CHRISTMAS TREE INSECT CONTROL

Extension Bulletin 353

Farm Science Series

March 1967

Cooperative Extension Service

Michigan State University

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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U. S. Department of Agriculture, N. P. Ralston, Director, Cooperative Extension Service, Michigan State University, E. Lansing, Mich.

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CHRISTMAS TREE INSECT CONTROL

By Ray L. Janes,[1] William E. Wallner[2] and James W. Butcher[3-4]

COMMERCIAL CHRISTMAS tree growing has become an important Michigan enterprise. Along with planting, shearing, and harvesting, *insects must be controlled to give a high percentage of marketable trees.* Unfortunately, insects hinder normal growth and damage tree quality. Because of these pests, some growers have lost as much as 80 percent of their potentially salable trees.

Numerous insects damage Christmas trees; all parts of the plant (roots, trunk, branches, twigs, and needles) can be affected at one time or another. When considering their control, remember that: (1) Insects usually damage trees in different ways; and (2) insects can be present at different times of the year. These two conditions complicate Christmas tree insect control.

This bulletin has four sections. The first outlines some ideas about a spray program. The second describes insects and mites and lists control methods. The third gives dosage rates and warnings about the insecticides and miticides you will be using. The fourth describes the equipment needed.

To identify insects properly, learn the important parts of their bodies. The labeled photographs on page 4 show a **sawfly larva** (caterpillar-like worm), **June beetle adult,** two types of scales and the two kinds of **mites** found on pines. Refer to these drawings when insects or mites are described.

NOTE: *When insects have wings, they are attached to the thorax.*

To properly identify a tree's damaged parts, learn the important names of its structure. The two photographs on page 5 show a **Norway spruce** and a cross section of a **white pine trunk.** The important parts of the spruce and the white pine cross-section are labeled. Refer to these drawings when damaged parts of a tree are described. **NOTE: The numbers in parentheses following each insecticide or miticide in Section II refer to the same numbers in Section III that describe the insecticides or miticides.** *In some cases, dosages are given in Section II without referring to Section III.*

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Plant Christmas Trees For Better Insect Control

Christmas tree insect control depends largely on how well you can apply treatments. Hard to control insects, such as European pine shoot moth, white pine weevil, scales, mites, and others, require thorough application of insecticides. With heavy ground equipment, leave roadways every 40 feet. These roadways will allow you to spray your trees effectively from two sides.

WARNINGS

All insecticides, fungicides and nematocides are poisonous in varying degrees. Some are very dangerous to use. Handle these materials cautiously so that they will not poison livestock, children, or the user. Read the label on the package carefully for instructions on how to use all insecticides, fungicides, and nematocides. State and federal literature also contains valuable information on the proper use of these chemicals.

NOTE: DO NOT ALLOW INSECTICIDES OR MITICIDES TO DRIFT ONTO PASTURES, HAY FIELDS, FOOD CROPS, LAKES, STREAMS, PONDS OR WOODED AREAS OTHER THAN YOUR OWN CHRISTMAS TREE PLANTATION. When used on animal or human food crops, certain restrictions are placed on the chemicals listed in this bulletin. When applied to water, many of the materials listed herein can kill fish.

To determine the dangers of drift, read the label on the package. Follow the same restrictions for insecticide and miticide drift as for direct application of the same materials to food crops. For dangers of fish poisoning from insecticides applied to water and for their effect generally upon wild life, get information from your county agricultural agent.

Insecticides vary in their poisonous effects on birds and other wildlife. Generally chemicals such as DDT, aldrin, dieldrin, and chlordane are more persistent than malathion, dimethoate, dibrom, and methoxychlor. If at anytime there is a question about the use of the more dangerous materials, MALATHION can be used advantageously on sawflies, jack-pine budworm, and other foliage feeders.

POISON CONTROL CENTERS:

Your doctor can get help for insecticide, fungicide, and nematocide poison cases. Have him telephone or write one of the poison control centers listed on page 28.

IDENTIFICATION KEY FOR THE INSECTS*

Place of injury	Description of damage, insect, or mite	Name of insect or mite
Damage to roots	Small roots eaten; bark of larger roots stripped; larger root tips missing. Large (up to 1½ inches long), white curved grubs with brown heads and thoracic legs.	White grubs (June beetles)
	Small rootlets eaten; bark often removed. Small, (up to 1/5 inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Strawberry root weevil
Damage to trunk	Bark damaged at ground level; blackened pitch present. Small, (up to ½ inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Pine root collar weevil
	Small, pinkish worms with black spots occur inside wilted terminals. Top of tree dies because of tunneling around terminal and lateral growth of first whorl or elsewhere on the main trunk. Growth may enlarge above girdled stem.	Zimmerman pine moth
Damage to bark of trunk, stems and twigs	Gum may ooze from damaged bark turning into a white scale-like material. A STICKY, HONEYDEW IS PRESENT. White speckled, brown, or yellowish-green sucking insects that feed in colonies or move about slowly.	Aphids
	Gum oozes from damaged bark turning into a white scale-like material. Injured needles are brown, notched on one side, and often bent over. Buff or dark-tan beetles, ½ inch long.	Anomala beetle (pine chafer)
	In the spring, gum oozes in droplets from leader bark. Injured needles and leader bark turn brown and die in July. Small holes occur in the bark.	White-pine weevil
Damage to twigs or branches	Ball of gray or brownish pitch located in branch crotches. A reddish worm with brown head occurs inside the ball.	Pitch-blister moth
	Small, green or brown-pineapple, or cone-like galls or swellings located at the base of new twig growth on Norway, white, black, and red spruce.	Eastern spruce gall aphid
	Green or brown (often slightly curved) galls located on new growth tips of oriental, Colorado blue, Sitka, and Engelmann spruce; similar to eastern spruce gall, but longer and less compact.	Cooley spruce gall aphid
	Irregular areas chewed in bark of twigs. Pitch globules harden and give twigs whitish cast.	Pales weevil
Damage to shoots	Shoot stunted, yellow or brown. In the spring and fall, the tunnel inside the damaged shoot or bud can contain a brown worm.	European pine shoot moth
	Terminal and lateral shoots wilt, break off at right angles, then turn brown during July and August. One or more larvae completely tunnel out center of shoot.	Pine shoot borer

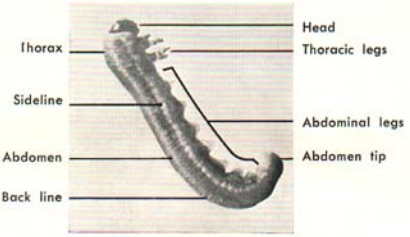
*Not all of the insects given in the bulletin are listed in this Identification Key. Consult the index for others.

IDENTIFICATION KEY FOR THE INSECTS

Place of injury	Description of damage, insect, or mite	Name of insect or mite
Damage to needles	Needles often entirely eaten. When mature (¾ inch long), these worms are dirty gray-green with black heads and striped bodies. They feed in large groups. Present from early May to early June.	European pine sawfly
	Needles often entirely eaten. When mature, (1 inch long) these worms are red-headed and yellow-bodied with six rows of black spots down the back. They feed in large groups. Present from early July to mid-August.	Red-headed pine sawfly
	Needles chewed off at base and webbed together when new growth is 1 to 1½ inches long. Reddish brown worms with yellowish sides and a shiny black or brown head are often found inside the web.	Jack-pine budworm
	Needles notched just above the sheath; the needles often turn brown and break over at the notch. Heavy beetle feeding completely destroys needles. Damage caused by buff or dark-tan beetles, ½ inch long.	Anomala beetle (pine chafer)
	Pine foliage yellows in September, turns brown in spring. Brown flecks present beneath bark of needle bearing parts of plant. Spittle masses on sweet fern, blackberry, and other plants, but not on pines; the adults feed on pines.	Saratoga spittlebug
	Needles brown; twigs die from tip to trunk. Spittle masses present on pine twigs and branches, mid-May to July.	Pine spittlebug
	Needles yellowish with a gray-speckled appearance. Black specks present especially on the underside of the needles.	Mites
	Elongated white or yellowish-white shield-like scales on the needles. Length of these scales is not more than 1/9 inch. Off-colored foliage; growth is stunted.	Pine needle scale
	Oval, chestnut-brown insects about ¼ inch long on branches nearest tips. Tree growth stunted; branches or trees killed; foliage covered with black sooty accumulations.	Pine tortoise scale
	Needles stunted and brown, dropping prematurely. Black or lemon yellow insects 1/16 inch long feed on buds and needles of new growth, causing brown patches.	Thrips
	Needles stunted, tips become distorted, and turn brown. Mites 1/125 inch long feed in the needle sheath and along inside blade of needle.	Eriophyid mites
	Other troubles	Name of trouble
	Needles yellowish with brown tips or grayish-green with yellow tips.	Drought and wind burn
	In early spring, young spruce shoots turn white or yellowish-white. The needles on these shoots are crisp and dry.	Frost damage

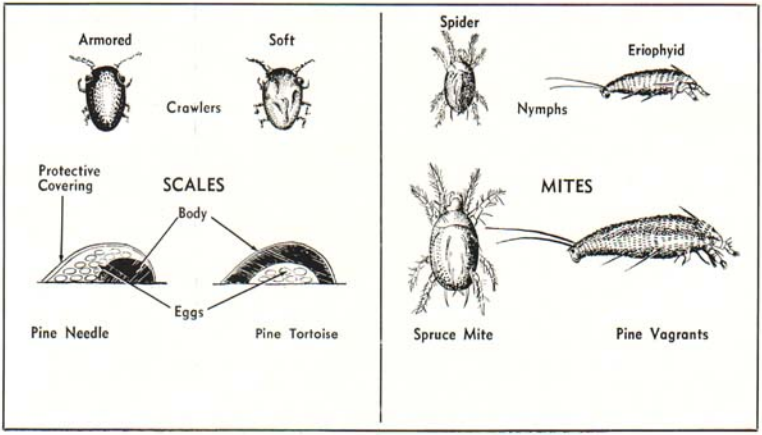
Insect Identification Parts

June beetle adult

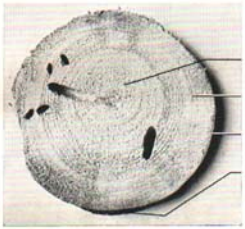


Sawfly worm. Note the eight pairs of legs on the abdomen. By contrast, moth caterpillars have only five pairs of abdominal legs.

Scales and Mites Affecting Christmas Trees



Structure of a tree



Cross-section of white pine trunk.

Seedlings

SECTION I

SPRAY PROGRAM

Work out a spray program for your Christmas tree planting. For example, if two or more insects occur on the trees at the same time, select an insecticide that will control all of them. If a single insecticide is not available *then combine* two materials that will do the job.*

A careful reading of the control sections for each insect will help you make proper selections.

A spray program started early and continued through the growing season, gives better results than sporadic treating on an emergency basis.

