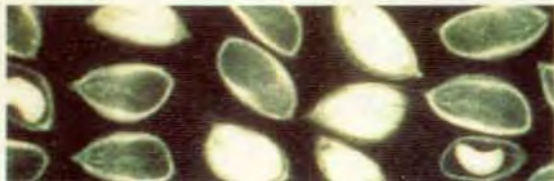


A Guide to Insect Pests in Douglas-fir Seed Orchards

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SUMMARY

This guide covers the majority of insects that feed upon cones and seeds, or destroy potential cone-bearing branches, in Douglas-fir seed orchards. Emphasis is on the recognition of the various stages of insect development and damage. A section is included on insect control.

RÉSUMÉ

Ce guide comprend la plupart des insectes qui se nourrissent de cônes et de graines et qui détruisent les branches qui produiraient des cônes dans les pépinières du sapin de Douglas. L'accent est placé sur l'identification des diverses stades du développement de l'insecte et des dégâts. Une partie concernant le contrôle des insectes est aussi incluse.

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INTRODUCTION

The increasing demand for Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, seed for reforestation, has placed greater emphasis on production of quality seed in seed orchards and in seed production areas.

Because production is often seriously affected by cone and seed insects it is important to recognize these insects in order to prevent or reduce the losses caused by them. This bulletin was therefore prepared as an aid for seed orchard workers.



Insects listed in order of importance

Note: Because the insect populations vary from year to year, particularly in the case of Douglas-fir coneworm, western spruce budworm and seed bug, the insects' order of importance will also change.

DESCRIPTIONS

Douglas-fir cone moth, *Barbara colfaxiana* (Kearfott)

The Douglas-fir cone moth is one of the most common and destructive insects in Douglas-fir seed orchards and seed production areas. Severe infestation of cone moths can cause seed losses from 60-100%, moderate 30-60% and light 0-20%. One larva in a cone can destroy 65% of the seed, two or more 100%.

Eggs are laid on the bracts of conelets (Fig. 1) in late April through early May, and hatch 2 or 3 weeks later. The larva mines scales and bracts, and enters the cone to feed on seeds (Fig. 2). The cream colored larva has a black head that turns brown as the larva develops (Fig. 3). By the end of July, feeding is completed and the larva spins a cocoon in the cone, where pupation and overwintering occur (Fig. 4). Normally the mottled grey adult (Fig. 5) emerges the following spring, but the insect may remain in the pupal stage for another year or more if the subsequent crop is poor.

Severely affected cones may be undersized, distorted, or both, and often have fine frass on the outside.



Fig. 1. Cone moth eggs on Douglas-fir conelet.



Fig. 2. Cone moth larva and damaged cone.



Fig. 3. Cone moth larva in Douglas-fir cone.



Fig. 4. Cone moth pupae. 1/ pupa in cocoon. 2/ pupa with portion of cocoon removed.



Fig. 5. Cone moth adult.



Fig. 6. Gail midge larvae and damage.

Douglas-fir cone gall midge, *Contarinia oregonensis* Foote

Gall midges occur throughout the range of Douglas-fir, but are commoner in coastal regions. When the insect population is large, all seeds in a cone may be destroyed (Fig. 6).

The mosquito-like adult (Fig. 7) emerges in April, when Douglas-fir flower buds are opening, and the female lays small pink, elongated eggs near the base of cone scales (Fig. 8). The eggs are difficult to see without magnification, unless they are laid in clusters, as frequently occurs. Eggs hatch in 2 or 3 weeks. The larva feeds on the inner surface of a scale near the base and a gall is formed which fuses the developing seed to the scale. The reddish orange, u-shaped larva (Fig. 9) remains in the gall until wet weather in the fall, whereupon it emerges, falls to the ground and spins a cocoon in which it overwinters. Normally larvae pupate in early spring and adults emerge in April. However, like most cone insects, the gall midge can diapause and remain in the cocoon a year or more if the next cone crop is poor.



Fig. 7. Adult gall midge.



Fig. 8. Gall midge eggs.



Fig. 9. Gall midge larva in gall.

