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Christmas Tree Insect Control

Michigan State University Extension Service

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CHRISTMAS TREE

Insect Control



MICHIGAN STATE UNIVERSITY

Cooperative Extension Service • East Lansing

WARNINGS:

All insecticides, fungicides and nematicides 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 nematicides. 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, or ponds UNLESS THERE IS NO DANGER INVOLVED. 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 in this bulletin 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, get information from your county conservationist.

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 42.

Cover photo: Pine spittlebug

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 ½ inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Strawberry root weevil
Damage to trunk (root collar) at ground level	Bark damaged at ground level; blackened pitch present. Small, (up to ⅓ inch long) white curved grubs with brown heads; no thoracic or abdominal legs.	Pine root collar weevil
Damage to bark of trunk, stems and twigs	Gum oozes from damaged bark turning into a white scale-like material. A STICKY, HONEY DEW 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, ⅓ 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 common blue, Colorado blue, Sitka, and Englemann spruce; similar to eastern spruce gall, but longer and less compact.	Cooley spruce gall aphid
	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. Growth enlarged above girdled stem.	Zimmerman pine moth
Damage to shoots	Shoots stunted, yellow or brown. In the spring and fall, the tunnel inside the damaged shoot can contain a brown worm.	European pine shoot moth

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 ($\frac{7}{8}$ 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. 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 $1\frac{1}{2}$ 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, $\frac{1}{3}$ 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 $\frac{1}{9}$ inch. Off-colored foliage; growth is stunted.	Pine needle scale
	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

Christmas Tree Insect Control

By RAY L. JANES,¹ JAMES W. BUTCHER,² and WALTER F. MOROFSKY.³

Commercial Christmas tree growing has become an important Michigan enterprise. Along with planting, pruning, 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 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 6

show a sawfly worm and a June beetle adult. Refer to these drawings when insects 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 pages 6 and 7 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.

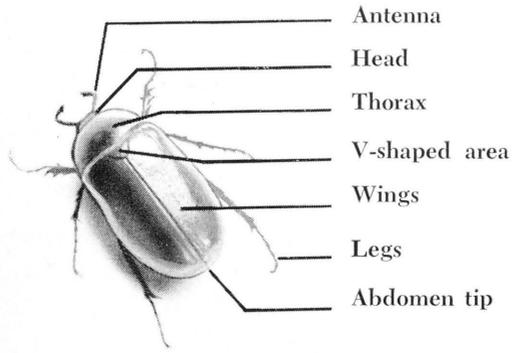
PLANT CHRISTMAS TREES FOR BETTER INSECT CONTROL

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, 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.

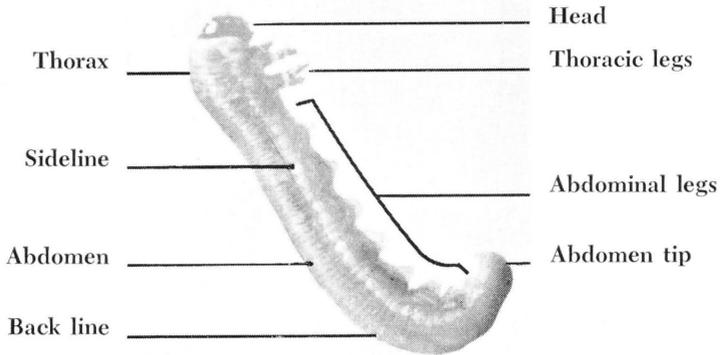
¹Associate Professor (Extension) of Entomology