While it is not possible to suggest a single control for all pests, recent MSU research shows that white pine weevil, Zimmerman pine moth, root collar weevil and European pine shoot moth are all susceptible to a *mid-April spray.*

DDT or DDT-lindane mixture applied carefully as a drench to the leader, main stem and root collar area will control the first three pests.

If pine shoot moth is also a problem, thoroughly wet the bud area. *This mid-April spray may be all that is needed in any given year for the insects mentioned,* although there may be some advantage to fall spraying for *certain* insects.

For the other insects listed in the bulletin, follow the control directions given for them.

Concerning seasonal information about Christmas tree insect control, contact your county agricultural agent.

*When mixing two different insecticides in the spray tank, be sure they will combine safely. Help for the compatibility of insecticides is in American Fruit Grower's, Farm Chemicals, "Spray Compatibility Chart, 1967," or Michigan State University Extension Bulletins, E-212 (1967 Farm Science Series) or E-154 (1967 Farm Science Series).

SECTION II

ANOMALA BEETLE (Pine chafer)

Trees Damaged: The adult insect prefers jack and Scotch pines but also feeds on red and white pines.

How to Identify: The adult anomala beetle occurs in two colors. The female is tawny or buff; the male is dark-tan with a greenish-bronze head. The female is 9/16 inch long while the male is 5/16 inch. Note: this pest belongs to the same family as the white grubs.

Adult anomala beetles. The dark colored ones are males; the light ones are females. About 1/3 inch long.

Life History: Anomala beetle eggs are laid in grassy soil often near the trees upon which the adult feeds. The grub feeds on grass rootlets and other materials; it passes the winter in the soil. Grub feeding continues again in the spring. Pupation occurs in early June and the adult comes from the soil about June 15 to July 5, depending on the location.

Type of Injury: The adult is the only form that damages the foilage of evergreens. It notches the needle just above the sheath causing it to bend downward and turn brown. However, large numbers of beetles tend to devour both needles and sheaths. Also the bark is damaged causing pitch to form on its surface. This pitch eventually dries into a hard, gray-white, scaly material. Thus, areas of branches are stripped of needles and bark is damaged, reducing tree value.

Control: Apply treatments directly to adult beetles on the foliage. Spray or dust (spray is better) with DDT (4a, or 4c, or 4e, or 4f, or 4h), lead arsenate (7a), or carbaryl (Sevin), (12a, or 12b, or 12c).

APHIDS

Trees Damaged: Aphids damage all pine and spruce trees.

How to Identify: Winged and wingless aphids occur on needles, twigs, or branches. Their color varies from yellowish-green or brown to black. While most aphids affecting evergreens are quite small, the white pine aphid is nearly ¼ inch long. Aphids have two tubes (cornicles) projecting upwards and backwards from near the abdomen tip. Aphid honeydew is usually present on infested trees.

Life History: Pine and spruce aphids overwinter either as nymphs or black eggs on needles and twigs. The eggs hatch into nymphs that in time give birth to living young. Several generations occur each year. Most aphids present during the summer months are females. These also give birth to living young. It is only in the fall or during adverse summer weather that males appear and eggs are laid.

Typical winged adult aphid. Enlarged about 6 times. The two outside tubes projecting from the abdomen tip are typical of aphids.

Type of Injury: Aphids suck juices from branches, twigs, and needles of Christmas trees. This feeding causes galls, swelling of woody parts, leaf injury, or leaf curl. Gum often oozes from aphid feeding wounds. This gum hardens in time, in many cases reducing the trees' sale value.

Note: Sooty mold fungus often grows on the honeydew of aphids and the secretion of scale insects. Best control of it is the prevention or elimination of aphids and scale insects.

On valuable trees, sooty mold can be removed as follows: Use 4 ounces of detergent to 100 gallons of water.

Aphid feeding damage. Aphid injury is the gray damage to the new growth needles.

Best results follow where the spray is applied with pressure. Rinse trees with water to remove the material within 24 hours after application. Dilute any accumulation of the detergent on grass to prevent burning.

Control for the aphids: Spray or dust (spray is preferred) as soon as aphids are seen, usually in late April or May. Use malathion (9a, or 9b, or 9c), or lindane (8a, or 8b, or 8c), or benzene hexachloride (2a, 2 pounds or 2b), or nicotine sulfate (1 pint 40 percent liquid plus 5 pounds of soap) or nicotine sulfate and oil (1 pint 40 percent liquid plus ½ gallon 60 to 70 second oil). Repeat treatment at 7-to-10-day intervals, or as needed. **Note:** For mist-blower application, use 6 pints of 50 percent malathion emulsion or 3 pints of 20 percent lindane emulsion to 100 gallons of water. Apply 35 to 50 gallons of this spray to an acre.

BARK BEETLES

Trees Damaged: Many kinds of bark beetles attack pines and spruce grown for Christmas trees.

How to Identify: The area just beneath the bark is grooved (engraved) by numerous designs. From a larger

Bark beetles or engraver-beetles form egg and brood galleries (tunnels) in the inner bark or sapwood, or in both. Each kind of beetle makes its own design.

central groove (tunnel) smaller tunnels run at right angles through the inner bark. Both adult beetles and grubs (worms) can be present at the same time in the tunnels or in the outer bark. Full grown grubs are ¼ to ¾ inch long, curve-bodied, legless, and whitish with a reddish-brown or black head. The adults are about 1/16 to ¾ inch long, and range in color from brown to reddish-brown to black. Small round holes are usually present in the outer bark of infested trees.

Life History: Life activities vary a great deal among the many kinds of bark beetles that damage pines and spruce. Generally, however, these insects overwinter as grubs in the inner bark. During June and July they come out of the bark as adults. At egg-laying time, the females tunnel egg galleries along the inner bark next to the sapwood part of the tree. Their eggs are laid in the sides of these galleries. The eggs hatch into grubs that make tunnels through the inner bark. One or more broods occur each year, depending on the kind of bark beetle.

Type of Injury: Bark beetles injure and sometimes destroy the food-and-water-carrying areas of the tree, often killing it in a year or two. Their feeding may also loosen the bark.

Control: If possible, maintain tree vigor by fertilizing and watering. Bark all cut logs or felled trees within the vicinity of Christmas tree plantings. Keep slash (cut limbs, tops, etc.) in the open and turn it often to kill the beetles with the sun's heat. Spray trunks and branches of growing trees June 1 and again August 1 with DDT (4c or 4a), or lindane (8b or 8a).

COOLEY SPRUCE GALL APHID

Trees Damaged: This aphid produces galls on Colorado blue, Sitka, and Englemann spruce. It also feeds on Douglas fir, but does not form galls on this tree.

How to Identify: Elongated pineapple- or cone-like curved galls or swellings, 1 to 2 inches long, are located **at the tip** of new twigs. When the galls open in July, you can see the aphids inside of them.

Cooley spruce gall aphid; the gall shown is about 1/3 actual size.

Life History: The life history of Cooley spruce gall aphid is extremely complicated. However, the following information will give you a good idea of how this insect lives: It overwinters as a nymph at the base of spruce or Douglas fir buds. In the spring, the overwintering nymph matures and lays eggs. The eggs hatch and the young feed on the base of new spruce needles, causing them to swell and form galls. In July or August the galls open, and **some** of the escaping aphids fly to Douglas fir where they lay eggs on needles. The eggs hatch and the nymphs overwinter on this tree. The next summer these aphids either continue to live on Douglas fir or fly back to spruce. Cooley spruce gall aphid can also live continuously on spruce.

Type of Injury: Cooley spruce gall aphid feeds on spruce by sucking juices from the needles. This feeding causes the spruce tree to form galls. Some of the aphid-injured twigs become weakened, deformed, or die.

Control: Spray or dust (spray is preferred) spruce trees in late April or early May with BHC (2b, 2a, or 2c), or lindane (8a, or 8b, or 8c). When aphids occur on Douglas fir, treat with the same materials as given for spruce. If practical, remove and destroy the galls on spruce before they open in July.

Note: Do not plant Colorado blue, Sitka, or Engelmann spruce in the same planting with Douglas fir. This will help control Cooley spruce gall aphid on spruce.

EASTERN SPRUCE GALL APHID

Trees Damaged: The eastern spruce gall aphid produces galls on Norway, white, black, and red spruce.

How to Identify: Located **at the base** of new twigs are small pineapple-or cone-like galls or swellings up to ¾ inch long. When the galls open in July, you can see the aphids inside of them.

Life History: This aphid overwinters as a tiny bluish-gray nymph, mainly at the base of spruce buds. In the spring, the overwintering nymph matures and lays eggs. The eggs hatch

Eastern spruce gall aphid.

and the young feed on the base of new needles, forming galls. In late July or August, the galls turn brown and open, allowing the enclosed aphids to escape. These soon develop wings and lay eggs from which the overwintering nymphs hatch. **Note:** Eastern gall aphid does not normally live on Douglas fir.

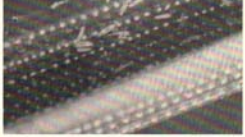
Type of Injury: The eastern spruce gall aphid sucks juices from spruce needles and other tender plant parts. Some of the injured twigs die, or may become weakened or deformed.

Control: Spray or dust (spray is preferred) in early April before the buds begin to swell or in early fall when the aphids are on the foliage. Use BHC (2b, 2a, or 2c), or lindane (8a, or 8b, or 8c). If practical, remove and destroy the galls before they open in July.

ERIOPHYID MITES

Trees Damaged: Scotch, red Austrian, white and mugho pines.

How to Identify: Extremely small (1/125 inch long) wormlike, creamy-white creatures occur inside the needle sheath or along the inside blade of the needles. The tips of the needles are twisted or hooked, brown in color and if the injury has progressed far enough, dead. Stunting and deforming of new growth is a characteristic symptom.



Eriophyid mites on the inside blade of a pine needle (highly magnified).

Life History: It appears that adult hibernating forms overwinter and become active with the first warm weather of April. Eggs are laid in or on the needle sheath. Several overlapping generations occur by late fall.

Type of Injury: Eriophyid mites pierce the needles, liberating juices which they take up through their sucking-type mouth parts. Injury to Christmas trees is twofold: 1) Loss of plant juices and 2) Preventing movement of fluids in the needle due to the lacerations and punctures by the mites. This type of feeding and the damage it produces, turns the needle tips yellow or brown and premature drop of these plant parts occurs.

Control: Two sprays of malathion (9a or 9b), one during early May and another in 10 days, will reduce populations. Spray branches and needles thoroughly.

EUROPEAN PINE SAWFLY

Trees Damaged: The European pine sawfly feeds on jack, red, and Scotch pine plantings 2 to 15 feet tall.