Douglas-fir coneworm, *Dioryctria abietivorella* (Grote)

Although rarely present in large numbers, a single larva may destroy all seeds in a cone by indiscriminate feeding on seeds and scales (Fig. 10). The damaged cones have large holes and coarse frass on the outside (Fig. 11). Larvae occur in the cones from June until September. The mature larva is about 2 cm long, reddish brown, and becomes very active when disturbed (Fig. 12). The adult is mottled grey, with a wing-span of about 2.8 cm (Fig. 13). Figure 14 shows coneworm eggs on cone scales. The life history is not completely known.

Larvae of the Douglas-fir coneworm will also enter graft unions, increment borer holes and other areas with damaged bark, and mine in the inner bark.



Fig. 10. Inside of damaged cone.



Fig. 11. Outside of cone infested by Douglas-fir coneworm.



Fig. 12. Larva of coneworm.



Fig. 13. Adult coneworm.



Fig. 14. Coneworm eggs on Douglas-fir cone scale.



Fig. 15. Female and male seed wasp.

Douglas-fir seed wasp, *Megastigmus spermotrophus* Wachtl

Seed losses caused by this wasp are not usually severe; however, endemic populations occur throughout the range of the host.

The small wasps (Fig. 15) lay eggs in the seeds of immature cones in June. The female oviposits through the cone scale and into the developing seed (Fig. 16). The small white larva feeds on the tissues within the seed, leaving only the seed coat (Fig. 17). Feeding is completed in 6 to 8 weeks, and the larva overwinters in the seed. Pupation occurs in late spring, and the adult wasp emerges through a hole in the seed coat (Fig. 18). However, if conditions are unsuitable, the larva may remain in the seed for 1 to 3 years.



Fig. 16. Seed wasp eggs in seed of Douglas-fir.



Fig. 17. Seed wasp larva.



Fig. 18. Seed from which adults have emerged.

There is no external evidence of the insect in infested seeds. Before insects have emerged, they can be detected by dissection or by X-raying the seeds. After emergence, the exit hole through which the insect escapes from the seed is evidence of infestation.

Western spruce budworm, *Choristoneura occidentalis* Freeman

Normally, the insect feeds on foliage and buds of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), amabilis fir (*Abies amabilis* (Dougl.) Forbes) and grand fir (*Abies grandis* (Dougl.) Lindl.). However, the insect is found in seed orchards in small numbers, frequently feeding on seeds and cone scales. The larva is about 25 mm long, has a light to dark-brown body, with cream spots on the upper surface (Fig. 19). Feeding is sometimes confined to the scales on the cone mid-section, causing it to become deformed (Fig. 20).

Larvae feed from mid-May through June. Pupation occurs in the cocoon, in the damaged portion of the cone or attached to its surface. The adults emerge from mid-July to the beginning of August (Fig. 21).



Fig. 19. Western spruce budworm larva and damaged Douglas-fir cone.



Fig. 20. Longitudinal section of damaged Douglas-fir cone.



Fig. 21. Spruce budworm adult.

Seed bug, *Leptoglossus occidentalis* Heidemann

This sucking insect feeds on the seeds of Douglas-fir and various other species of conifers. It was not considered a seed orchard pest until 1977, when it appeared in large numbers in seed orchards and natural stands, destroying about 36% of the seeds in one orchard.

The reddish brown to dark-grey adults (Fig. 22), 15 to 18 mm long, emerge in May or early June and feed on the developing cones. The brown, barrel-shaped eggs are laid from June until mid-August, on the edge of needles (Fig. 23). They hatch in about 2 weeks and the young bugs (nymphs) feed and develop on foliage, then move onto the cones. The insect inserts its tube-like mouth parts through cone scales and into the seed (Fig. 24) and supposedly enzymes in the saliva dissolve the endosperm so that it can be ingested. By the end of September, most bugs are fully mature. The period between egg hatch and adulthood is approximately 5 weeks. Feeding continues until the onset of cool weather or until seeds drop from the cones. The bug overwinters in bark crevices or wherever it is protected from the weather.

The endosperm in damaged seeds is shrivelled but this can only be detected by cutting open or X-raying the seeds.



Fig. 22. Adult seed bug.



Fig. 23. Seed bug eggs and emerging nymph.



Fig. 24. Seed bug feeding on Douglas-fir cone.

