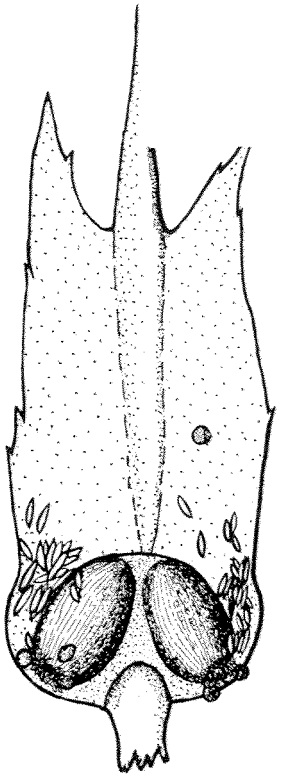

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DOUGLAS-FIR CONE INSECTS AND THEIR CONTROL

by
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Norman E. Johnson[1] and Alan F. Hedlin[2]

INTRODUCTION

A number of different insects can cause severe seed losses in Douglas-fir cones and each is capable of destroying a high percentage of the seed crop. The more important insects occur throughout most of the natural range of the host tree although their prevalence may vary locally. For example, the Douglas-fir cone moth is more common in drier interior areas and the Douglas-fir cone midge more prevalent in wetter coastal areas.

The control recommendations described are based on the results of experiments conducted by Weyerhaeuser Company and the U.S. Forest Service in Washington and Oregon, and by the federal Department of Forestry and Rural Development in British Columbia.

LIFE HISTORY AND HABITS OF MAJOR CONE INSECTS

The period of attack in relation to conelet development is shown in Figure 1 for all species. Conelet development is pictured in Figure 2.

Douglas-fir cone moth (*Barbara colfaxiana* (Kft.))

This moth appears in late April and May to lay its eggs on the bracts of young Douglas-fir conelets (Figure 3,A). Moths fly only in the evening and can be seen circling from early dusk until dark in search of cones on which to lay eggs. The eggs are flattened and either oval or circular in outline. They are yellowish white at first, becoming darker as the embryo develops within the transparent skin.

Eggs hatch in about two to three weeks and the young larvae bore into the cone, usually in the angle between the cone bract and scale. They soon migrate to the centre of the cone and feed on seeds (Figure 3,C). Larval feeding is completed by the latter half of July, when the insect spins a tough cocoon in the cone. The insect overwinters in the cocoon and the moth emerges the following

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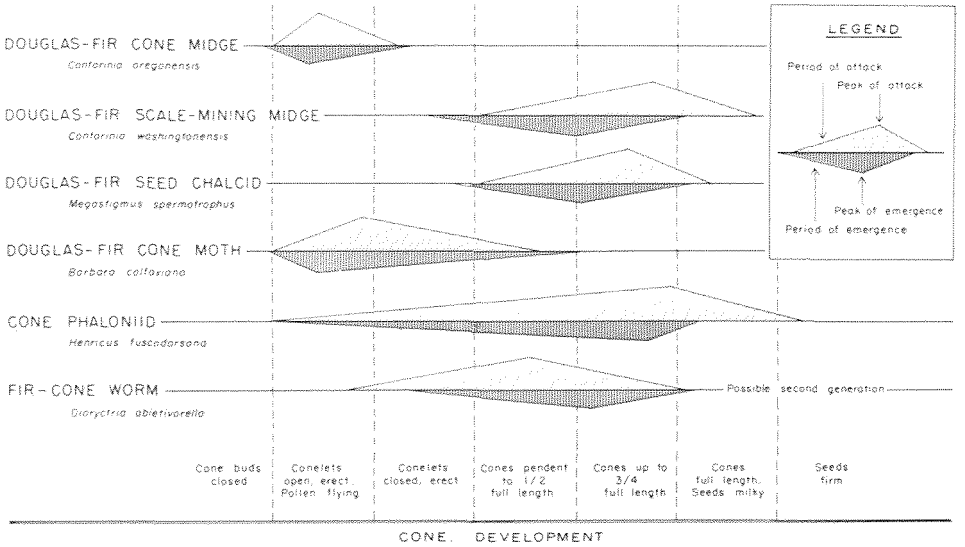

Figure 1. The period of emergence and attack for six important insects that attack Douglas-fir cones. To achieve maximum control of all species with a single application, chemical should be applied when the cones are pendent to half full length.

spring. Distorted cones covered with frass indicate a heavy infestation by the Douglas-fir cone moth (Figure 3,B).