How to Identify: When mature, the European pine sawfly larva (worm) is ¾ inch long; its head is black and the body dirty gray-green with a lighter green line down the back. On each side of the lighter green line, two whitish lines border a stripe of dark green which sometimes is nearly black. The European pine sawfly feeds in large groups on mature foliage. When disturbed, it immediately raises its head.

Life History: During September and October, eggs are laid in a series of slits cut in the needle's edge of the current season's growth. They overwinter in the needles and hatch in early May. While feeding, the worms move from needle to needle. There is only one brood a year.

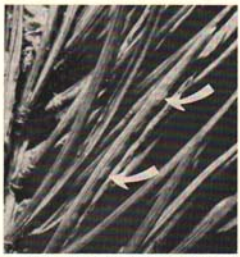
Type of Injury: The European pine sawfly feeds only on mature foliage. When numerous, it strips the old needles from the trees; thus, single branches or a whole tree can be killed.

Note: Since the damage is almost entirely to mature foliage, there is a greater chance for the tree to recover than if the injury were to new needles. However, because any amount of foliage damage will reduce tree vigor, control of European pine sawfly should be done before extensive injury occurs.

European pine sawfly. Note the 7 or 8 pairs of legs on the worm's abdomen; moth caterpillars have no more than 5 pairs of these abdominal legs.

Control: Apply treatments as soon as the sawfly is seen, usually early May to early June. Delayed treatment can result in severely damaged trees. Spray or dust with DDT (4a, or 4c, or 4e, or 4f, or 4h) or with lead arsenate (7a), or carbaryl (Sevin), (12a, or 12b, or 12c). Aircraft or mist blower application of insecticides can be effectively employed to control this insect. Note: (See Section IV for information about the use of aircraft and mist blowers for insect control.)

A virus extract (taken from diseased European pine sawfly larvae) gives excellent control of this insect, *but is not effective for others.* Consult the Entomology Department, Michigan State University or the Michigan Conserva-



Eggs of European pine sawfly laid in slits cut along edge of needle.

tion Department for information on availability. **Note:** Aphids and other insects may affect the trees at the same time the European pine sawfly does. Therefore, it is usually best to select a chemical that will control all pests.

EUROPEAN PINE SHOOT MOTH

Trees Damaged: This insect damages two-and three-needled pines. It prefers red, but also attacks Scotch and mugho pines extensively.

How to Identify: The adult has whitish legs, a rusty orange-red body, and a wing expanse of about ¾ inch. When present in plantings, it can be seen flying around the trees in late June and early July.

When first laid, the eggs are small, flat, and yellowish; later they turn reddish brown. The full grown caterpillar is about ¾ inch long and brownish with black head and thorax, and is found in damaged shoots in the spring.

European pine shoot moth caterpillar (about twice normal size) and its damage to a pine shoot. Note the hardened pitch as shown by the light laid-open area around the caterpillar.

Life History: Eggs are laid on the surface of needles and shoots. The young caterpillar (hatching from an egg in about 10 days) bores first into a needle base. Later in the summer, it leaves the needle and bores into a bud. This boring causes a flow of pitch which hardens over the bud, covering up the caterpillar's burrow.

European pine shoot moth pupal case attached to a damaged shoot. Eggs are laid about 10 days after these cases appear.

Winter is passed as a caterpillar in the bud or under the hardened pitch. In the spring, the half-grown caterpillar leaves its overwintering place, and bores into an uninjured shoot. In late May or early June, the caterpillar becomes full grown and pupates inside the damaged shoot. The adult moth comes from the shoot, usually during the last half of June.

Type of Injury: The European pine shoot moth adult does not injure pines. The caterpillar, however, damages needles, buds, and shoots. This often deforms the tree by stunting the twigs and branches. Spring-tunneled shoots turn yellow and then die. The tunnel inside the shoot tells the presence of this insect.

Control: Apply DDT (4d or 4b—4d is best) *when the caterpillars begin to move from overwintering places to new shoots,* usually April 15 to 30. NOTE: Methoxychlor may be substituted for DDT, using the same formulations and dosages. Dimethoate (1 pt. of a 4-lb. per gal. emulsion to 100 gals. of water) may also be used instead of DDT.

Good summer control is possible with only one spray. Apply it as soon as all adults have emerged from their pupal cases or when 50% of the eggs have hatched. Either of these two conditions occur in most years about July 4 in the lower peninsula. Preferred for this summer spray is carbaryl (Sevin), (12b), or dimethoate (1 pt. of 4 lb. per gal. emulsion)—to 100 gallons of water. DDT (4d or 4b) and methoxychlor (1 gal. of a 2 lb. per gal. emulsion to 100 gals. of water) may be used but they are not so effective as during spring temperatures.

See your county agricultural agent for the best time to treat for this insect.

Air-blast sprayers (mist-blowers) will give reasonable control of European pine shoot moth. Use suggested insecticides at 4 times the dilute strength. Deliver at least 35 to 50 gallons of liquid per acre. **Note:** (See Section IV for information on the use of concentrate sprays in mist-blowers.) This strength mist-blower spray should be sufficient for small trees (2nd- and 3rd-year growth). For older trees (4 feet or taller) you may need to use an 8X concentrate spray. For control of heavy infestations especially in older trees, get special control information.

Read Section IV for information about the use of airplanes and helicopters against European pine shoot moth. If an airplane is used, apply DDT (4h). **Note: DDT is the only insecticide we are suggesting for use in airplanes for controlling European pine shoot moth.**

Pruning will aid European shoot moth control. See Michigan State University (Department of Forestry) literature for instructions on how to shear Christmas trees. Burn infested shoots pruned up to July 1, or the moths may emerge to lay eggs for another generation. If shearing is delayed until after all eggs are laid on the shoots (usually about July 10-15) many of them will be destroyed.

European pine shoot moth damage to pine shoots. Note the stubby growth.

GRASSHOPPERS

Trees Damaged: Grasshoppers attack all pines and spruce.

How to Identify: These insects feed on many field and vegetable crops and are well known to everyone; therefore, further description seems unnecessary.

Grasshoppers destroy or damage Christmas trees by devouring the needles. Note: The grasshoppers that usually damage Michigan pines and spruce are about 1 inch long when mature.

Life History: Destructive Michigan grasshoppers lay their eggs in the soil; winter is passed in this stage. Grasshopper eggs, depending on the species, hatch during May, June, or July. Some species, such as the lesser migratory grasshopper, can have two broods a year; most species, however, have only one brood. Grasshoppers are more apt to damage Christmas trees in drought years.

Type of Injury: Grasshoppers are mainly foliage feeders. On pines and spruce, they eat the needles and occasionally scar the bark. Most pine trees cannot replace lost needles. Damaged bark oozes pitch which hardens into an undesirable scale-like material.

Control: Use aldrin (1a, or 1b, or 1c), or chlordane (3a, or 3b, or 3c), or dieldrin (5a, or 5b, or 5c), or heptachlor (6a, or 6b, or 6c). For good grasshopper control, spray both ground vegetation and trees.

Note: Grasshoppers often come from areas outside the plantings. When safe, treat these places before the insects move into the trees.

JACK PINE BUDWORM

Trees Damaged: This insect prefers jack pine, but will, under some conditions, damage Scotch, red, and white pine, and white and Norway spruce.

How to Identify: New needles, 1 to 1½ inches long, are chewed off at the base and webbed together. This damage is done by a dark brown or reddish brown worm with a white collar behind the head. When mature, the worm is 1 inch long and has yellowish sides with a shiny black or brown head.

Life History: The jack pine budworm passes the winter on the tree as a small caterpillar (worm) inside a silken gray cover. In the spring, the worm bores into old needles and feeds on pollen. As it grows, it feeds on both new and old needles. The mature caterpillar pupates on the foliage in early July. The adult lays eggs in late July; there is only one brood a year.

Spruce budworm: The jack and spruce budworms, are similar in appearance, and do about the same kind of damage. When mature, the spruce budworm and jack-pine budworm are about 1 inch long. Note the pupa between the two caterpillars.

Type of Injury: Trees can be stripped of needles resulting in permanent loss of foliage; also the webbed needles look unsightly and the weakened tree is subject to attack by other insects.

Control: Apply treatment in late June when the worms are about ½ inch long. Depending on your equipment, use DDT (4a, or 4c, or 4f, or 4h), or lead arsenate (7a), or malathion (9a, or 9b, or 9c).

Jack-pine budworm damage to jack pine. It feeds also on Scotch, red, and white pine, and white and Norway spruce.

MITES

Trees Damaged: Mites affect all pines and spruce. They are more apt to damage trees grown on droughty (sandy) soils. **Note:** Prolonged drought favors mite damage on all Christmas tree growing sites. Use of DDT on the trees, also increases the possibility of mite injury.

How to Identify: The needles of mite damaged plants are yellowish or bronze in color. Close examination of the needles shows whitish or brownish

Adults and eggs of spruce mite. Note: Adults are about 1/50 inch long. When mature, mites have 8 legs; insects have 6 legs.

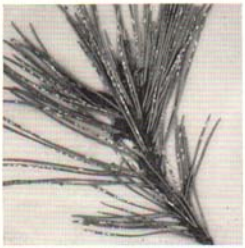
spots on their surface. Also present will be small, dark specks of mite frass often netted with silk thread. Mites, when jarred from twigs or branches onto white paper, can be seen moving about.

Life History: The different kinds of mites overwinter either as eggs or adults. The eggs are laid usually on the needles. Several broods occur, each taking about 30 days to mature. Very young mites can have six legs as do insects; larger immature and adult mites have eight legs (four pairs).

When first laid, mite eggs are shiny and white; afterwards, they often turn reddish. A hand lens or microscope is usually needed to see mite eggs and most nymphs and adults. Adult mites range in color from yellow, grayish-yellow, grayish-green, to yellowish-red or red. In some cases mite color depends on the kind of food eaten.

Type of Injury: Mites damage pine and spruce trees by piercing the needles and sucking the plant juices. Mites compete with trees for plant foods during periods of hot-dry weather. This condition robs the plant of vigor at a time when it needs all its strength to withstand drought and high summer temperatures.

Control: Spray when first signs of mite damage appear on the plant, usually during July and August. Use one or a combination of chemicals listed under Miticides (10). Spray needles and branches thoroughly.



Pine needle scale. This scale occurs in two colors: white or yellowish-white. They are slender and not more than 1/9 inch long.

PINE NEEDLE SCALE

Trees Damaged: This insect infests white, red, Austrian, Scotch, and mugho pines; spruce is also affected.

How to Identify: When numerous, this insect whitens the needles. The female scale is elongated, yellowish-white, and about 1/9 inch long; the male is slender, white, and about 1/12 inch long.

Life History: Winter is passed as purplish eggs underneath the female scale. One or two broods can occur depending on the locality. The eggs hatch into crawlers; these usually appear in May and again in July.

Type of Injury: This scale sucks needle juices. Infested needles appear yellowish and whitened; eventually they become weakened and often drop from the tree.