²Assistant Professor of Entomology

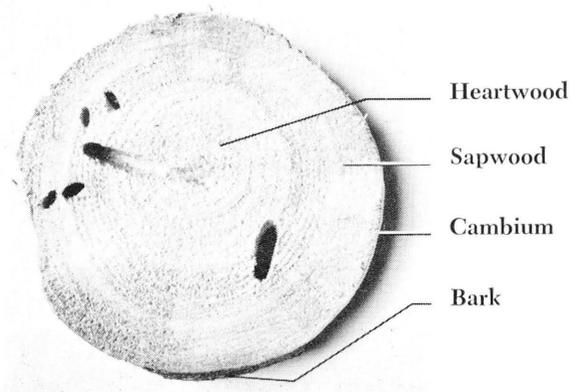
³Professor of Entomology



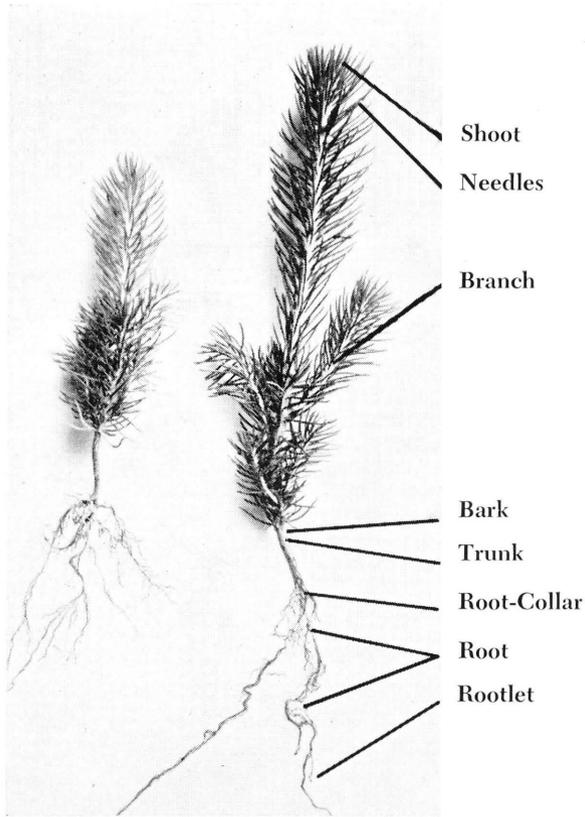
June beetle adult



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



Cross-section of white pine trunk.



Seedling of Norway spruce

SECTION I

SPRAY PROGRAM

This spray program lists controls for the six insects most likely to affect Christmas trees. **Based on the need of your plantings,** use one or more of the treatments given in the

following table. **NOTE:** For the best control of **individual** insects affecting your trees, use the **information in Section II** of this bulletin.

SPRAY TREATMENTS

Trees damaged	Insects to be controlled	When to spray§	Amount to 100** gallons of water
Scotch, white, red, and jack pine, and Norway spruce	White pine weevil	April 15 to 30, or when the buds begin to swell.	1 gallon of 25 percent DDT emulsion or 4 pounds of 50 percent wettable DDT powder*
Austrian, Scotch, red, and mugho pines	European pine shoot moth NOTE: For best shoot moth control, apply treatments in April and again in June (see below for June treating instructions).	The exact time depends on an early or late season. Apply the weevil and shoot moth spray as instructed for white pine weevil, using DDT for both insects.	
Jack, red, and Scotch pines	European sawfly	About June 10	3 quarts of 25 percent DDT emulsion or 3 pounds of 50 percent wettable DDT powder*
Jack, red, Scotch, and white pines	Anomala beetle	June 10 to 15	3 quarts of 25 percent DDT emulsion or 3 pounds of 50 percent wettable DDT powder*
Austrian, Scotch, red, and mugho pines	European pine shoot moth	June 20 and again June 30 for two treatments#	1 gallon of 25 percent DDT emulsion or 4 pounds of 50 percent wettable DDT powder*
Jack, red, Austrian, Scotch, and mugho pine	Red-headed pine sawfly	About July 20	3 quarts of 25 percent DDT emulsion or 3 pounds of 50 percent wettable DDT powder*
Red, Scotch, Austrian and white pines	Zimmerman pine moth	About August 20	4 pounds of 50 percent wettable DDT powder or 1 gallon of 25 percent DDT emulsion*

*Continuous use of DDT permits a build-up of mites on your trees. See the section on mites for control of this pest.