Fir coneworm (*Dioryctria abietivorella*)

This insect occurs sporadically but is capable of causing considerable destruction. The moth usually emerges in spring but may emerge in the fall. The egg laying habits are not fully known, but eggs laid in the spring hatch in early summer. The larva feeds in a manner similar to that of the Douglas-fir cone moth, except that it feeds throughout the cone and one larva may destroy a cone completely. Large quantities of frass are common on the surface of infested cones (Figure 4). The larva is larger and darker in colour than that of the Douglas-fir cone moth. In the fall, the mature larva leaves the cone to spin a soft round cocoon in which to overwinter. The immature larva remains dormant over winter to resume feeding in the spring and complete its metamorphosis in late summer.

The Douglas-fir cone midge (*Contarinia oregonensis* Foote)

Adults emerge in the latter half of April and early May when Douglas-fir flowers are being pollinated. The midge forces itself between the conelet bracts and lays eggs near the developing

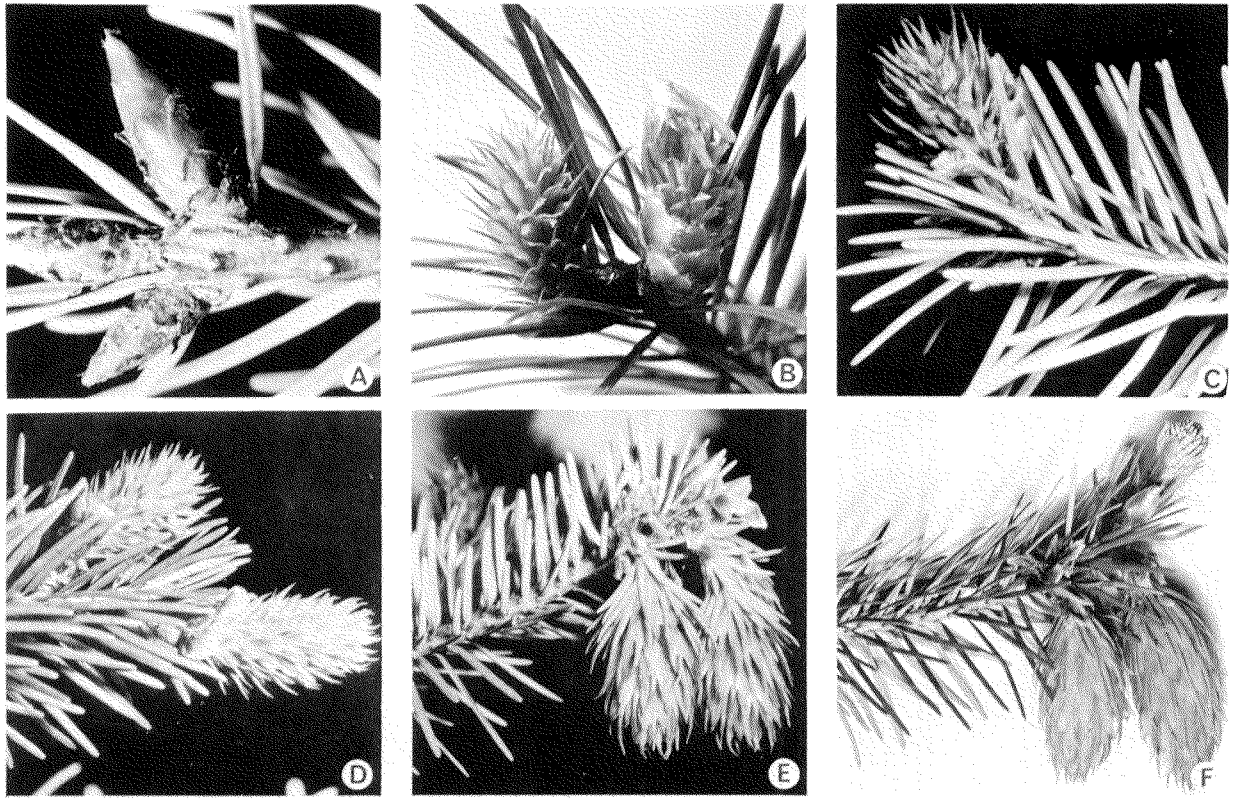

Figure 2. Early stages of Douglas-fir cone development: (A) Unopened female cone bud in contrast to two vegetative buds; (B) Newly opened conelets; (C) Conelet erect and starting to close; (D) Conelets closed and starting to turn down; (E) Conelets just down; (F) Vegetative growth starting, conelets about 1/3 to 1/2 full length.

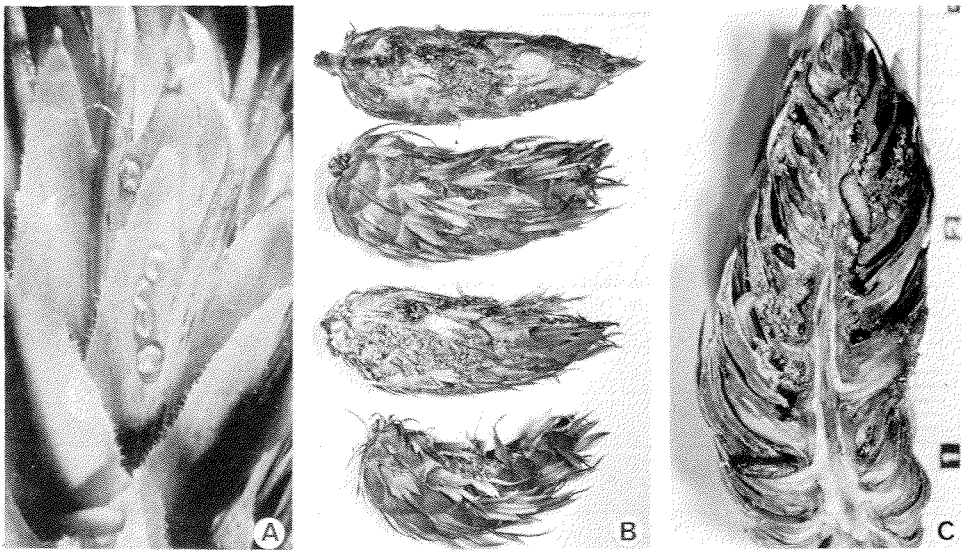

Figure 3. (A) Douglas-fir cone moth eggs on bracts of conelet; (B) Cones deformed by cone-moth attack; (C) Sliced cone showing damage caused by mature larvae.

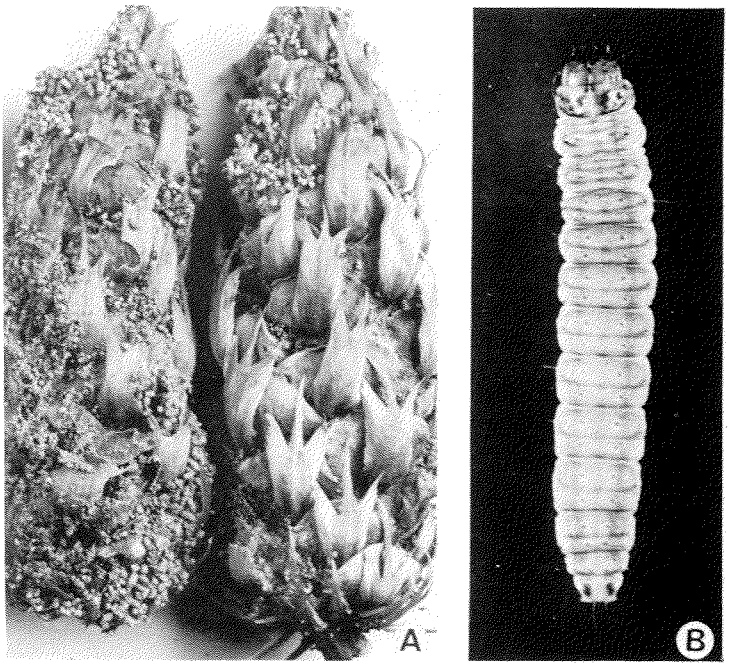

Figure 4. Douglas-fir heavily infested with the fir coneworm. At right, mature larva.