Control: Apply a dormant spray (11b or 11c) in early spring before buds break. Or spray or dust (spray is preferred) when the crawlers are present in late May (usually when lilacs are in full bloom) and again in July. Use DDT (4c, or 4a, or 4e, or 4f), or malathion (9a, or 9b, or 9c), or carbaryl (Sevin) (12a, or 12c, or 12d). At least two treatments 10 days apart are needed for each brood.

PINE ROOT COLLAR WEEVIL

Trees Damaged: This insect prefers Scotch, red, and jack pine, but may also attack Austrian and white pine.

How to Identify: The grub is curve-bodied, footless, and white with a brown head. It is larger (1/3 inch long) than the strawberry root weevil grub (1/5 inch long). Blackened pitch oozes from an infested tree where the roots and trunk join at the soil's surface.

Life History: The pine root collar weevil passes the winter as an adult in bark crevices and in ground litter. The winter is also passed as grubs under the bark, or pupae in earthen cells in soil next to the tree trunk. Eggs are

Pine root collar weevil. Damage is to bark and wood near the soil surface. Blackened pitch oozes from the wound.

laid at the base of the tree in pockets chewed by the female, or in the soil up to 2 inches from the tree. The adult beetle can live 3 or 4 years; the grub lives 1 year. Newly matured adults appear every year; there is one brood a season.

Type of Injury: The pine root collar weevil feeds on the bark, inner bark, and sapwood. This feeding girdles the bark and prevents the tree from getting proper nourishment.

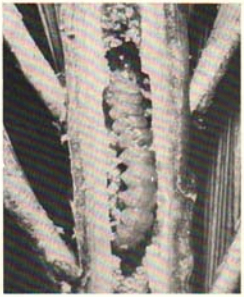
Control: Avoid planting Scotch pine in pine root collar weevil infested areas. For treating infested trees, use lindane (8a or 8b), BHC (3 lbs. of 12% wettable powder or 3 pts. of an emulsion containing 2 lbs. of chemical per gal.—to 100 gallons of water), or chlordane (3a or 3b). When convenient during the summer or when controls for other insects are being applied, spray or pour this treatment next to the trunk at ground level. Apply enough spray to thoroughly wet the tree's root collar, and to soak the soil. **Note:** The rotation of seedbeds in nurseries and clean cultivation of fallow land intended for tree planting for at least 1 year, usually controls this insect.

PINE SHOOT BORER

Trees Damaged: This insect favors Scotch, jack, white pines, but may also injure Austrian, red, and pitch pines as well as white spruce and Douglas fir.

How to Identify: Larvae tunnel out the pith of the new growth of ter-

minals and laterals from a few inches above old growth to the tip. This causes shoots to break off at right angles and die. As many as three larvae may infest a shoot. Injury is most apparent in late July.



Full-grown pine shoot borer larva within Scotch pine shoot.

Exit hole of pine shoot borer made by larva in vacating mined-out shoot. Larva drops to ground beneath the tree, pupates, and overwinters.

Life History: Winter is passed by pupae in the soil and litter beneath the trees. During early May the small, coppery moths with a wing expanse of ⅝ inch emerge and lay eggs on the new growth. Within two weeks the young larvae hatch from the eggs and bore into the center of the shoot. During June and July the dirty white larvae with brownish-yellow heads feed by boring out the center of the shoots. Larvae mature during July and early August, reaching a length of about ¾ inch and chew a hole out through the shoot and drop to the ground and pupate. There appears to be only one brood each year.

Type of Injury: Adult moths do not cause any feeding injury. Larval tunnelling in laterals ruins the shape of the tree; injury to terminal leaders results in the loss of a year's growth to the tops of the trees. Plants are not killed by this insect but their shape is ruined.

Scotch pine showing injury by pine shoot borer. Note how new shoots bend and break at right angles but remain attached to tree.

Control: Spray in early May when the adults are first noted. Use DDT (4b or 4d) making sure to cover completely all foliage. A second spray may be necessary should cool weather cause moths to emerge over an extended period of time.

PINE TORTOISE SCALE

Trees Damaged: This scale attacks Scotch, Austrian, red and jack pines.

Pine tortoise scale and associated black sooty plant discoloration.

How to Identify: Immobile, oval chestnut brown insects, about ⅛ inch long, suck plant juices from branches near tips. Large amounts of honeydew, a clear sugary substance excreted by the scales, adhere to the plant. This honeydew serves as a medium for, and is turned black by, a sooty mold fungus.

Life History: The pine tortoise scale has one brood each year. Winter is passed by immature females in protected places on the rough bark of the twigs. Beginning the third week in June each female lays 1,000 or more eggs beneath its body. These hatch in a few hours and the reddish crawlers exit from beneath the mother scale and migrate to the terminal branches. In late August females mature, mate with the winged short-lived males, and continue to feed until cold weather occurs.

Type of Injury: The pine tortoise scale damages pines by retarding vigor and killing branches or entire trees. The black sooty accumulations further disfigure trees.

Control: Apply a dormant spray of (11a, or 11b, or 11c), anytime after plant growth ceases in fall and before it begins in spring or apply Sevin (12a, or 12c, or 12d), DDT (4a, or 4b, or 4c), or malathion (9a, or 9b), when the crawlers are active, usually between June 20 and July 1.

PINE TUBE MOTH

Trees Damaged: As far as is known, this insect feeds only on white pine.

How to Identify: An elongated, hollow tube made of white pine needles is typical of this insect's damage. The tube is formed by binding a number of needles together with silken threads.

Pine tube moth. This insect forms the tube by binding several needles together.

Life History: The pine tube moth has two broods each year. For the first brood, eggs are laid on the needles in May. The mature worm is ¾ inch long and yellowish-green with a greenish-brown head that has a brown patch on each side. Winter is passed inside the tube as a greenish-yellow pupa.

Type of Injury: The pine tube moth damages white pine in two ways: First, the silk bound needles are unsightly; second, needle tips are eaten. This insect often leaves old tubes and builds new ones.

Control: Spray in June when the first tubes are formed. Use DDT (4a or 4c), lead arsenate (7a), or carbaryl (sevin) (12a, or 12c, or 12d).

PINE SPITTLEBUG

Trees Damaged: Both adult and nymph (immature form) feed on branch and twig bark of all pines and Norway, white, and black spruce. Scotch, jack, and eastern white pine are, however, preferred by this insect.

How to Identify: Spittle masses occur among the needles of twigs and branches. Feeding damage by this insect causes brown foliage and a drought-like appearance. Unless spittle masses are present, the true nature of adult pine spittlebug damage is hard to tell.

The adult pine spittlebug is boat-shaped, ⅜ inch long, and light brown with both light and dark spots scattered over the wings, thorax, and head.

Life History: The pine spittlebug passes the winter as an egg in plant tissue at the base of terminal buds. In May, the egg hatches into the nymph that produces the spittle mass. The nymph, protected inside the spittle mass, sucks the tree's juices. The adult feeds and lays its eggs during July and August.

Control: About June 15, apply treatment (spray is preferred) for the spittle masses on the trees. Use BHC (2b, or 2a, or 2c), lindane (8a, or 8b, or 8c) or DDT (4a, or 4c, or 4e, or 4f). For control of the adults feeding on Christmas trees in July and August, use DDT(4c or 4a).

Note: Control of the nymphs in the spittle mass is preferred to treatment for the adult spittlebugs.

Pine spittlebug. Note the masses of spittle (foam) hanging to branches and needles.

PITCH-BLISTER MOTH

Trees Damaged: The pitch-blister moth attacks jack, lodgepole, and ponderosa pines.

Pitch-blister moth. This insect forms a brownish or grayish hollow pitch ball at branch forks.

How to Identify: This insect forms a hollow ball of gray or brownish pitch at branch forks. The ball is about the size of a marble. A reddish worm with a brown head may be seen inside the pitch ball until about May 15. The wood underneath the bark is exposed by the worm's feeding.

Life History: The pitch-blister moth passes the winter as a worm inside the pitch ball. The worm changes to an adult moth about June 1. This insect lives about 2 years as a caterpillar.

Type of Injury: Damage by this insect is mainly to the food carrying tissues of the tree. The worm often girdles the twig killing it above the wound; needle flagging can also result from such feeding. Twigs can be deformed if they are not killed outright.

Control: A good chemical control has not been worked out for this insect. Pruning is suggested when practicable.

RED-HEADED PINE SAWFLY

Trees Damaged: The red-headed pine sawfly feeds on jack, red, Austrian, mugho, and Scotch pine plantings, 1 to 15 feet tall.

How to Identify: The very young worm is whitish and unspotted with a brown head; the mature worm is 1 inch long; has orange-red head, and 6 rows of black dots running lengthwise of the yellow body. The red-headed pine sawfly feeds in large groups first on the old and then on the new growth. When disturbed, it immediately raises its head. Yellowish-green frass piles are very evident under infested trees.

Life History: This insect has one or two broods a year. Winter is passed in the ground as a **mature** worm in a brown paper-like cocoon. First brood adults come from the ground some time during the first 2 weeks of June. Eggs are laid in cuts in the needles; first brood worms begin feeding in early July.

Type of Injury: The red-headed pine sawfly is a foliage feeder. When numerous it strips the needles, often killing single branches or whole trees.

Control: Spray or dust as soon as sawfly worms are seen. Delayed treatment can result in severely damaged trees. Apply DDT (4a, or 4c, or 4e, or 4f, or 4h), or lead arsenate (7a), or carbaryl (Sevin), (12a, or 12c, or 12d).

SARATOGA SPITTLEBUG

Trees Damaged: The adult spittlebug damages jack, red, and Scotch pines in natural and cultivated stands 2 to 15 feet tall. The spittle mass containing immature spittlebugs (nymphs) occurs on sweet fern, blackberry, and other plants, but not on pines.

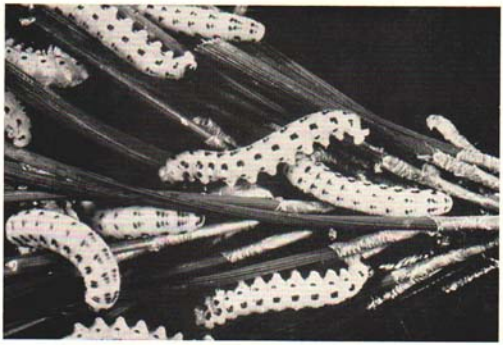
How to Identify: The spittle mass occurs on fern and other plants June 15 to July 15. The adult spittlebug feeds on pine trees from July 15 to October. When mature, the nymph inside the spittle mass is light mahogany in color and about ⅛ inch long. The pine-feeding adult is ¾ inch long, tan to light brown, with a light stripe running down the back and wavy lines on the wings.

Life History: The insect passes the winter as a purplish, yellow or usually black egg between pine bud-scales. The egg hatches into a nymph as soon as tree growth begins in the spring. It drops to the ground and forms spittle masses on sweet fern and other plants near the ground level. The nymph matures by July 15 and the adult flies to pine.