**The amounts given are for hydraulic (dilute) sprays and not for air-blast, mist blowers, or airplanes. Read Section IV on Equipment for descriptions and uses of machinery for Christmas tree insect control.

§The dates given for the time to treat are for normal seasons. For the best time to treat for Christmas tree insects, see your county agricultural agent.

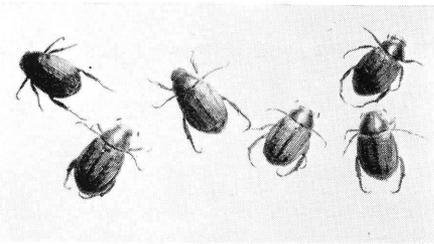
#See your county agricultural agent for the best time to treat for pine shoot moth. Proper timing of treatments is especially important for this insect.

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 6/16 inch long while the male is 5/16 inch. Note: This pest belongs to the same family as the white grubs.



Adult anomala beetle. The dark colored ones are males; the light ones are females. About $\frac{1}{2}$ 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 foliage

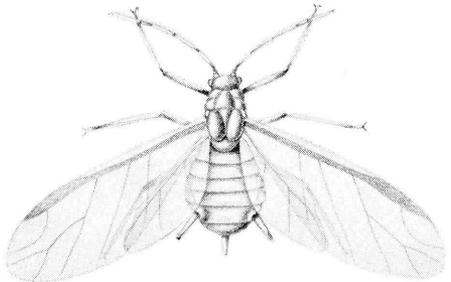
of evergreens. It notches the needle just above the sheath causing it to bend downward and turn brown. However, large numbers of beetles tend to devour both needles and sheaths. Also the bark is damaged causing pitch to form on its surface. This pitch eventually dries into a hard, gray-white, scaly material. 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) or lead arsenate (7a).

APHIDS

Trees Damaged: Aphids damage all pine and spruce trees.

How to Identify: Winged and wingless aphids occur on needles,



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

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 $\frac{1}{4}$ 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.

Type of Injury: Aphids suck juices from branches, twigs, and needles of Christmas trees. This feeding causes galls, swelling of woody



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

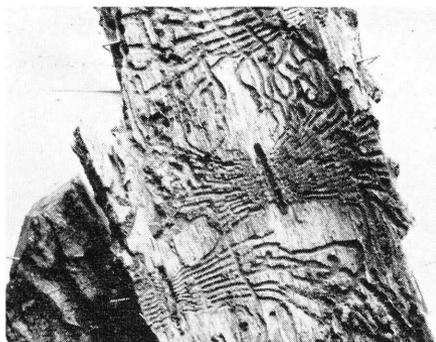
parts, leaf injury, or leaf curl. Gum often oozes from aphid feeding wounds. This gum hardens in time, in many cases reducing the trees' sale value.

Control: 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 nicotine sulfate and soap (10a), or nicotine sulfate and oil (10b). 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 inner bark, or the area next to the tree's sapwood is grooved (engraved) by numerous designs. From a larger 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 $\frac{1}{8}$ to $\frac{3}{8}$ inch long, curve-bodied, legless, and whitish with a reddish-brown or black head. The adults are about $\frac{1}{16}$ to $\frac{3}{8}$ 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.



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.

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 2. 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 common blue, 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 normal 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 malathion (9a, or 9b, or 9c), or nicotine sulfate and soap (10a), or nicotine sulfate and oil (10b), 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 common blue, Colorado blue, Sitka, or Englemann 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 $\frac{3}{4}$ inch long. When the galls open in July, you can see the aphids inside of them.



Eastern spruce gall aphid.

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 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.