seed (Figure 5,A). Eggs hatch in two to three weeks and the young larvae tunnel into the scale tissue causing a gall to form around the seed (Figure 5,B). The gall prevents seed development or fuses the seed and cone scale. In the autumn when mature dry cones become wet with fall rains, larvae emerge and drop to the ground where they spin small brown cocoons in the litter. They overwinter in the cocoon and pupation occurs in the spring.

Douglas-fir scale midge (*Contarinia washingtonensis* Johnson)

Adults emerge during late May and early June to lay their eggs in young cones about the time foliage buds are bursting. The eggs are laid in small clusters in the angle between the cone bract and scale. Young larvae tunnel into the scale tissue where they feed in the central portion of the scale, usually in small groups (Figure 5,C). Infested scales turn brown before the cones are mature, but galls are not formed. When the larvae complete their development in the fall they drop to the ground and spin light brown cocoons in which to overwinter. Pupation occurs the following spring.

Douglas-fir seed chalcid (*Megastigmus spermotrophus* Wachtl)

Adults emerge in late May and June from seeds on the ground, or those left in the cones. The female (Figure 6,A) deposits its eggs by inserting its ovipositor through the cone scale and into the young seeds. Eggs hatch in late June and early July. A single larva develops in each seed and devours the endosperm (Figure 6,B). In autumn the larva drops to the ground with the seed when it is shed from the mature cone. Pupation occurs within the seed the following spring.

CHEMICAL CONTROL

Need for Control

Because of the variation in cone crop size and insect abundance, it may not be necessary or desirable to spray each year. Knowledge of the condition of the cone crop the previous year will aid in deciding when to spray. If the cone crop the previous year was large and heavily infested with insects, it is likely that the current crop will also be heavily infested. If the current cone crop is smaller than last season, the insects may destroy all the seed. However, if the cone crop was light or moderate and was not severely infested, it is unlikely that an infestation will occur in a similar, or larger current crop.

A decision as to whether to spray can be determined by sampling for insect eggs at the time the young cones are closing and turning down (Figure 2,D). We suggest five conelets per tree be