Strawberry root weevil grubs. They are about 1/5 inch long. They do not have thoracic or abdominal legs as do moth caterpillars and sawfly worms.

Type of Injury: The Saratoga spittlebug adult feeds by sucking juices usually from pine tops. This feeding causes the foliage to turn yellow in September and brown in the spring. This condition is known as "flagging." When a spittlebug injured twig is shaved with a knife, brown feeding punctures are present in the sapwood.

Control: Apply treatment during July when most of the spittlebugs have left the spittle masses (usually the second or third week of July). Use DDT (4a, or 4c, or 4f, or 4h) to spray the trees. Treating the spittle masses on sweet fern, etc., has only limited value.



Red-headed pine sawfly. Note the 7 or 8 pairs of legs on the worm's abdomen; moth caterpillars have no more than 5 pairs of abdominal legs.

STRAWBERRY ROOT WEEVIL

Trees Damaged: This insect feeds on the roots of all pines and spruce.

How to Identify: Strawberry root weevil-damaged trees lack fibrous roots, and the root bark is often stripped. A small, legless, curve-bodied, cream-white grub with a brown head may be found around the roots until about July 1. The mature grub measures 1/5 inch.

Life History: The strawberry root weevil lays eggs in the soil during July and August. Winter is passed

Strawberry root weevil grub damage to pine seedling roots.

mainly as a small grub. Grub feeding occurs during late summer and fall, and again in the spring. There is only one generation a year.

Type of Injury: This insect destroys the tree's fibrous roots; these roots take up soil water. Hence, strawberry root weevil-damaged trees look droughty and stunted.

Control: If strawberry root weevil damage is widespread in nurseries or plantings, treat as follows:

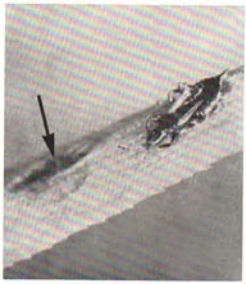
1. When the adult beetles feed on the trees in late June or early July, spray with chlordane (3a or 3b), or DDT (4a, or 4c, or 4f, or 4h).

2. Before planting trees, treat the soil with chlordane (3d, or 3e, or 3f), or aldrin (1d, or 1e, or 1f), or dieldrin (5d, or 5e, or 5f, or 5g), or heptachlor (6d, or 6e, or 6f). Apply **only** one of these materials to the soil's surface and **immediately** disc 4 inches deep. **Note:** Soil treatment for strawberry root weevil can be applied **in a band** along the row. Use one-third of the amount of chemical given for the complete soil treatment and apply in a band 2 feet wide where trees are planted in 6-foot rows. Also some protection is afforded by dipping the roots of seedlings in ⅜ of 1% aldrin emulsion prior to planting. Handle treated seedlings with rubber gloves.

Strawberry root weevil adults. They are about ¼ inch long. Note the rows of small pits on the wing covers.

THRIPS

Trees Damaged: To date, only Scotch pine has been found infested. However, they may occur on other pines.



Adult thrip on Scotch pine needle. Note the area damaged by thrip feeding (arrow).

How to Identify: The adult is black, about 1/16 inch long, winged and shaped like an alligator. Immature thrips are slightly smaller, lack wings, and are orange-yellow in color. Both adults and nymphs are found on buds or needles of new growth.

Life History: Thrips activity begins during June but reaches highest populations during July and August. Many overlapping generations occur by fall. Hot, dry weather contributes to rapid thrips buildup. They overwinter usually as adults.

Type of Injury: Thrips have rasping-sucking mouthparts. They rasp the bud or needle tissues, liberating plant juices which they suck up. This feeding produces brown patches ⅛ to ¼ inch long on the new growth. Heavily infested trees have distorted, stunted foliage and eventually die.

Control: Spray when thrips are first noted, usually during June. Use malathion (9a or 9b), or diazinon (2 lbs. of 25 percent wettable powder or 1 quart 25 percent emulsion) to 100 gallons of water. Apply thoroughly to all needles and branches.

WHITE GRUBS OR JUNE BEETLES

Trees Damaged: All pines and spruce are affected by these insects.

How to Identify: The small tree roots are missing; the bark of larger roots is eaten, or the tips are missing. White, curve-bodied grubs with brown heads may be found around the tree roots. These grubs vary in length from about ⅛ to 1⅛ inches.

Life History: June beetles overwinter in the soil either as grubs or adults. In May or June, the adults come out of the soil, feed on the leaves of broad-leaf trees (especially oak), and lay their eggs in grass sod. Each egg hatches in 2 or 3 weeks; the

The white grubs of the May or June beetles. When mature, these grubs can be 1½ inches long.

grub (depending on its kind) lives from 1 to 5 years in the soil before it comes out as an adult.

Type of Injury: White grub root injury prevents the tree from getting water and nutrients. Damaged trees look droughty and stunted.

Control: If white grub damage is widespread in nurseries or plantings, treat as follows:

1. When the adult beetles are feeding on the trees in June or early July, spray with chlordane (3a or 3b) or DDT (4a, or 4c, or 4f).

2. Before planting trees, treat the soil with chlordane (3d, or 3e, or 3f), or aldrin (1d, or 1e, or 1f), or dieldrin (5d, or 5e, or 5f, or 5g), or heptachlor (6d, or 6e, or 6f). (For light sandy soil, 5 actual pounds per acre of chlordane, or 3 of either aldrin, dieldrin, or heptachlor are enough for white grub control.) Apply only one of these materials to the soil's surface and **IMMEDIATELY** disc 4 inches deep. **Note:** Soil treatment for white grubs can be applied **IN A BAND** along the rows. Use one-third of the amount of chemical given for the complete soil treatment and apply in a band 2 feet wide where trees are planted in 6-foot rows. This treatment can be applied either before or at the time of planting.

3. Some protection is afforded the roots of seedlings by dipping prior to planting as for strawberry root weevil.

White-pine weevil damage. Note hole at point of knife blade.

WHITE-PINE WEEVIL

Trees Damaged: This insect prefers white pine, but also damages jack, red, and Scotch pines, and Norway spruce.

How to Identify: The adult is about ¼ inch long; it is brownish with white spots scattered over the body. The adult mouth parts are formed into a curved snout about 1/16 inch long. The grub is curved, white, footless, and when mature, slightly longer than the adult. Both the adult and its grub may be found under the bark of damaged leaders where they feed on the inner bark. As the adults escape from the leader, they may also be found in the bark.

Life History: Pearly-white eggs are laid in small punctures made by the female in leader bark. The young grub (hatching from the egg) feeds on the inner bark. By August, the grub is fully grown. It then pupates and the adult leaves the tree about 2 weeks later through a small opening in the bark.

The white-pine weevil overwinters as an adult in ground litter. It becomes active when air temperatures reach about 50°F. for several days, usually sometime during the last 2 weeks of April in Michigan.

Type of Injury: Both the white-pine weevil adult and grub cause damage.

White-pine weevil grub damage to bark of leader.

Tiny glistening drops of resin occur on the bark of the leader, indicating adult feeding or egg laying. By feeding on the inner bark, the grub girdles the leader; this causes it to curl and die.

Control: Spray the leaders when adults become active during the last 2 weeks of April or just before the buds swell. Use DDT (4d, or 4b, or 4g, or 4h) or lead arsenate (7a or 7b). This treatment for white-pine weevil comes about the same time as does the one for European pine shoot moth control.

When white-pine weevil is numerous, it may be necessary to treat individual leaders. Spray the entire leader in mid-April to the point of run-off. In 100 gallons of water, use 8 gallons

White pine leader killed by white-pine weevil grubs.

of 25 percent DDT emulsion, or 8 gallons of 23 percent heptachlor emulsion. When an extender such as Aroclor 5460 is used in a spray, use 4 gallons of 23 percent heptachlor plus 1½ gallons of 75 percent Aroclor, or 2½ gallons of 20 percent lindane emulsion plus 3 quarts of 75 percent Aroclor stock solution in 100 gallons of spray. A 75 percent Aroclor solution is made by dissolving 1 pound of Aroclor 5460 in 1 pint of technical xylene.

Note: The performance of DDT is not noticeably improved by Aroclor.

Weevil control with fixed-wing aircraft has been erratic. However, helicopters give good control, using 2 pounds of actual DDT in 2 gallons of

fuel oil per acre. Apply at first signs of adult weevil activity.

Pruning and burning weevil-damaged leaders before July 15 will help reduce white-pine weevil damage to Christmas trees. However, pruning does not eliminate tree-growth loss or possible infestation of undamaged leaders. For best white-pine weevil control, spray your trees with an insecticide before they become infested with this insect. See Michigan State University (Department of Forestry) literature for instructions on how to shear Christmas trees.

Zimmerman pine moth injury. Note hardened pitch at whorl and narrow stem below point of attack. Also larger stem above this point.

ZIMMERMAN PINE MOTH

Trees Damaged: Austrian, Scotch, jack, white and red pines are injured.

How to Identify: The adult Zimmerman pine moth may have a front wing span of one and a half inches. These wings are dark gray with narrow, irregular, red lines front to back. The hind wings are light-brown. The eggs are about one-third the width of a Scotch pine peedle, oval to round in shape, light brown when laid, reddish brown when fully developed. The larva, (worm-like feeding stage) is about ¾ inch when fully grown. The head is dark brown and the body dotted with small, dark spots. The body may be brown, pinkish-brown or greenish-brown. The pupa like the larva is about ¾ inch but light to dark brown in color.

Zimmerman pine moth larva amidst mass of pitch.

Life History: The eggs are laid in wounds and bark crevices, normally between August 5 and 25. They hatch in 8 to 10 days and the young larvae overwinter in hibernacula (nests) under bark scales. In the spring they become active and normally have bored into the inner bark and sapwood by about April 20. Sometime between July 15 and August 20 the larvae become mature and pupate in a feeding tunnel beneath the thin outer bark. The first moths come from the pupa cases about August 7 and continue throughout the rest of the month.

Type of Injury: Damage varies on different species of pines. For example, on forest-grown jack pine, feeding takes place in wounds produced by pine-oak rust. Young red pines may have leaders tunneled by the larvae; larger trees may have "flat tops" due to leader injury. On Christmas trees, mainly Scotch and Austrian pines, damage can occur any place on the main stem or in the terminal shoots.

Control: Between April 5 and 20, spray with enough pressure to wet the bark and main stem, especially where the branches join the main stem. **Note:** It is not controlled by spraying the foliage.

Use the following materials for Zimmerman moth: BHC (2a, but increase the rate to 8 pounds, or 2b, but increase the rate to 2 quarts), or endosulfan (Thiodan) (1⅓ quarts of an emulsion containing 2 pounds of actual chemical per gallon, or 1⅓ pounds of 50 percent wettable powder)—either material to 100 gallons of water. For another treatment: If the temperature is below 60 degrees F., apply DDT (4d alone). If the temperature is above 60 degrees F., apply DDT (4d) plus ¾ pint of a Dibrom emulsion containing eight pounds of chemical per gallon.