Douglas-fir cone scale midge, *Contarinia washingtonensis* Johnson

The pink or red larvae of these insects are frequently found in or about cone drying sheds. Although often abundant, they have only a slight effect on seeds.

The mosquito-like adult emerges in mid-May or early June and lays eggs in small clusters between the cone scale and bract. The resulting larvae feed on cone scales, just below the surface and under the seed wing, usually in clusters in longitudinal tunnels (Fig. 25). Cones, light to moderately infested, show little outward signs of damage; however, if the infestation is heavy, cone scales will die and turn red prematurely. Figures 26 and 27 show the outside and inside appearance of infested cones. Larvae leave the mature cone in early fall and drop to the ground, where they spin cocoons and overwinter. Pupation and emergence of the adult occurs in the spring. If the subsequent cone crop is poor, many larvae will remain dormant for another year.



Fig. 25. Scale midge larvae.



Fig. 26. Outside of cone infested by scale midge larvae.

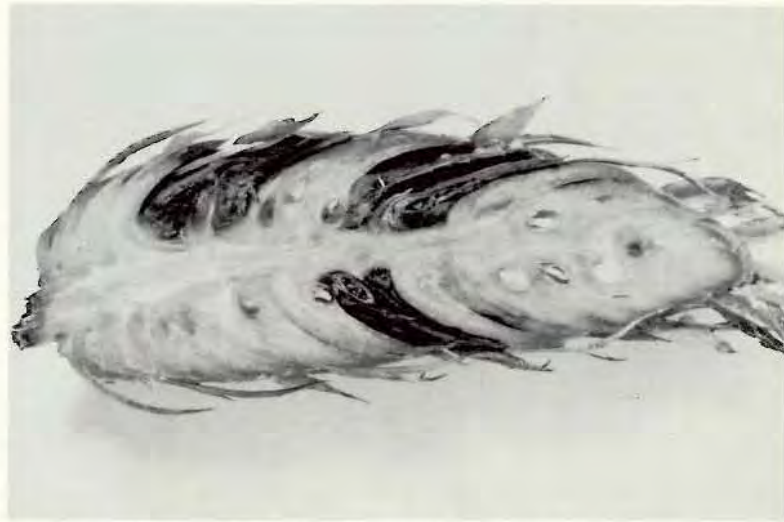


Fig. 27. Longitudinal section of cone damaged by scale midge.



Fig. 28. Cocoon opened to show larva.

Douglas-fir fall coneworm, *Holcocera immaculella* McDunnough

Larvae are often found in the fall, when most other cone insects have completed their feeding. The individual insect can be destructive, feeding randomly on scales and seeds. Moths emerge in June to lay eggs on cone scales and bracts. Larvae feed in the cones during the summer, reaching maturity by fall. The mature larva is about 12 mm long, dark red above and pink underneath (Fig. 28). When feeding is complete, they overwinter in flattened, circular cocoons covered with dry frass or pebbles (Fig. 29). The cocoons can be found on the surface of the cones and in the ground. The larva pupates in May. The insect is seldom abundant, and thus is not a major pest in Douglas-fir cones.



Fig. 29. Cocoon of Douglas-fir fall coneworm on cone scale.

**Twig miner, *Argyresthia pseudotsuga*
Freeman**

The larvae mine the twigs and tips of Douglas-fir branches, thus reducing their cone-bearing capability. Shortly after the insect commences feeding, the shoot becomes flaccid and slightly lighter green (Fig. 30). By mid-summer, 25 to 33% of the twig turns brown (Fig. 31) and, by the following spring, the entire twig is discolored.

The adult moth lays eggs in April near the base of buds, on scales or needles. Eggs hatch in May and larvae enter the twigs at a node, mining in a spiral pattern around the new wood, or directly into the wood. Larvae feed until late fall (Fig. 32), when they move to the base of the twig and construct a pupal chamber. Pupation takes place around the end of January, the insect remaining in the pupal stage until April, when the adult emerges (Fig. 33).



Fig. 30. Current growth of Douglas-fir affected by twig miner.



Fig. 31. Appearance of infested twig 6-8 months after attack.



Fig. 32. Twig miner larva and mined portion of twig.



Fig. 33. Pupa of twig miner; hole through which adult will emerge; portion of mined twig.