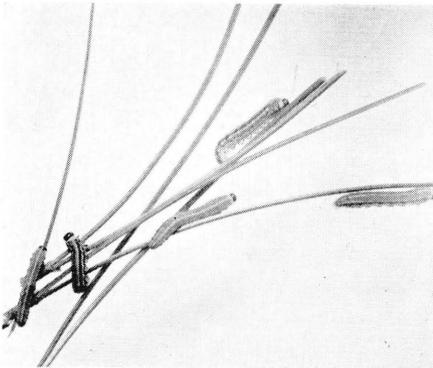
Type of Injury: The eastern spruce gall aphid sucks juices from spruce needles and other tender plant parts. Some of the injured twigs die, or become weakened or deformed.

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 malathion (9a, or 9b, or 9c), or nicotine sulfate and soap (10a), or lindane (8a, or 8b, or 8c). If practical, remove and destroy the galls before they open in July.

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 $\frac{7}{8}$ in. 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.



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.

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 tree; thus, single branches or a whole tree can be killed.

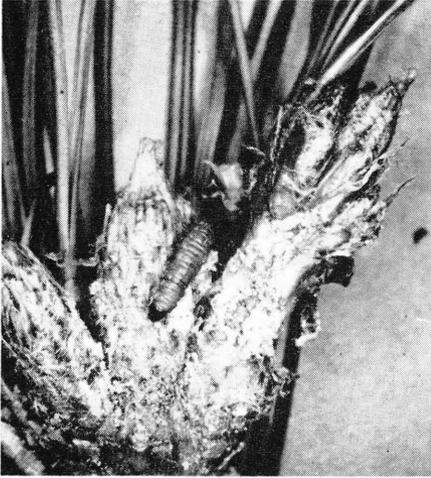
Control: Apply treatments as soon as this sawfly is seen, usually early May to early June. Delayed treatment can result in severely damaged trees. Spray with DDT (4a, or 4c, or 4e, or 4f, or 4h) or with lead arsenate (7a).

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 $\frac{3}{4}$ inch. When first laid, the eggs are small, flat, and yellowish; later, they turn reddish brown. The full-grown caterpillar is about $\frac{5}{8}$ inch long and brownish with black head and thorax.

Life History: Eggs are laid on the surface of needles and twigs near branch tips. The young caterpillar (hatching from an egg) bores first into a needle base. This boring



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.

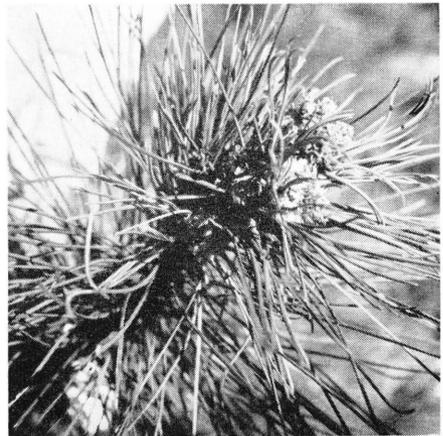
causes a flow of pitch which hardens over the bud, covering up the caterpillar's burrow. Winter is passed as a caterpillar in the bud or under the hardened pitch. In the spring,



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

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.



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

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. When you have severe shoot moth damage or for additional protection, apply DDT (4d or 4b

—4d is best) June 20 and again June 30. (The exact time depends on whether the season is early or late.) See your county agricultural agent for the best time to treat for this insect. Note: You have only about 7 days in which to satisfactorily apply the April spray—the first of these 7 days begins when the caterpillars start moving from overwintering places to new shoots. Delayed treatment is less effective because it does not control the early moving caterpillars.

To date, not enough is known about the use of a mist-blower (airblast sprayer) against European pine shoot moth to make unqualified suggestions for its use. However, for control of this insect with a mist-blower, DDT (4g) at 35 to 50 gallons of spray per acre is the best material to use. Note: DDT Formulation 4g in this bulletin represents a 4X concentrate. (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 8 gallons of 25 per cent DDT emulsion to 100 gallons of water at 35 to 50 gallons of spray per acre. For control of heavy infestations especially in older trees, get special control information.