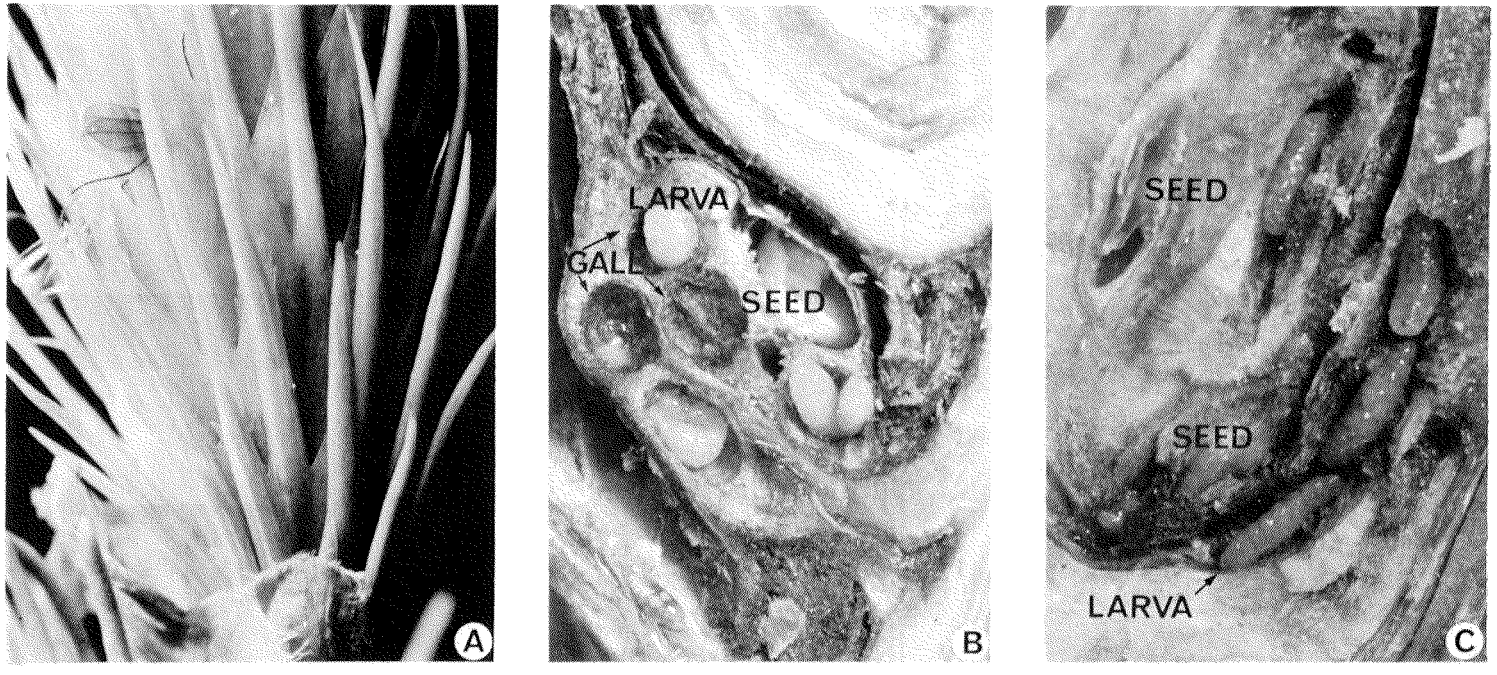

Figure 5. (A) Wings and legs of a female cone midge as she oviposits in a Douglas-fir conelet; (B) Close-up of a sliced cone showing mature cone midge larvae in gall around seed; (C) Close-up of larvae of scale midge around seed. Note the absence of a gall and how the larvae lie straight rather than curved as do the larvae of the cone midge.