Douglas-fir cone beetle, *Ernobius punctulatus* (Leconte)

Damage by this insect is relatively minor, since green cones are not attacked. The reddish brown adults are 2.5 to 4.5 mm long (Fig. 34) and the larvae are white, curled, with yellowish brown heads (Fig. 35). The beetles will infest mature cones before or after harvest. Both adults and larvae may feed on scales and seed throughout the year. Although they occur infrequently, they can, when they infest cones, destroy large numbers of seeds, and damage cones stored for extended periods.



Fig. 34. Douglas-fir cone beetle.



Fig. 35. Douglas-fir cone beetle larvae and damaged scales.

Douglas-fir twig mining beetle, *Pityophthorus orarius* Bright

Overwintering beetles emerge from twigs in the spring, when new shoots on Douglas-fir are about 50 mm long. The small black beetle, approximately 1.5 mm long, selects a twig and tunnels into the previous year's growth directly below the node. A small chamber is made into which one egg is usually laid. Shortly after the parent beetle enters (Fig. 36), new growth of the twig becomes flaccid (Fig. 37). When the egg hatches, the larva feeds mainly in the previous year's growth, but will also mine new shoots. By mid-July, current growth on the infested twigs turns red. These beetles kill new shoots and as these are potential cone bearers, a beetle infestation may affect the cone crop that follows.



Fig. 36. Beetles in Douglas-fir twig.



Fig. 37. Flaccid appearance of new shoots killed by beetle attack.



Fig. 38. Cooley spruce-gall aphid on Douglas-fir foliage.

Cooley spruce-gall aphid, *Adelges cooleyi* (Gillette)

Although the aphid does not cause significant damage, the white cotton tufts on needles and cones (Figs. 38 to 39) may concern seed orchardists. The life cycle is complicated because of six different forms of the insect and an alternate host, which is spruce. On spruce, it forms cone-shaped galls which kill tips of branches. When on Douglas-fir, the egg and nymphs (immature aphids) are covered with a cotton-like wax and are attached to the underside of needles and to the bracts and scales of young green cones. The aphids occur anytime between spring and fall and cause discoloration and distortion of the foliage and possible needle drop, but there is no evidence that they effect seed production.



Fig. 39. Cooley spruce-gall aphid on Douglas-fir cone.

Silver spotted tiger moth, *Halisidota argentata* Packard

The caterpillars are most noticeable in the early spring, in colonies under loose webbing, feeding on the foliage of terminal twigs. It is a pest on most conifers in the southwestern part of the province; however, Douglas-fir is the preferred host.

The adult moth, which has a wing-span of from 40 to 50 mm, is yellowish brown (Fig. 40). The adults emerge during July and August and the female lays small pea green eggs on twigs and needles. The eggs hatch in about 21 days, depending on weather conditions. The small greenish brown, hairy caterpillars, feed in groups until late fall. They hibernate in webs during the winter and resume feeding in the spring (Fig. 41). When nearly mature the larvae leave the colonies and become solitary feeders. Mature larvae are about 35 mm long, and are reddish brown with tufts of yellow and brown hairs, which can cause skin irritations. In June they spin a dark brown cocoon using silk and body hairs, in which they pupate.

The insect is controlled by natural enemies



Fig. 40. Silver spotted tiger moth adult.

and is seldom a problem. However, when encountered in the orchard and to prevent further damage, it is advisable to either cut off the infested branch, or using a pair of gloves, remove the caterpillars from the branch and dispose of the colony.



Fig. 41. Tiger moth larvae and damage.

**Fir cone maggot, *Earomyia barbara*
McAlpine**

The adult maggot is a small, shiny black fly about 4 mm long, with wings much longer than the body. The white, elliptical egg (1.5 mm long) is laid under a cone scale during the spring. When the egg hatches, the larva mines into the cone. Although the maggot tunnels through scales and seeds, it is thought to be predacious, its main host being the larvae of gall and scale midges (Fig. 42). When mature, the larva is about 6-7 mm long, white, with black hooks or mouth parts. In the late summer or early fall, the larva leaves the cone and spins a cocoon in the ground. The fir cone maggot is uncommon in Douglas-fir cones.

