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Cone & Seed Insect Monitoring Report North Idaho Seed Orchards 2004

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Introduction

Insects that feed on cones and seeds are common in our forests and can often become "pests" in seed orchards where seed is of high value from genetically superior trees. This is especially true in blister rust resistant western white pine (*Pinus monticola* Dougl.) orchards. North Idaho seed orchards are routinely examined for cone and seed insects and their damage by Tree Improvement and Forest Health Protection personnel throughout the spring and summer to determine insect abundance and the need for treatment. The most important insects affecting cones or seed in North Idaho white pine seed orchards are cone beetles (*Conophthorus ponderosae* Hopkins), coneworms (*Dioryctria abietivorella* Grote), and seed bugs (*Leptoglossus occidentalis* Heidemann). Cone beetles can destroy 90% or more of the western white pine cone crop (Shea et al. 1983, Williamson et al. 1966). Seed bugs and coneworms impacted between 50-80% of cones in certain western white pine seed orchards (Connelly and Schowalter 1991, Haverty et al. 1986). Other insects sometimes found on the cones or in seed include adelgids (*Pineus coloradensis* (Gillette)), seed chalcids (*Megastigmus* sp.), and the lodgepole cone moth (*Eucosma rescissoriana* Hein.).

This report documents insects found in 2004 at western white pine seed orchards at the Coeur d'Alene, Lone Mountain, and Grouse Creek tree improvement areas. Western larch at Grouse Creek is now starting to produce cones and was also examined in 2004.

Methods

Few practical methods exist for monitoring cone & seed insects in western white pine. A variety of methods have been tried in the past with marginal results including light traps, sticky traps, and direct observations using ladders and binoculars (Gast 1991). In 2004, we examined cones from the height advantage of a bucket truck since the majority of cones are located in the tops of the trees. Numbers of insects or damage seen and cones examined were recorded and a percent damage calculated. Cones were also examined on the ground as they were harvested.

Attractant pheromones have been identified for cone beetles but are not yet available for the other insects. Pityol and alpha-pinene have been shown to be most attractive to North Idaho cone beetles (Rappaport et al. 2000). Seven Japanese beetle traps fitted with Nalgene plastic cups and baited with pityol and alpha-pinene were placed in the upper crown of trees at Grouse Creek white pine seed orchard in early

April. They were monitored every few days and beetles collected.

Results

Coeur d'Alene Seed Orchard

This orchard was examined in late May, early July, and mid-August. Cone beetle damaged cones were obvious and abundant during all examinations (Table 1). The decrease in cone beetle damaged cones from May and July to August is likely not an actual decrease in the population but an artificial decrease due to attacked cones falling off trees and therefore not sampled. Adult seed bugs were found in May and both adults and nymphs were abundant by early July. Damage by coneworms was just starting to be noticeable in early July but became quite conspicuous by mid-August. After numerous seed bugs were found in July, the orchard was sprayed with permenthrin on July 21, 2004. Seed bugs found in August were likely immigrants from surrounding ponderosa pine.

Table 1. Numbers of cones examined and insect damage recorded by seed orchard.

Orchard	Date examined	# cones	# trees	Clean* cones	Cone beetles	Cone-worms	Adelgids	Seedbug adults	Seedbug nymphs
Coeur d'Alene	5-24-04	264	13	54%	44%	0	0	5	0
	7-6-04	532	20	56%	43%	0.2%	1%	12	14
	8-12-04	210	10	42%	26%	32%	0	2	6
Lone Mtn.	7-19-04	356	15	98%	1.4%	0.6%	0	1	0
Grouse Creek	7-8-04	268	12	73%	27%**	0	0	3	0
	8-17-04	897	bushels examined	59%	15%	26%	0	3	0

*clean cones = cones with no external damage

**two sampled trees had 71% and 55% of their cones killed by cone beetles

Grouse Creek Seed Orchard

This orchard was examined in early July from a bucket truck, and in mid-August from the ground as bushels of cones were collected (Table 1). Averages of 27% of cones examined in July were killed by cone beetles. However, individual trees contained higher damage levels. Two trees sampled had 71% and 55% of their cones killed by cone beetles. Cone beetle damage can be fairly spotty with damage in certain parts of an orchard or on certain trees. No coneworm damage was seen in July and few seed bugs noticed. In August, cones were examined after they were picked and put into bushel baskets. Large numbers of cones can be examined this way but cones damaged by cone beetles can be missed either because they fell off the tree already or because they were very small and not picked. Only 15% of cones examined from bushels showed evidence of cone beetles, while 26% had evidence of coneworm feeding (mainly frass).