Read Section IV for information about the use of airplanes 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.

Pruning will aid European shoot moth control. See Michigan State University (Department of Forestry) literature for instructions on how to prune Christmas trees. Burn infested shoots; or the caterpillars can crawl back onto the trees.

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.

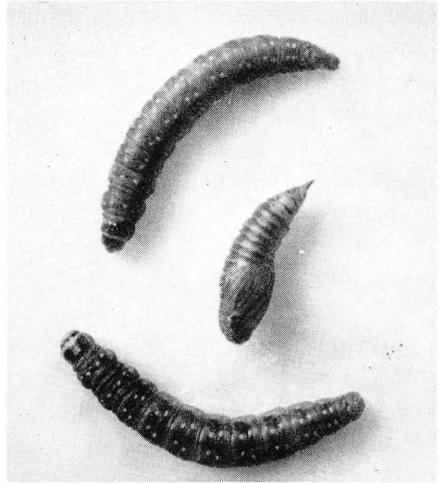
Control: Use aldrin (1a, or 1b, or 1c), or chlordane (3a, or 3b, or 3c), or dieldrin (5a, or 5b, or 5c), or heptachlor (6a, or 6b, or 6c). For good grasshopper control, spray both ground vegetation and trees. **Note:** Grasshoppers often come from areas outside the plantings. When safe, treat these places 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.

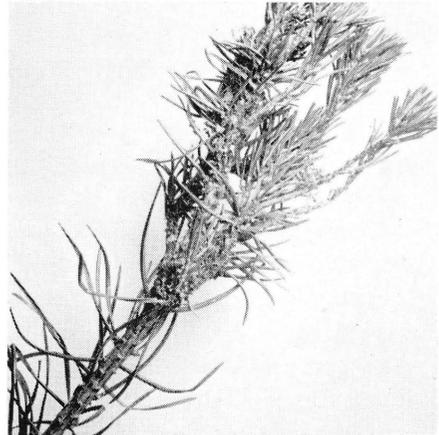
How to Identify: New needles, 1 to 1½ inches long, are chewed off at the base and webbed together. This damage is done by a dark brown or reddish brown worm with a white collar behind the head. When mature, the worm is 1 inch long and has yellowish sides with a shiny black or brown head.

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



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

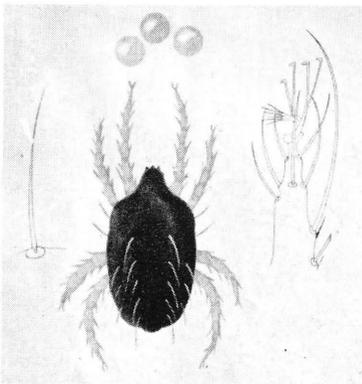
webbed needles look unsightly and the weakened tree is subject to attack by other insects.

Control: Apply treatment in late June when the worms are about 1/2 inch long. Depending on your equipment, use DDT (4a, or 4c, or 4f, or 4h), or lead arsenate (7a).

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: Mite damaged plants are yellowish or bronze in color. Close examination of the needles shows whitish or brownish spots just under the bark. 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.



Common red mite. It is about 1/50 inch long. When mature, mites have 8 legs; insects have 6 legs.

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 or dust (spray is preferred) when first signs of mite damage appear on the plant, usually during July and August. Use ovex (11a or 11b), or Aramite (2a or 2b), or malathion (9a, or 9b, or 9c). Spray needles and branches thoroughly.

PINE NEEDLE SCALE

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

How to Identify: When numer-

ous, 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.