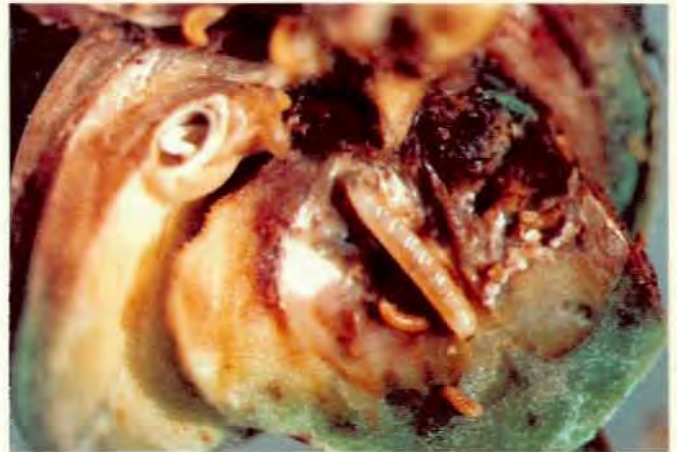


Fig. 42. Fir cone maggot larva and scale midge larvae.

Foliage moth, *Cnephasia longana* (Haworth)

The larvae feed on the current foliage and buds of young Douglas-fir seed orchard stock. When an infestation is heavy, up to 80% of the foliage and buds may be eaten. The insect is most common in damp meadow areas and normally prefers other hosts; e.g., strawberry, clover and alfalfa. The adult lays its eggs on the surface of erect fence posts, stakes, etc., in mid-June. The eggs hatch in July and the larvae crawl into suitable crevices on the post or tree and spin silken hibernacula. They remain in the crevices until the following March. They then emerge and commence mining in the buds, and later feed on foliage. Feeding continues until mid-June, when pupation occurs. Figures 43-44 show the various types of damage.



Fig. 43. Defoliation on Douglas-fir seed orchard stock caused by foliage moth larvae.



Fig. 44. Close-up of needle damage by foliage moth larvae.

PREVENTION AND CONTROL

Seed loss by insects can be reduced in several ways:

- (a) if possible, establish orchards in areas away from natural stands of the same species;
- (b) pick and remove all cones each year, to ensure removal of insects;
- (c) alter flowering time of orchard-grown trees from surrounding stands of the same species. This will put them out of phase with peak insect activity; the cold-water spray treatment may prove to be a useful technique for this;
- (d) spray young cones with a systemic insecticide if insect populations indicate a need for chemical control. To determine if control is necessary, effective sampling should be carried out.

Sampling to determine if chemical control is warranted.

The majority of cone insects lay their eggs in the spring when pollination takes place; thus, immediately after pollination, flowers should be examined for insect eggs, using the following sampling methods:

- (e) 5 to 10% of the cone bearing trees in the orchard should be sampled. Select the trees at random and pick five conelets from different sections of the cone bearing area of each tree;
- (f) examine cone bracts for cone moth eggs. These can be seen easily with the naked eye. If one or more eggs are found on 60% of the cones examined, some control measures are recommended;
- (g) when looking for gall midge eggs, each conelet should be dissected and five scales and the attached bract examined under a stereo-micro-

scope or 10 X hand lens. The eggs, only 0.25 mm long, are laid near the ovules and, when abundant, appear as a small pink mass around them. If eggs occur on three or more scales per cone, control measures should be taken. There is no practical method for predicting losses from seed wasps or other moths.

Before using insecticides, ensure that all recommended procedures and precautions are strictly adhered to. The applicator must be thoroughly familiar with the book published by the Provincial Ministry of the Environment, entitled "Handbook for Pesticide Applicators and Pesticide Dispensers".

The Cooley spruce-gall aphid.

The Cooley spruce-gall aphid can be controlled by spraying during May or June with 2.5% oleate soap solution which is harmless to the applicator and the environment.

Treatment of infested seed.

Larvae of the Douglas-fir wasp, *Megastigmus spermotrophus*, can be killed by keeping the seeds at 45°C for 40 hours. Seed moisture content prior to treatment must not exceed 10% (dry weight basis). If seed is more than 1 year old, the treatment period can be reduced to 35 hours. This treatment has no harmful effect on seed germination or seedling growth.

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