Cone beetles were caught in pheromone traps from April 12-June 29 (fig. 1). Traps were monitored every few days and trap catch numbers pooled each week. Peaks in beetle flight occurred in the 2nd week of April and 1st and 3rd weeks of May. The drop in trap catch numbers the 3rd week of April was likely due to cool, wet weather. Flight was over by the end of June.

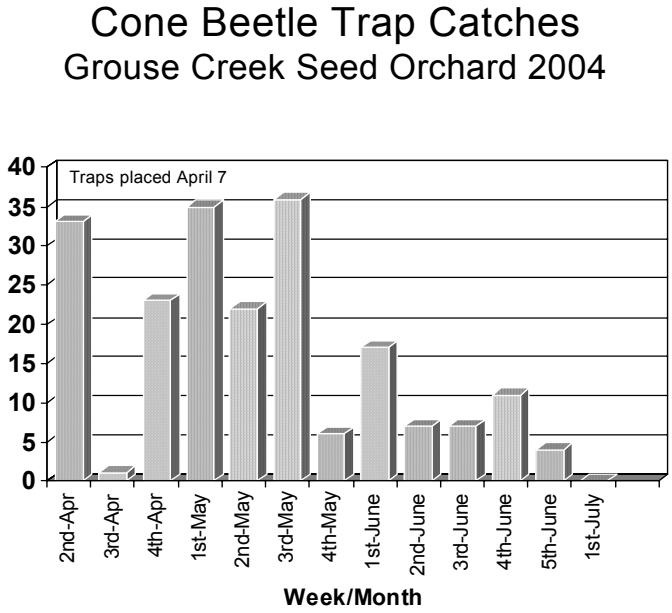

Fig. 1. Cone beetle trap catches at Grouse Creek seed orchard in 2004.

Developing cones from the larch seed orchard were also examined in early July. At that time, we discovered many cones that were slightly stunted but had no other signs of insect damage. These cones were brought to the lab and later produced frass and caterpillars of *Dioryctria* sp. (coneworms).

Lone Mountain Seed Orchard

This orchard was examined only once, in mid-July. Cones were examined from Phase II and mid-elevation sections. Very little coneworm and cone beetle damage was found and few seed bugs were noticed (Table 1).

Insect Biology

Cone beetles

The ponderosa pine cone beetle, *C. ponderosae* Hopkins (=*contortae* Hopkins, = *monticolae* Hopkins, =*flexilis*) is the only cone beetle species affecting pines in the Inland Northwest (Wood 1982). It infests western white pine, ponderosa pine (*P. ponderosa*), lodgepole pine (*P. contorta*) (Furniss 1997), and even high elevation limber pine (*P.flexilis*)(Keen 1958) and whitebark pine (*P. albicaulis*)(Kegley et al. 2001). Cone beetles are in the same family as bark beetles (Scolytidae) and are small, dark brown beetles, about 1/8 – 3/16 inches long. Cone beetles spend the winter inside cones killed the previous summer, and begin to fly in April or May as soon as ambient temperatures are consistently in the 60's. They attack developing second year cones, often leaving a characteristic pitch tube at the base of the cone (fig. 2). Developing cones are killed rapidly by the adult beetles girdling the cone axis causing them to be stunted. Eggs are laid and larvae hatch and feed inside the cone. Feeding of larvae pulverize the inside of cones into a powder. Larvae develop into immature adults by the fall to overwinter again in cones. White pine cones killed by cone beetles usually fall to the ground and in winter are covered by snow, offering protection from extreme weather conditions for overwintering beetles (Williamson et al. 1966).

Fig.2. Pitch tube on outside of cone attacked by cone bettle.