OTHER INSECTS

Besides the insects already listed, several others may or may not damage Michigan Christmas trees. These are:

Pine webworm: This caterpillar infests red, white, and jack pine. When mature, it is ¾ inch long, and yellowish-brown with two brown stripes down each side of the body. The worm lives in a silken tube. The tube is formed on a twig and encloses pine needles upon which the worm feeds.

Control: No chemical control suggested. Handpick the tubes when first seen and destroy.

Red-pine Sawfly: Up to this time, the red-pine sawfly has damaged only red and jack pine; it relishes old needles. The worm is gray-green, black-headed, and when mature, ¾ inch long. The body has a light green backline, and a dull-black line at the base of the legs. Only one brood occurs—from early May to late June.

Control: Spray or dust with DDT (4a, or 4c, or 4e, or 4f, or 4g) or lead arsenate (7a), or carbaryl (Sevin), (12a, 12c or 12d) in June and July.

Pales Weevil: The adult is about ¾ inch long, being nearly twice as large as the white pine weevil. The pales weevil is dark to reddish-brown with gray or yellow markings on the thorax and wing-covers.

The pales weevil passes the winter mainly as adults in ground litter (some however as larvae in stumps and roots). They become active during April, May, and June, feeding on twig bark and base of saplings. Eggs are laid in the inner bark of freshly cut

logs or larger roots of pines. The adults emerge in September and severely damage young trees.

Control: For this insect, control methods are threefold:

1. When replanting a cutover area, delay until the inner bark of stumps and roots have dried and turned brown. This is a must if damage by the insect is to be avoided. Seedlings may be protected by dipping the tops in 2 percent aldrin emulsion before planting. Use 1 gallon of aldrin emulsion containing 1.6 pounds of chemical per gallon to 11⅓ gallons of water. While planting dipped plants, wear rubber gloves.

2. To prevent development of larvae in stumps cut the previous fall, spray about May 1 with BHC in kerosene. Dilute 1 gallon of BHC (containing 2 pounds of chemical per gallon) with 10 gallons of kerosene. Apply to stumps as a mist, using a compressed air sprayer or other suitable equipment.

3. Remove cut trees from plantations when possible. These provide food and encourage build-up of weevils and other bark feeders.

Rhyacionia adana **(moth):** This insect is closely related to the European pine shoot moth. While the two insects resemble each other closely, they nevertheless, have different feeding and life-cycle habits. For differences, compare the following on *R. adana* with the section on European pine shoot moth.

R. adana passes the winter as a pupa attached to the root-collar just beneath the soil surface. The moth emerges about mid-April when the temperature reaches 50 degrees F. Not too long afterward, eggs are laid on the inside of the needle just above the sheath. Hatched larvae enter the inner side of the needles just above where the eggs were laid. In early June they leave the old needles and eat at the base of needles on new shoots.

The mature larva of *R. adana* is about ¾ inch long, yellowish- to reddish-brown with the head dark brown to black and the thorax, black.

Control: Apply DDT mid-April and again in late May. Use 1 gallon of a DDT emulsion containing 2 pounds of actual chemical–to 100 gallons of water.

Note: No research has been done in Michigan to set the exact time to apply the treatments. These timing suggestions are based on available research information.

Tortricids (moths): Two tortricids have already been discussed – Jack-pine budworm and pine tube moth. Two others are *Tortrix alleniana* and *Tortrix pallorana.*

These latter moths are very similar to each other in habits and appearance. The following life history notes are for *T. pallorana.* It has two broods a year with adults present in late June and again in August. The larvae of the second brood overwinters as partially grown worms in *hibernacula* (nests) on *alfalfa* and *clover.*

Mature larvae are about 1 inch long and a uniform light-or-yellowish green. Only the last two instars (an instar is the period between molts) of the first brood feed on conifers, normally during May and June. They tie the shoots of a single branch together and feed in this enclosed area.

Control: Follow the instructions for jack-pine budworm or pine tube moth.

Nantucket Pine Tip Moth: The wing expanse of the moth is about 7/16 inch. Its body is reddish-brown with silver-gray markings on the wings. Full grown larvae are about ¾ inch with yellowish to light brown bodies. The head and thoracic shield are dark brown.

The circular, flattened, and light-yellow eggs are usually laid on shoots, buds, or needles. Upon hatching, the larvae normally feed on new shoots near the base of needles. A protective web is spun over the feeding areas; later these become covered with pitch. As the larvae mature, they bore either into buds or the succulent growth near the tip of the shoots. Here they finish their growth, pupate, and overwinter in this stage.

Control: This moth is presently of minor importance in Michigan. No control is suggested for it at this time.

OTHER TROUBLES

Frost Damage: In early spring, buds and new growth turn white or yellowish-white. The needles on these are crisp and dry.

Frost damage to young buds.

Pine Grosbeak: This bird eats the upper buds, especially of Scotch pine.

Sapsucker: The yellow-bellied Sapsucker feeds on the sap and cambium of Christmas trees. It makes round holes in the bark, penetrating to the cambium layer. The mechanical damage causes the trees to bleed, forming gums on the bark. The damaged bark also permits diseases and insects to enter the tree.

Squirrels: Occasionally twigs and branches are cut from Christmas trees. This may be the work of squirrels. Perhaps the best evidence of this kind of damage is the teeth marks on the dismembered twig or branch.

SECTION III

INSECTICIDES

For good insect and mite control, you must know how to use insecticides and miticides (chemicals) effectively. Most insecticides and miticides are available in several different formulations. Each formulation has its own use for Christmas tree insect and mite control.

This insecticide and miticide information is divided into two parts. The first discusses the forms (formulations) in which you can use the various insecticides and miticides. The formulations given are the more common ones. Read the label on the container for instructions on how to use formulations not discussed in this bulletin.

The second part of this section discusses the individual insecticides and miticides and lists the formulations usually available for insect and mite control. Also included in this second part are the WARNINGS on the use of each insecticide and miticide.

Formulations

A. Dusts

Dusts are dry powders which normally contain a lower percentage of insecticide than do wettable powders. Dusts are used as bought. **They are not mixed with water.** Use them on those insects against which they are effective. Dusts generally are less effective than either wettable powders or emulsions.

B. Emulsions

These insecticides are liquids. They must be mixed with water, turning it milky. Emulsions are usually more toxic to plants than either wettable powders or dusts. Hence, use them strictly according to directions.

Emulsions in concentrated form are dangerous if spilled on clothing and skin. Wash with soap and water immediately after spilling on the skin. Change clothing.

C. Wettable Powders

These insecticides are similar to dusts. (See paragraph A above.) They contain, however, a higher percentage of chemical than do dusts. For some insect control purposes, wettable powders are used as bought instead of dusts. However, wettable powders are more often mixed with water and applied as sprays. Wettable powders can either be used in dilute or concentrate sprays although emulsions are more suited for use in concentrate sprays. Avoid breathing or getting wettable powders on the skin. Use masks and protective clothing.

D. Other Formulations

Aerosols, vapors, and oil solutions are not normally used on Christmas trees (see footnote, under Aldrin, page 20). Oil solutions which resemble emulsions in the concentrated form generally do not mix with water and if applied alone could injure trees.

WARNINGS

- Avoid heavy application to tender (young) trees, especially when using aldrin, chlordane, dieldrin, and heptachlor emulsions.
- Use aldrin and heptachlor granules only for soil insects.
- People with sinus trouble may find lindane and BHC especially annoying.
- Nicotine sulfate is a dangerous material to handle, especially in the concentrated form. It can be especially dangerous when used in a mist-blower.
- Ovex especially may cause skin irritation if it comes in contact with the hands, face, and body.
- Avoid getting Aramite in the eyes.
- Avoid breathing insecticide sprays or dusts.
- If emulsions, granules, dusts, or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- Avoid storing insecticides where children can be harmed by them.
- Read the label on the package. Follow directions.

Descriptions and formulations of 11 insecticides and miticides suggested for various insect and mite control problems follow:

1. Aldrin: This insecticide is a chlorinated hydrocarbon similar to chlordane and dieldrin.

Aldrin is available in the following three forms for treating tree foliage:

No.	Aldrin formulations*	Amount per 100 gallons of water	Amount per gallon of water
1a	25 percent wettable powder	1 pound**	1 tablespoon
1b	23 percent emulsion	1 pint**	1 teaspoon
1c	2% percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read section IV for information on the use of insecticide concentrate in a mist-blower.

Aldrin formulations for soil treatment follow:

No.	Aldrin formulations*	Amount per acre
1d	5 percent granules	100 pounds
1e	25 percent wettable powder	20 pounds
1f	23 percent emulsion	2% gallons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
Note: Immediately after applying aldrin to the soil surface, disc it 4 inches deep.
**Insecticide solutions are not used normally on Christmas trees; however, there are a few exceptions. In these types of formulations, the insecticide is dissolved in a solvent (usually oil) and the combination used without mixing with water. Solutions are used almost entirely for control of household insects. Insecticide emulsions have some characteristics similar to solutions, but emulsions are mixed with water before applying. Emulsions are sprayed normally on plants growing outdoors for all kinds of insects.

2. Benzene hexachloride (BHC): This material is a chlorinated-hydrocarbon and is closely related to lindane. BHC is not widely used as an insecticide on fruits and vegetables because it may cause an off flavor (chemical taste) in these products. However, this taste problem is absent in Christmas trees. The chemical can be substituted freely for lindane; however the dosage will be different.

You can buy BHC in three forms for use on trees. The following table lists its common formulations:

No.	BHC formulations*	Amounts per 100 gallons of water	Amount per gallon of water
2a	12 percent wettable powder*	4 pounds**	4 tablespoons
2b	Emulsifiable concentrate containing 2 pounds of chemical per gallon	1 quart**	2 teaspoons
2c	3 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

3. Chlordane: This insecticide is a chlorinated hydrocarbon similar to aldrin and dieldrin.

Chlordane is available in the following three forms for treating foliage:

No.	Chlordane formulations*	Amount per 100 gallons of water	Amount per gallon of water
3a	40 percent wettable powder	2½ pounds**	2½ tablespoons
3b	72 percent emulsion	1¼ pints**	1¼ teaspoons
3c	5 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower

Chlordane formulations for soil treatment follow:

No.	Chlordane formulations*	Amount per acre
3d	40 percent wettable powder	25 pounds
3e	72 percent emulsion	1¼ gallons
3f	5 percent dust	200 pounds

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
Note: Immediately after applying chlordane to the soil surface, disc it 4 inches deep.