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



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

Life History: The pine root collar weevil passes the winter as an adult in ground litter; the grub passes the winter underneath infested tree bark. Eggs are laid at the base of the tree in pockets chewed by the female. 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

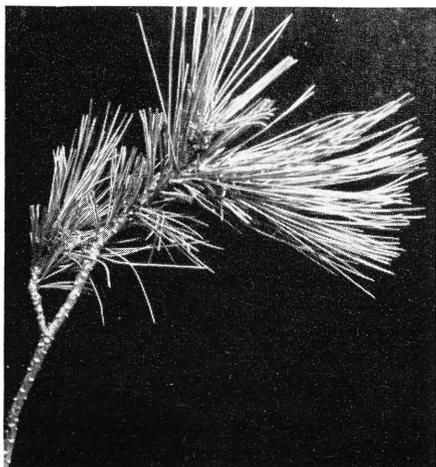
tree from getting proper nourishment.

Control: Avoid planting Scotch pine in pine root collar weevil infested areas. For treating infested trees, use lindane (8a or 8b), or chlordane (3a or 3b). 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:** Seed-bed rotation and clean cultivation of fallow land, for at least 1 year, usually controls this insect.

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 $\frac{1}{2}$ 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) or lead arsenate (7a).

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 foilage and a drought-like appearance. Unless spittle masses are present, the true nature of pine spittlebug damage is hard to tell.

The adult pine spittlebug is boat-shaped, $\frac{3}{8}$ 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



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

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 lindane (8a, or 8b, or 8c) or DDT (4a, or 4c, or 4e, or 4f). For control of



Spittlebug "foam" masses on grass and weeds. Saratoga spittle masses are like these but are found on sweetfern, blackberry, and similar plants. See page 22.

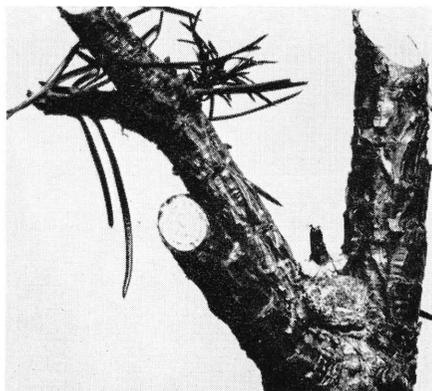
the adults feeding on Christmas trees in July and August, use DDT (4c or 4a).

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

PITCH-BLISTER MOTH

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

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.



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

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

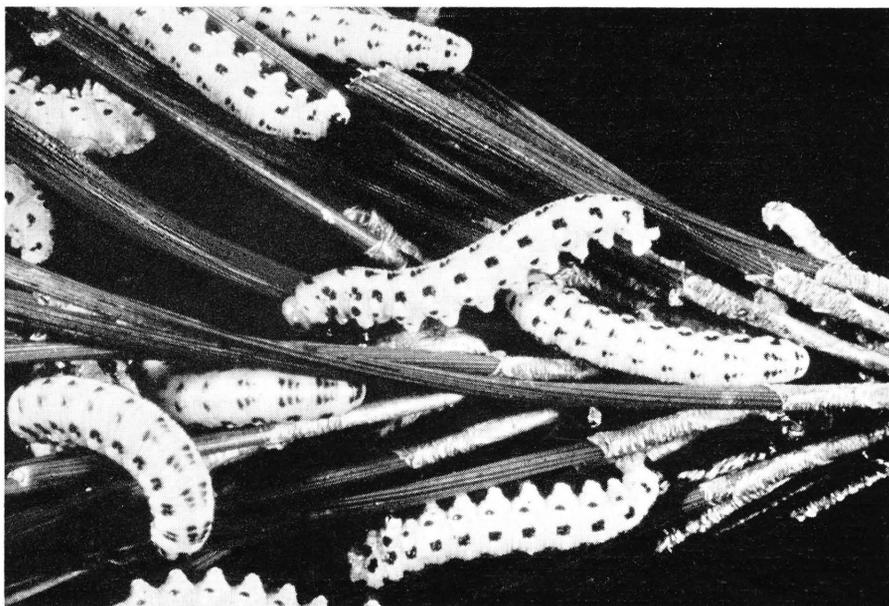
Trees Damaged: The red-headed pine sawfly feeds on jack, red, Austrian, mugho, and Scotch pine plantings, 1 to 15 feet tall.