Seed Bugs

Western conifer seed bugs have been observed feeding on Douglas-fir and several species of pine from British Columbia to Mexico (Koerber 1962). Adult seed bugs hibernate over the winter—often invading people's houses in the fall—and emerge in spring. They are strong fliers and are easily disturbed. Mating and egg laying occur in late May through early July. Eggs are laid in rows on needles. Seed bug nymphs look similar to adults only smaller and with more orange on their abdomens (fig. 3). They are gregarious, do not have wings, and do not fly. Both nymphs and adults feed on seed from the outside of cones. They have a long, sucking beak (mouthpart) that they insert through cone scales to a seed. Seed contents are dissolved by seed bug saliva and then consumed. Seed bug feeding causes the endosperm of the seed to shrivel. Damaged seeds are not viable and can be detected by radiography or biochemical marker based techniques (Lait et al. 2000, Bates et al. 2002). Seed bug feeding early in the growing season can also cause substantial abortion of developing 2nd year white pine cones (Connelly and Schowalter 1991).

Coneworms

The fir coneworm, *D. abietivorella*, has a broad host range. It has been found infesting true firs, Douglas-fir, many species of pine, spruces, western larch, and western hemlock in Canada, the northeastern United States, and in the west from Alaska to northern Mexico (Sopow et al. 1996). Its life cycle is not well known.

Fig. 3. Seedbug nymphs on western white pine cone.

Pheromone trap testing in high elevation whitebark stands caught a few moths in July and August (Kegley et al. 2001). At Grouse Creek seed orchard in 2002, a few moths were trapped data). With so few moths caught, we are unsure when their peak flight occurs in north Idaho, but we do know that they are present during the summer months as early as late June. In a study of infested cones that were bagged on the trees in August to prevent insect escape, 37% of coneworms emerged from cones and spun silk hibernacula inside of the bags to overwinter. Another 42% of the larvae spun a silk chamber on or inside the cone. Of the remaining larvae, 13% developed into adults before winter and 8% were parasitized by wasps (Gast 1991). This indicates that the majority of the population spends the winter either as pupae or pre-pupae in cones or in the duff and emerges as adults in the summer. A small portion of the population develops into adults in late summer. Whether they spend the winter as adults or lay eggs before winter is unknown. Larvae are purplish-brown in color, are very mobile and will emerge from one cone to feed on another. Their feeding may cause discoloration on the outside of the cone with conspicuous frass in mid- to late-summer (fig. 4).

Fig. 4. Western white pine cone damaged by coneworms (left) compared to normal cone (right).

Insect Management

The most effective method of controlling insects in seed orchards is using an integrated pest management system including monitoring, sanitation, pheromones (when available), and correct timing of treatments.

Since many insects spend the winter inside damaged cones, removing these cones each year will remove resident populations and should be done annually. However, immigration of insects from surrounding forests can also be a problem.

Single or multiple applications of synthetic pyrethroids have been effective in reducing cone crop damage due to the aforementioned insects. However, multiple applications of these insecticides within a summer have sometimes led to outbreaks of scale insects. Timing of insecticide applications is critical since many of the insects are protected once they bore into the cones. Timing must coincide with adult activity outside the cone which varies by insect species. Seed bugs are active from May through September. Cone beetles fly in spring—usually April and May. Coneworm life cycle is not well known but two applications of fenvalerate, once in May and once in June significantly increased seed yield and protected cones from coneworms (Haverty et al. 1986). Applications of behavioral chemicals such as 4-allylanisole (4aa) against cone beetles, have been used elsewhere with promising results. These may be available in the future as formulations improve (Nancy Gillete, personal communication).

Pheromones in traps can be used to monitor insect populations and help in timing of insecticide treatments. However, at this time, only cone beetle pheromones are currently available. Using pheromones to "trap out" cone beetles have been tried in the past. But current pheromones trap mostly males, and even unmated females continue to kill cones. In addition, trap-outs over several years have not shown a reduction in cone damage (Nancy Gillete, personal communication). Research continues to try to identify pheromones attractive to female beetles. We have tested different pheromones for many years in an attempt to attract coneworm adults. The pheromones identified appear to be unstable and none have consistently caught a sufficient number of moths in the field. More recently, research had identified a new pheromone which has shown promise in the field and may be available for use in the near future (Nancy Gillete, personal communication)

Prescribed burning in seed production areas in the Midwest have been successful in reducing damage from the red pine cone beetle, *Conophthorus resinosae* Hopkins, red pine cone moth, *Eucosma monitorana* Heinrich and the red pine coneworm, *Dioryctria disclusa* Heinrich (Miller 1978). Use of a propane flamer for control of white pine cone beetles, *Conophthorus coniperda* (Schwarz) has also been used with success in the Midwest (Sery and Katovich 1996). This technology has potential to be useful in western white pine orchards.