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4. DDT is a chlorinated hydrocarbon. Also in this group of chemicals are aldrin, chlordane, dieldrin, heptachlor, and other similar materials. DDT MUST BE USED IN DIFFERENT FORMULATIONS FOR DIFFERENT KINDS OF EQUIPMENT AS FOLLOWS:

FOR USE IN HYDRAULIC SPRAYERS
(Including knapsack and compressed air sprayers)

No.	DDT* formulations	Amount per 100 gallons of water	Amount per gallon of water
4a	50 percent wettable DDT powder	3 pounds	3 tablespoons
4b	50 percent wettable DDT powder	4 pounds	4 tablespoons
4c	25 percent emulsion	3 quarts	6 teaspoons
4d	25 percent emulsion	1 gallon	8 teaspoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

WARNINGS:

- Avoid overdosing Christmas trees with oil-type formulations.
- Avoid exposing hands and face especially to oil and emulsion-type DDT formulations. If materials are spilled on the body, wash immediately with soap and water.
- Do not apply DDT to creeks, rivers, ponds, or lakes containing fish.
- **Do not apply DDT to pastures, hay fields, or other foods for dairy animals and beef stock intended for slaughter.** DDT drift is a problem especially when this insecticide is applied with an airplane or mist-blower.
- **Read the label on the package. Follow the directions.**

FOR USE IN POWER DUSTERS
(Including hand-type dusters)

No.	DDT* formulation	Amount per 100 gallons of water	Amount per gallon of water
4e	5 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION I.

FOR USE IN MIST-BLOWERS

See Section IV on equipment for further information about mist-blowers (air-blast sprayers) and concentrate sprays.

No.	DDT* formulations	Amount per 100 gallons of water	Amount per gallon of water
4f	25 percent emulsion	3 gallons	8 tablespoons
4g	25 percent emulsion	4 gallons	11 tablespoons

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.

FOR USE IN AIRPLANES

4h. For airplane and helicopter application, buy DDT oil formulations ready to use. Each gallon of material should normally contain 1 pound of DDT. Apply 1 pound of DDT in 1 gallon of oil to each acre of Christmas trees. When 2 gallons of oil containing 2 pounds of DDT are applied to an acre, apply 1 gallon along the rows and the other gallon across the rows.

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5. Dieldrin: This insecticide is a chlorinated hydrocarbon very similar to chlordane and is used in the same way.

Dieldrin is available in three forms for treating Christmas tree foliage:

No.	Dieldrin formulations*	Amount per 100 gallons of water	Amount per gallon of water
5a	50 percent wettable powder	1 pound**	1 tablespoon
5b	15 percent emulsion	3 pints**	3 teaspoons
5c	1½ percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

Dieldrin formulations for soil treatment follow:

No.	Dieldrin formulations*	Amount per acre
5d	5 percent granules	100 pounds
5e	50 percent wettable powder	10 pounds
5f	15 percent emulsion	3½ gallons
5g	1½ percent dust	330 pounds

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
Note: Immediately after applying dieldrin to the soil surface, disc it 4 inches deep.

6. Heptachlor: This insecticide is a chlorinated hydrocarbon similar to aldrin and dieldrin.

Heptachlor is available in the following three forms for treating tree foliage:

No.	Heptachlor formulations*	Amount per 100 gallons of water	Amount per gallon of water
6a	25 percent wettable powder	1 pound**	1 tablespoon
6b	23 percent emulsion	1 pint**	1 teaspoon
6c	1½ percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

Heptachlor formulations for soil treatment follow:

No.	Heptachlor formulations*	Amount per acre
6d	25 percent wettable powder	20 pounds
6e	23 percent emulsion	2½ gallons
6f	5 percent granules	100 pounds

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
Note: Immediately after applying heptachlor to the soil surface, disc it 4 inches deep.

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7. Lead Arsenate: This insecticide is the most commonly used stomach poison for chewing insects because it is effective and causes less injury to plants than other kinds of arsenicals. Lead arsenate is a powder. It is used in water as a suspension spray or mixed with a diluent (filler) for use as a dust.

Lead arsenate may be used alone at the rate of 3 pounds to 100 gallons of water. However, it will be more effective if used according to the suggestions given in 7a in the following table. Formula 7b in this same table is for control of white-pine weevil only. (Spray the leader.)

No.	Ingredients*	Amount per 100 gallons of water	Amount per gallon of water
7a	Lead arsenate (100 percent wettable powder)	3 pounds**	3 tablespoons
	Summer oil or	1 quart	2 tablespoons
	Milk	.....	½ cup
7b	Lead arsenate (100 percent wettable powder)	.....	¾ pound
	Boiled linseed oil	.....	4 fluid ounces
	Commercial spreader-sticker	.....	½ teaspoon

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

8. Lindane: This material is a chlorinated hydrocarbon as is DDT, and is especially related to BHC. Lindane is not widely used as an insecticide on fruits and vegetables because it may cause an off-flavor (chemical taste) in these products. However, we do not have this taste problem when using it on Christmas trees.

You can buy lindane in three forms for use on trees. The following table lists its common formulations:

No.	Lindane formulations*	Amount per 100 gallons of water	Amount per gallon of water
8a	25 percent wettable powder	1½ pounds**	1½ tablespoons
8b	20 percent emulsion	1 pint**	1 teaspoon
8c	1 percent dust (Use as purchased)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.
Note: A lindane emulsion spray is especially desirable for control of all kinds of leaf miners on shade, ornamental, and Christmas trees.

9. Malathion: This is a phosphate-type insecticide related to parathion, TEPP and other similar materials. Malathion is different from parathion and TEPP in at least one important respect. It is NOT as DANGEROUS TO USE at THE TIME OF APPLICATION AS PARATHION or TEPP. It must be kept in mind, however, that no matter how safe a material may seem to be, it can be dangerous if used improperly.

Malathion is available in three different formulations, as given in the following table:

No.	Malathion formulations*	Amount per 100 gallons of water	Amount per gallon of water
9a	50 percent emulsion	1½ pints**	1½ teaspoons
9b	25 percent wettable powder	3 pounds**	3 tablespoons
9c	5 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR EACH INSECT OR MITE. SEE SECTION II.
**This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist-blower.

Malathion is listed for control of numerous insects in this bulletin. It is especially effective against aphids and mites. Whether you use it in one form or another will depend greatly on the type of spraying or dusting equipment you have. For the most part, however, sprays tend to be better than dusts for treating Christmas trees.

10. Miticides: There are several miticides and ovicides available that will adequately control mites on pines. Miticides control active mites whereas ovicides kill the eggs. For controlling both active mites and eggs choose a material which will control both stages, or use a combination of a miticide (acaricide) and an ovicide. Note: Concentrate (mist blower) application of miticides is not recommended.

Formulation	Amount Per 100 Gallons of Water	Amount Per 1 Gallon of Water
Aramite* 15 percent wettable powder	2 pounds	2 tablespoons
Aramite* 25 percent emulsion	1 pint	1 teaspoon
Chlorobenzilate† 25 percent wettable powder	1½ pounds	1½ tablespoons
Chlorobenzilate† 25 percent emulsion	1 quart	2 teaspoons
Genite* 50 percent wettable powder	2 pounds	2 tablespoons
Genite* 25 percent emulsion	1½ pints	1½ teaspoons
Kelthane† 18.5 percent wettable powder	2 pounds	2 tablespoons
Kelthane† 18.5 percent emulsion	1 quart	2 teaspoons
Morestan*† 25 percent wettable powder	½ - 1 pound	½ - 1 tablespoon
Ovex* 50 percent wettable powder	2 pounds	2 tablespoons
Tedion* 25 percent wettable powder	1 pound	1 tablespoon
Tedion* 10 percent emulsion	1 quart	2 teaspoons

* Ovicide
† Miticide

11. Oils and Other Dormant Sprays: Apply before buds break in the spring, after danger of freezing nights has passed and when the temperature is above 40°F. Follow all label instructions. Generally, dormant sprays are most effective when applied late in the dormant season.

No.	Formulations	Amount per 100 Gallons of Water	Amount per Gallon of Water
11a	Dormant oil*	2 gallons	5 tablespoons
11b	Dormant oil* containing 2% ethion	2 gallons	5 tablespoons
11c	Lime Sulfur suspension	12 gallons	1 pint

* Many types of oils are available. However, narrow cut, paraffinic, superior oils of 60- to 70- second viscosity by the Saybolt test are preferred. These are sold under various trade names and are ready for dilution in water. It is not recommended that spreaders or stickers be combined with commercially prepared oils since the addition may reduce their effectiveness. COMPLETE COVERAGE OF ALL PLANT PARTS IS ABSOLUTELY ESSENTIAL FOR EFFECTIVE INSECT OR MITE CONTROL. Therefore, mist blower application of oils is not recommended because it does not give the uniform coverage of a hydraulic spray and may cause plant injury. Do not apply oils to sugar and Japanese maples, birch, beech, walnut, hickory or butternut since plant injury may result. Oil will remove the bloom from blue spruce but will not permanently injure trees.

12. (Carbaryl) SEVIN: This insecticide is a carbamate insecticide with good residual properties. It is available in various formulations. The following table lists its common formulations for treating tree foliage:

No.	Sevin Formulations	Amount Per 100 Gallons of Water	Amount Per Gallon of Water
12a	50% Wettable Powder	2 pounds*	2 tablespoons
12b	50% Wettable Powder	3 - 4 pounds*	3 - 4 tablespoons
12c	4 Flowable	1 quart*	2 teaspoons
12d	85% Wettable Powder	1⅓ pounds*	1⅓ tablespoons

* This amount is for use in dilute spray. Read Section IV for information on the use of insecticide concentrate in a mist blower.

SECTION IV

EQUIPMENT

Choose equipment well and use it carefully for Christmas tree insect control. With the exception of airplane application, roadways must be present in all plantations where power equipment is used. Types of equipment and their use are given below.

Compressed Air Sprayer:

The water capacity of a compressed air sprayer is usually 3 to 4 gallons. Air is pumped into the tank, thus forcing the spray out when the nozzle is opened. Emulsions and wettable powders can be applied with a compressed air sprayer. Because this sprayer has limited size, it is not practical for large acreage spraying. Agitate the sprayer when you use wettable powder.

Knapsack Sprayer:

The water capacity of a knapsack sprayer is usually 3 to 5 gallons. This sprayer is carried on the back and continuously hand-pumped. Both emulsions and wettable powders can be applied with a knapsack sprayer. Because this sprayer has limited size, it is not practical for large acreage spraying. The knapsack sprayer must have a built-in agitator for successful operation especially when wettable powder insecticide is used.

Rotary Duster:

The rotary duster is operated by a hand crank. Continuous cranking is necessary while it is in use. A duster of this type is limited to small Christmas tree numbers.

NOTE: Only a few Christmas tree insects are controlled satisfactorily with insecticide dusts. From this standpoint, dusting has little overall practical value. See Section II for those insects that can be controlled satisfactorily with a dust.