How to Identify: The very young worm is whitish and unspotted with a brown head; the mature worm is

1 inch long, orange-red headed with 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



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.

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).

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 sweetfern, 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 $\frac{1}{3}$ inch long. The pine-feeding adult is $\frac{3}{8}$ 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.

Type of Injury: The Saratoga spittlebug adult feeds by sucking

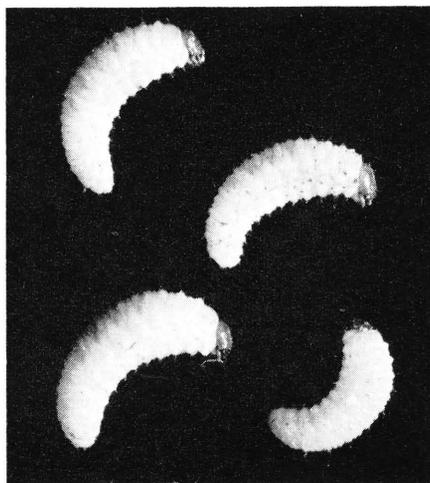
juices usually from pine tops. This feeding causes the foilage to turn yellow in September and brown in the spring. This condition is known as "flagging." When a spittlebug injured twig is shaved with a knife, brown feeding punctures are present in the sapwood.

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.

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



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

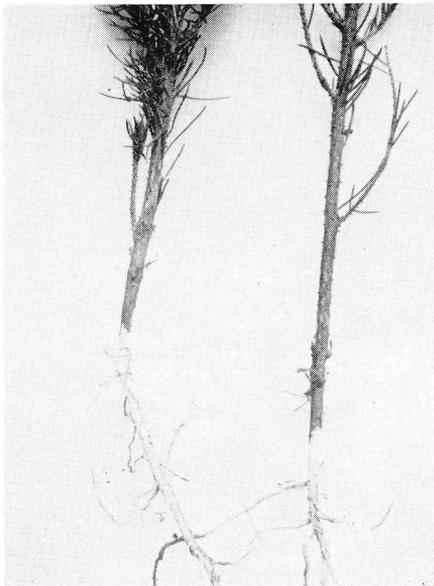
stripped. A small, legless, curve-bodied, cream-white grub with a brown head may be found around the roots until about July 1. The mature grub measures $\frac{1}{2}$ inch.

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

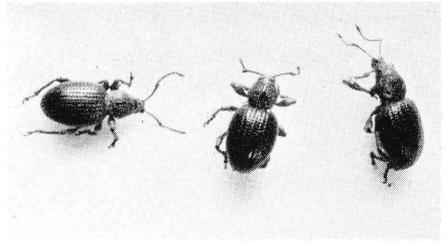
Type of Injury: This insect destroys the tree's fibrous roots; these roots take up soil water. Hence, strawberry root weevil-damaged trees look droughty and stunted.

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

1. When the adult beetles feed



Strawberry root weevil grub damage to pine seedling roots.



Strawberry root weevil adults. They are about $\frac{1}{4}$ inch long. Note the rows of small pits on the wing covers.

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.

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 $\frac{1}{2}$ to $1\frac{1}{2}$ inches.



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

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 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 hep-

tachlor (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.

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 ¼₁₆ 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 or in the bark of damaged leaders.

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



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

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. Tiny glistening drops of resin occur on the bark of the leader, indicating adult feeding or egg laying. By feeding on the inner bark,



White pine weevil grub damage to bark of leader.

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.



White pine leader killed by white pine weevil grubs.

