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Making a Clean Sweep of Cone Gall Midge

Duff Removal Shows Promise as a Non-Chemical Approach to Douglas-fir Seed Orchard IPM

Dr. Charles J. Masters, Technologist, Weyerhaeuser Company

Seed damage by the Douglas-fir cone gall midge (DFCGM) (*Contarinia oregonensis* Foote) is a major cause of reduced seed yield in orchards of Douglas-fir. Infestations of this critter have destroyed up to 80 percent of the seed in some crop years.

About Douglas-fir Seed Orchards

Douglas-fir (*Pseudotsuga menziezii* (Mirb) Franco) is the dominant tree species in the Pacific Northwest. It is considered a major commercial species in North America, with many uses ranging from lumber, poles, plywood and other reconstituted wood products to pulp used for the production of paper and boxes. Forest land that is harvested to provide these products is regenerated with seedlings grown from seed genetically improved through breeding, testing, and selection for desired characteristics such as growth rate. This improved seed is then mass-produced in a seed orchard.

Douglas-fir foliage & cones.

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A seed orchard is like any other orchard in many respects. Like an apple or cherry orchard, a seed orchard is a plantation of genetically superior trees, isolated to prevent pollen contamination from inferior sources and intensively managed to produce an abundant crop. In this case, the crop is tree seed.

The Value of Quality Seed

Losing 80 percent of a crop is no small matter. When DFCGM infestations are high, their damage translates into significant economic loss for Douglas-fir seed orchards. Not only does the loss of seed increase the cost of the seed that is harvested, the average genetic value of the remaining seed is reduced by the indiscriminate feeding. The resulting seed is lower in quality, resulting in less wood at harvest time. Inferior seed leads to other problems, such as delays in meeting projected growth milestones, adding an additional economic burden for some land managers.

Let's look at an example of the value of genetically improved tree seed. It is estimated that about 700,000 acres of commercially harvested trees are planted in the western United States annually. The percent improvement in growth from using genetically improved seed should average about ten percent. Since the average net present value (NPV) contribution of these trees capable of faster growth is a conservative $50 per acre over trees planted using unimproved seed, the incremental farmgate value of genetically improved tree seed is estimated to be $35 million NPV annually. The bottom line, based on my understanding of the economics, is that it's time these little critters took a hike!

Adult Douglas-fir cone gall midge on a seed cone.

The Opportunity Lies in the Duff

The Douglas-fir cone gall midge is a nasty little critter indeed, if you are in the business of producing seed. The adult emerges during the period Douglas-fir flowers are open and receptive to pollen. The female lays her eggs on the developing cone scales near the seed. Following egg hatch, larval feeding on the scale tissue stimulates the formation of a gall, which encases the developing insect and either restricts the development of the seed or

fuses the seed to the scale making extraction impossible. In the fall or winter, after the dry cones have become wet by rain, midge larvae drop from the open cones onto the duff or the orchard floor and overwinter in the spent pollen buds. It is this aspect of the DFCGM life cycle that the pest should have reconsidered before deciding to inhabit a seed orchard.

Orchard managers have long known gall midge larvae are concentrated in the duff layer beneath trees for several months of the year while overwintering. This aspect of its life cycle was thought to be an opportunity for cultural control. However, it wasn't until relatively recently that the motivation and resources existed to exploit this. Small-scale studies on the manual removal of duff were initiated in 1994 by entomologists Christine Niwa, U.S. Forest Service (USFS) Forestry Sciences Laboratory, Corvallis, Oregon, and Dave Overhulser, Oregon Department of Forestry. They confirmed that a reduction in the number or weight of spent pollen cones from the duff layer resulted in a significant reduction in adult midge emergence. Over the three years of study, this manual removal of duff reduced emerging gall midge populations by an average of 55 percent compared to untreated check areas. In a subsequent study, results showed again a direct relationship between the removal of pollen cones and reduced midge survival. This study also confirmed that spent pollen cones are critical overwintering sites both in natural duff and over bare ground.

The Operational Challenge

Our first attempt at operational duff manipulation and removal in an orchard was initiated in 1998. We secured funding from private industry as well as state and federal government agencies. We used these funds to purchase a used Rac-O-Vac Turf Sweeper and to modify it for vacuuming and removing duff in an orchard setting. The USFS Equipment Development Center in Missoula, Montana, designed and implemented the modifications under the direction of Keith Windell, Project Engineer.

The operational trial of this sweeper consisted of three treatments, each replicated ten times. The treatments were: (1) using a flail mower to loosen the duff and then vacuuming, (2) flailing only for disturbance, and (3) an untreated control. For each treatment and replication, the equipment made one pass on the aisle sides of two neighboring orchard trees between the bole (trunk) and the drip-line of the crown in the fall of 1998. Eight midge emergence traps per replication were placed in the treated areas in April of the following year; these were monitored for midge emergence through the middle of May. Statistically significant treatment differences in midge emergence were observed with a 75 percent reduction in emergence in the flail-plus-vacuum plots compared to controls. We were able to significantly reduce midge emergence operationally, but two important questions remain to be answered.

1. Will a 75 percent reduction in midge emergence be enough to significantly reduce seed damage?

2. Is orchard-scale duff removal operationally feasible?

Taking It Into the Orchard

In preparation for future testing designed to answer the above questions, we conducted field trials comparing the Rac-O-Vac Turf Sweeper and a Tuff Vac 5000. Our objective was to determine which machine had the strongest vacuuming ability and the best orchard maneuverability, and which would adapt most readily for materials handling and disposal. We decided to go with the Tuff Vac 5000.

Unmodified Tuff Vac in a Douglas-fir orchard.

We secured funding for equipment modifications from the states of Washington and Oregon, from federal government agencies including the USFS and the U.S. Environmental Protection Agency (EPA), and from the Washington State Commission on Pesticide Registration.

Tuff Vac with modifications nearing completion.

At this writing, modifications to the Tuff Vac 5000 are nearing completion. We have designed and fabricated a bin and dumping mechanism for the Tuff Vac, have purchased a self-dumping trailer, and have fabricated side panels for the trailer. We plan to initiate an operational trial with the modified equipment in October 2003.

Developing integrated pest management approaches to resolving pest problems takes a significant investment of time and money. However, given the high priority we are placing on

environmental protection and minimizing risks to human health, researching and implementing integrated strategies is the only prudent course of action. DFCGM and the rest of you critters, beware! We are up to the challenge.

Chuck Masters is with the Weyerhaeuser Company and serves as the Forest Protection representative to the Washington State Commission on Pesticide Registration. He can be reached at (360) 330-1736 or chuck.masters@weyerhaeuser.com

The work described in this article is just one of many integrated pest management (IPM) efforts underway in Washington State. Several other Washington IPM projects are detailed in the March, April, and May issues of *Agrichemical and Environmental News,* available on the Internet at http://aenews.wsu.edu . For additional information on IPM in Washington State, please consult the following resources:

Urban IPM
Carrie Foss
(253) 445-4577
cfoss@wsu.edu

Ag IPM
Doug Walsh
(509) 786-9287
dwalsh@tricity.wsu.edu

CSANR
Center for Sustaining Agriculture and Natural Resources
Chris Feise
(253) 445-4626
http://csanr.wsu.edu/

WSPRS
Washington State Pest Management Resource Service
Catherine Daniels
(253) 445-4611
http://wsprs.wsu.edu

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