Power Duster:

The power-driven duster is suitable for treating large areas. Generally, it is lighter in weight than a sprayer and can pass over rougher ground. A power duster, however, has limited use because only a few Christmas tree insects are controlled satisfactorily with a dust. See Section II for the use of dusts.

Power Sprayer:

The power-driven hydraulic sprayer (it uses large amounts of water) is suitable for treating large acreages. Because water weighs 8 pounds a gallon, a loaded sprayer is normally heavier than a loaded duster. This will limit the sprayer's use on rough or sloping soils. **A hydraulic sprayer is satisfactory for control of all Christmas tree insects.**

Mist-Blower: (Also referred to as air-blast)

The mist-blower (it uses concentrated spray mixture) can treat large tree numbers. This machine uses small quantities of water to apply insecticides. While a hydraulic power sprayer uses 100 or more gallons of water to an acre, mist-blowers can use as little as 30 gallons of water to an acre. A mist-blower has two important drawbacks. 1. Not enough is known about its use against most insects damaging Christmas trees, especially the Zimmerman pine moth; 2. Generally it does not cover satisfactorily a spray-width of more than about 40 feet.

In comparison with a regular dilute spray, a concentrate spray is made by putting 2, 3, 4, or more times the amount of chemical in 100 gallons of water. When twice the amount of chemical is put into 100 gallons of water—that is called a 2X concentrate spray; three times is called 3X, and four times is called 4X, etc. For example: If 3 quarts of 25 percent DDT emulsion are put into 100 gallons of water to make a regular (dilute) spray, then 1½ gallons (6 quarts) of this same material in 100 gallons of water make a 2X concentrate spray; 2¼ gallons (9 quarts) make a 3X spray; and 3 gallons make a 4X spray.

The object of using a mist-blower (concentrate) spray is to apply less water (spray) per acre yet use the required amount of insecticide. This makes it possible to cover more ground per tankful and avoid extra hauling of water and compaction of soil. **For example:** Suppose 3 quarts of 25 percent DDT emulsion are used in each 100 gallons of hydraulic (dilute) spray. (This is the standard dosage for hydraulic spray when controlling anomala beetles, aphids, budworms, and sawflies but not for European pine shoot moth which requires a higher dosage of DDT.) Then 50 gallons of a 2X concentrate spray would apply the desired 3 quarts of 25 percent DDT emulsion. A 3X concentrate would take 33 gallons, and a 4X concentrate spray would take 25 gallons for the required 3 quarts of 25 percent DDT emulsion. Because European pine shoot moth control takes a larger amount (dosage) of DDT than other Christmas tree insects, concentrate sprays for shoot moth control are figured as follows:

Strength of Mixture	Amount of insecticide per 100 gallons of water
Dilute	1 gal. 25% DDT emulsion
2X	2 gal. 25% DDT emulsion
3X	3 gal. 25% DDT emulsion
4X*	4 gal. 25% DDT emulsion
5X	5 gal. 25% DDT emulsion
6X	6 gal. 25% DDT emulsion
7X	7 gal. 25% DDT emulsion
8X	8 gal. 25% DDT emulsion

* A 4X concentrate spray is the least amount you should use for European pine shoot moth control.

Remember that using a mist-blower or air-blast (concentrate) spray does not change the need for careful, thorough, and timely spraying. Effective protection of Christmas trees against insects requires thorough coverage.

Airplanes:

The airplane can treat large tree numbers. Airplane use is limited by such conditions as poor weather, telephone and electrical power lines near the trees, and hard-to-control insects. Special insecticide formulations must be used with airplanes.

Note: To date, airplane treating for European pine shoot moth control has not been very successful. If you attempt control of this insect with an airplane, apply twice for the same treatment: once along the rows and then again across the rows.

Helicopters:

Helicopters are usually better than airplanes for applying insecticides for control of Christmas tree insects. Their slow hovering motion makes it possible to apply treatments more uniformly and in amounts closer to dosage requirements. Even so, some insects like the Zimmerman moth will be hard to control with helicopters.

OTHER REFERENCES

You can get more information on the control of insects affecting Christmas trees than is given in this bulletin.

You can buy bulletins and leaflets on certain problems from the Superintendent of Documents, Washington 25, D. C. Bulletins and mimeographed materials are available at the Bulletin Office, Michigan State University, Box 231, East Lansing, Michigan. Single copies of most of this material are free. Your county agricultural agent also has literature from Michigan State University and the federal government.

MICHIGAN POISON CONTROL CENTERS

In Case of Poisoning

1. *Call your physician.* NOTE TO PHYSICIAN: The table below lists Poison Control Centers in Michigan which can furnish specific information including antidotes, for various trade and common named poisons. Services of the Centers are intended mainly for Medical Doctors. However, offices remain open 24 hours a day and can give emergency poison treatment advice over the phone.

2. *For poisons spilled on the skin:* Wash thoroughly with large amounts of soap and warm water. Particles in the eyes may be removed by thorough flushing with plain water. For phosphate materials absorbed through the skin, give atropine by injection or in tablet form.

3. *For poisons that have been inhaled:* Place the patient in the open air. Give atropine as directed above if a phosphate material is responsible. Administer artificial respiration when necessary.

4. *For poisons that have been swallowed,* induce vomiting as soon as possible. To do this, gently stroke the inside of the throat and/or give an emetic such as warm salt water (1 tablespoon in a glass of water). Repeat until the vomit fluid is clear. After the stomach has been emptied, give a demulcent such as raw egg white mixed with water.

5. When the physician arrives, he may inject 1/50 to 1/40 of a grain of atropine sulfate at hourly intervals for phosphate materials, or phenobarbital for chlorinated hydrocarbon chemicals.

NOTE: A new antidote, specific for phosphate chemicals, is available to doctors for emergency treatment of phosphate poisoning. This antidote, called PAM (protopam chloride or pralidoxime) can be injected intravenously by doctors or prescribed in tablet form. In several instances persons poisoned by phosphate chemicals have responded to PAM when atropine failed to give desired results.

City

ADRIAN
Poison Control Center
Emma L. Bixby Hospital
818 Riverside Drive
Colfax 5-6161
Robert Greiner, M.D.

ANN ARBOR
Poison Control Center
University Hospital
1313 E. Ann St.
Normandy 31631, Ext. 589
George H. Lowrey, M.D.

BATTLE CREEK
Poison Control Center
Community Hospital
200 Tomkins St.
Woodward 3-5521
Sterling L. Butterfield, R.Ph.

BAD AXE
Poison Control Center
Hubbard Memorial Hospital
CO 9-6444
Alice J. Shoemaker, R.Ph.
E. E. Steinhardt, M.D.

BAY CITY
Poison Treatment Center
Bay City Osteopathic Hospital
200 Mulholland St.
TWinbrook 3-9554
(Emergency Room under charge of Floor Supervisor)
Poison Control Center *
Mercy Hospital
100 15th St.
TWinbrook 3-9554
Theodore Meyer, Pharmacist

BENTON HARBOR
Mercy Hospital*
960 Agard
(see St. Joseph)

COLDWATER
Poison Control Center
Branch County Community Health Center
274 E. Chicago St.
279-9501
John C. Heffelfinger, M.D.
Office 278-2359

DETROIT
Poison Control Center
Children's Hospital
5224 St. Antoine St.
Temple 3-1000
Paul V. Wooley, Jr., M.D.;
Rosalyn Weintraub, M.D.
Poison Information Center
Registrar's Office
Herman Kiefer Hospital
1151 Taylor Avenue
Trinity 2-3334
Paul T. Sulehow, M.D.;
William G. Frederick, Sc.D.
Poison Treatment Center*
Saratoga General Hospital
15000 Gratiot Ave.
Lakeview 6-5100
Wm. B. Hennessey, Ch'cf Pharmacist

FLINT
Poison Control Center*
Hurley Hospital
6th Ave. & Begole
Cedar 2-1161
Douglas L. Vivian, R.Ph.

GRAND RAPIDS
Poison Control Center
Butterworth Hospital
300 Bostwick, N.E.
Glendale 1-3591
John R. Wilson, M.D.
Poison Control Center
Blodgett Memorial Hospital
1800 Wealthy, S.E.
Glendale 6-5301
John Montgomery, M.D.
Poison Control Center
St. Mary's Hospital
201 Lafayette, S.E.
Glendale 9-3131
Craig E. Booher, M.D.

JACKSON
Poison Treatment Center*
Foote Memorial Hospital
205 N. East
State 3-2711
Ethan Stone, M.D.

KALAMAZOO
Poison Control Center
Bronson Methodist Hospital
252 E. Lovell St.
Fireside 2-8821
H. Sidney Heersma, M.D.;
Wm. E. Johnson, Chief Pharmacist

LANSING
Poison Control Center
St. Lawrence Hospital
1210 W. Saginaw St.
372-3610
Robert F. Thimmig, M.D.
Poison Treatment Center
Edw. W. Sparrow Hospital
1215 E. Michigan Ave.
Ivanhoe 4-7721
Harry C. George, M.D.
Poison Treatment Center
Lansing General Hospital
2500 Devonshire Ave.
Ivanhoe 5-4311
John Morgan, Chief Pharmacist

LINCOLN PARK
Poison Control Center
Outer Drive Hospital
26400 Outer Drive
386-0606
W. S. Wheeler

MARQUETTE
Poison Information Center
St. Luke's Hospital
West College Ave.
Canal 6-3511
Thomas Bell, Pharmacist

MIDLAND
Poison Control Center
Midland Hospital
4005 Orchard Drive
TE 5-6771
R. E. Lorimer; D. N. Fields, M.D.

MONROE
Poison Control Center
Memorial Hospital of Monroe
700 Stewart Road
241-6509

PETOSKEY
Poison Control Center*
Little Traverse Hospital
416 Connable
Diamond 7-2551
Norbert R. Wegemer, Chief Pharmacist

PONTIAC
Poison Control Center*
St. Joseph Mercy Hospital
900 Woodward Ave.
Federal 4-3511
Robert J. Mason, M.D.

PORT HURON
Poison Control Center
Mercy Hospital
2601 Electric Ave.
Yukon 5-9531
Robert Lugg, M.D.

SAGINAW
Poison Control Center
Saginaw General Hospital
1447 N. Harrison Rd.
755-3411
Wm. G. Mason, M.D.
Poison Treatment Center
Saginaw Osteopathic Hospital
515 N. Michigan
PI 3-7751
Nicholas Latkovic, D.O.

ST. JOSEPH
Memorial Hospital*
2611 Morton Ave.
Berrien County Pesticide Control Center
2516 Niles St.
YUkon 3-1674
Marshall J. Feeley, M.D.;*
James W. Skinner, M.D.

WAYNE
Poison Treatment Center
Annapolis Hospital
33155 Annapolis
PA 2-4400
House Physician on duty

* Facilities available for determining cholinesterase levels in blood samples.