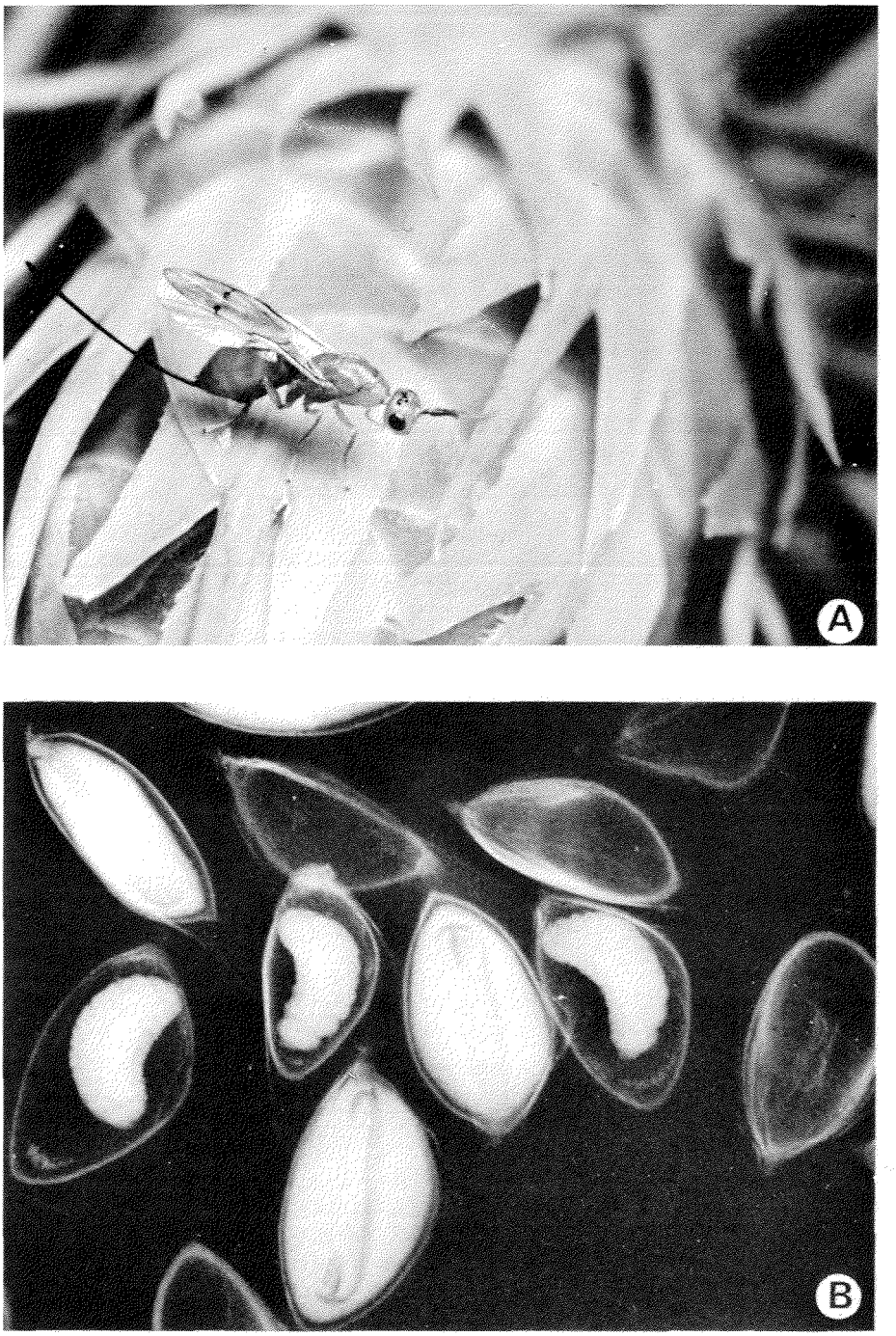

Figure 6. (A) Female chalcid searching for place to insert ovipositor; (B) X-ray of Douglas-fir seed showing normal, empty and chalcid-filled seed.

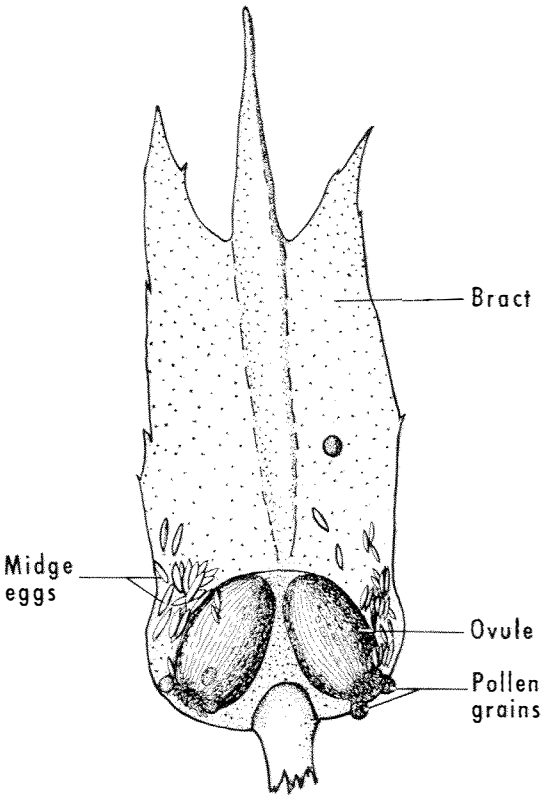

Figure 7. Douglas-fir gall midge eggs on young cone scale.

collected from each of several different parts of the crown from at least one of every 10 trees. The conelet bracts should be examined first for cone moth eggs, which are easily visible to the unaided eye (Figure 3). Each conelet should then be taken apart and examined for midge eggs. To do this, five scales and the accompanying bract are selected and examined under a dissecting microscope. The position of the eggs in relation to the ovules is shown in Figure 7. The eggs are small, only 0.25 mm. long, but when they are abundant they appear as a salmon-pink mass. This sampling procedure is the basis for the severity ratings shown in Table 1.

Severe infestations of midges and cone moths can be expected to reduce the seed yield from 60 to 100 per cent, moderate infestations from 20 to 60 per cent, and light infestations from 0 to 20 per cent. There is no easy way to predict losses from chalcids or other moths.