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References

Bates, S.L.; Lait, C.G; Borden, J.H.; and Kermode, A.R. 2002. Measuring the impact of *Leptoglossus occidentalis* (Heteroptera: Coreidae) on seed production in lodgepole pine using an antibody-based assay. Journal of Economic Entomol. 95(4): 770-777.

Connelly, A.E.; Schowalter, T.D. 1991. Seed losses to feeding by *Leptoglossus occidentalis* (Heteroptera: Coreidae) during two periods of second-year cone development in western white pine. J. Econ. Entomol. 84(1): 215-217.

Gast, S. 1991. Cone and seed insect surveys in north Idaho western white pine seed orchards 1991. USDA For. Serv. Northern Region FHP Rpt. 4 p.

Haverty, M.I.; Shea, P.J.; Stipe, L.E. 1986. Single and multiple applications of fenvalerate to protect western white pine cones from *Dioryctria abietivorella* (Lepidoptera: Pyralidae). J. Econ. Entomol. 79:158-161.

Keen, F.P. 1983. Cone and Seed Insects of Western Forest Trees. USDA For. Serv. Tech. Bull. 1169. 168 p.

Kegley, S.; Sturdevant, N.; Stein, J.; Willhite, B.; Flanagan, P.; Weatherby, J.; and Marsden, M. 2001. Cone and seed insects and their impact on whitebark pine. USDA For. Serv. Northern Region FHP Rpt. 01-6. 13p.

Furniss, M.M. 1997. *Conophthorus ponderosae* (Coleoptera: Scolytidae) infesting lodgepole pine cones in Idaho. Environmental Entomol. 26(4):855-858.

Lait, C.G.; Bates, S.L.; Kermode, A.R.; Morrissette, K.K.; Borden, J.H. 2000. Specific biochemical marker-based techniques for the identification of damage to Douglas-fir seed resulting from feeding by the western conifer seed bug, *Leptoglossus occidentalis* Heidemann (Hemiptera: Coreidae). Insect Biochemistry and Molecular Biology 31: 739-746.

Miller, W.E. 1978. Use of prescribed burning in seed production areas to control red pine cone beetle. Environ. Entomol 7: 698-702.

Rappaport, N.G; Stein, J.D; Del Rio Mora, A.A.; DeBarr, G; De Groot, P; and Mori, S. 2000. Responses of *Conophthorus* spp. (Coleoptera: Scolytidae) to behavioral chemicals in field trials: A transcontinental perspective. Can. Entomol. 132: 925-937.

Sery, W. and Katovich, S. 1996. Operation of a propane flamer for control of white pine cone beetles in a seed orchard, 1995 trials. USDA For. Serv. NE Area, draft FHP rpt. 4 p.

Shea, P.J.; Jenkins, M.J.; Haverty, M.I. 1983. Cones of blister rust-resistant western white pine protected from *Conophthorus ponderosae* Hopkins (= *C. monticolae* Hopkins). J. Georgia Entomol. Soc. 19(1): 129-138.

Sopow, S.L.; Benett, R.G.; Landry, J.F.; Landry B. 1996. Identification of the "grey" *Dioryctria* species of British Columbia (Lepidoptera, Pyralidae). J. Entomol. Soc. Brit. Columbia 93: 75-92.

Williamson, D.L.; Schenk, J.A.; Barr, W.F. 1966. The biology of *Conophthorus*

monticolae in Northern Idaho. Forest Science 12 (2): 234-240.

Wood, S.L. 1982. The Bark and Ambrosia Beetles of North and Central America (Coleoptera: Scolytidae), a Taxonomic Monograph. Great Basin Naturalist Memoirs No. 6, Brigham Young University, Provo, Utah. 1359 p.

Personal Communication

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