hoboken, NJ. p. 710.

Liang, K. Y. and Zeger, S. L. 1986. Longitudinal data analysis using generalized linear models, Biometrika. 73:13–22.

Pan, W. 2001. Akaike's information criterion in generalized estimating equations, Biometrics. 57:120–125.

SAS Institute Inc. 2007. SAS OnlineDoc® 9.2**.** Cary, NC: SAS Institute, Inc.

Strong, W.B., Millar, J.G., Grant, G.G., Moreira, J.A., Chong, J.M., Rudolph, C. 2008. Optimization of pheromone lure and trap design for monitoring the fir coneworm, *Dioryctria abietivorella*. Entomologia Experimentalis et Applicata. 126: 67–77.