What Chemicals to Use

The effectiveness of dimethoate (Cygon), Meta-Systox-R[R] and Bidrin[R] in controlling insects affecting Douglas-fir cones has been demonstrated.[3] Dimethoate is the least toxic to humans and Bidrin the most toxic. Use of the latter is not recommended except under supervision of trained personnel. Meta-Systox-R is generally considered the most satisfactory. The prices of dimethoate, Meta-Systox-R, and Bidrin are about $20.00, $24.00 and $30.00 per gallon respectively. Active ingredients for dimethoate is 2.67 lb. per gallon, 2 lb. per gallon for Meta-Systox-R and 8 lb. per gallon for Bidrin.

How to Mix the Chemicals

One-half to one per cent concentrations of dimethoate, Meta-Systox-R, or Bidrin will control Douglas-fir cone and seed insects if the foliage is covered thoroughly.

Recommendations for mixing the correct concentration are given in Table 2. For example, for a one percent concentration of Meta-Systox-R, add water to 4.1 gallons of emulsifiable concentrate to make 100 gallons[4] of spray. Three and one-tenth gallons of dimethoate, or 1.1 gallons of Bidrin, in a total of 100 gallons of spray mixture will give a one percent spray concentration of these chemicals.

Dimethoate and Meta-Systox-R can be mixed safely in the field if the following precautions are taken:

1. Do the mixing outdoors.
2. Have plenty of water on hand to thoroughly wash away any spilled chemical.
3. Wear heavy rubber gloves, rubber clothing, goggles and a respirator with approved filters designed for protection from organic phosphate fumes.
4. The person making the application should also wear the same kind of respirator and light rubber gloves. Preferably, he should also wear rubberized clothing and shoes which can be washed off at the end of each day.

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[3] Cygon is an American Cyanamid product; Meta-Systox-R a Chemagro product and Bidrin a Shell product. Orders should be placed with local suppliers well in advance of spraying.

[4] All measurements in U.S. gallons.

TABLE 1. SEVERITY OF CONE MOTH AND CONE MIDGE INFESTATION IN YOUNG DOUGLAS-FIR CONES.

Infestation	Cone Moth Cones infested with one or more eggs	Cone Midge Cone scales infested per cone
Severe	4 out of 5	3 or more
Moderate	1-3 out of 5	1-2
Light	Less than 1 out of 5	Less than 1

TABLE 2. AMOUNTS OF LIQUID CONCENTRATE TO OBTAIN PERCENTAGE MIXTURES BY WEIGHT*

Insecticide	Gallons of concentrate needed to make 100 gallons of spray (percentage concentration)				
	0.5	0.75	1.0	1.50	2.0
Meta-Systox-R 2 lb/gal. 25% of E.C.** weight	2.0	3.1	4.1	6.1	8.2
Dimethoate 2.67 lb/gal. 30.5% E.C. weight	1.5	2.3	3.1	4.6	6.2
Bidrin® 8 lb/gal. 80% E.C. weight	0.6	0.9	1.1	1.7	2.3

*These values are approximations for field use.

**Emulsifiable concentrate.

5. Dispose of pesticide containers by burying them in an area where they will not be disturbed.

6. If chemical is spilled on the skin, wash immediately and thoroughly with water. Get the man to a doctor as soon as possible. If, and only when symptoms of organic phosphate poisoning occur, administer atropine according to prescription.

When to Spray

Proper timing is important for the success of a control project. If a single application is to be used, it should be applied after the conelets have started to turn down but before they are fully down (Figure 2,D,E). If the application is too late, the midges will have done some damage; if it is too early, little control of chalcids or other late attacking insects can be expected.

How to Apply the Chemicals

The key to control is good coverage with the chemicals applied at the correct time. A hydraulic sprayer or mistblower can be used to apply the materials. If the trees are higher than 20 feet, a much more efficient job can be done from the platform of a truck-mounted ladder. The chemical should be sprayed until the foliage and cones are thoroughly wet. If the cones are only in the top half of the tree, only that portion need be sprayed. The best coverage is obtained when there is little wind.

Douglas-fir cone and seed insects can be controlled effectively if the application procedures are followed carefully. Because of the expense and risk involved, spraying should be done only when needed. This can and should be determined in every case by pre-spraying sampling.

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