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 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 1-1/3 gallons of 75 percent Aroclor, or 2 1/2 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.

Pruning and burning weevil-damaged leaders 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 prune Christmas trees.

OTHER INSECTS

Besides the 19 insects already listed, several others may or may not damage Michigan Christmas trees. Four of these are:

Pine Tortoise Scale: This scale is chestnut brown, somewhat longer than wide, rounded and $\frac{1}{4}$ inch long. It feeds on branches near the tips of Scotch, Austrian, and jack pine; large amounts of honey-dew are produced. The winter is passed as an immature female under the scale; there is one brood a year.

Control: Apply malathion (9a, 9b, or 9c) or DDT (4a, or 4b, or 4c) when the crawlers are present, usually June 20 and again July 1.

Pine webworm: This caterpillar

infests red, white, and jack pine. When mature, it is $\frac{3}{4}$ 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 feeds only on old needles. The worm is gray-green, black-headed, and when mature, $\frac{3}{4}$ 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 June to early July.

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

Zimmerman Pine Moth:¹ Austrian, Scotch, white and red pines are injured.

How to Identify: Look for wilted terminals and laterals from early to mid-June. A small pinkish worm with black spots occurs inside the shoot. In late June or early July, the worm leaves the shoot and tunnels into the terminal and lateral growth of the first whorl. Occasionally the worm bores into the center of the trunk and mines it for about $1\frac{1}{2}$ feet. Sometimes borings honeycomb the cambium.

¹This information on Zimmerman pine moth is based largely on research by Dr. D. L. Schuder, Assistant Professor of Entomology, Purdue University, Lafayette, Indiana. The authors gratefully acknowledge Dr. Schuder's willingness to make his findings available to Michigan Christmas tree growers through this bulletin.

Life History: Adult moths leave the shoots from mid-July to mid-September. Peak emergence occurs in mid- to late August. Eggs are laid near or on old insect injuries; also, pruning scars are believed to favor egg laying conditions. There is one generation a year.

Type of Injury: Damaged terminals wilt in early or mid-June. Tree tops can die after tunneling occurs in the terminal and lateral growth of the first whorl. Growth below the point of stem burrowing may be seriously retarded.

Control: (1) Remove and burn all "brood" trees (those showing trunk damage). (2) Apply DDT (4b or 4d) about August 20. Use hydraulic equipment.

OTHER TROUBLES

Frost damage: In early spring, young spruce shoots turn white or yellowish - white. The needles on these shoots are crisp and dry.



Frost damage to young spruce shoots.

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. Oil solutions which resemble emulsions in the concentrated form generally do not mix with water and if applied alone could injure trees.

THE INSECTICIDES

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	2½ 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	2½ 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.

WARNINGS:

- Avoid heavy application to tender (young) trees, especially when using aldrin emulsions.
- Use aldrin granules only for soil insects.
- Avoid breathing aldrin sprays or dusts.
- If emulsions, granules, or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- Read the label on the package. Follow the directions.

2. Aramite: This material is a proprietary compound. It is effective against leaf-feeding mites but not against aphids. Aramite can be used with all insecticides and miticides suggested in this bulletin except ovex. Both Aramite and ovex are miticides; therefore, little is gained by using them in the same treatment. Aramite is broken down by sunlight. Hence, in hot, dry weather its effectiveness does not last as long as when the summer weather is moderate. Careful spraying or dusting of the underside of the needles must be done for satisfactory results.

Aramite is sold in two forms. The following table lists these formulations:

No.	Aramite formulations*	Amount per 100 gallons of water	Amount per gallon of water
2a	15 percent wettable powder	2 pounds**	2 tablespoons
2b	3 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR MITE CONTROL. 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.

WARNINGS:

- Avoid breathing Aramite sprays and dusts.
- If spilled on the skin, wash off with soap and water.
- Avoid contact with eyes.
- Read the label on the package. Follow the directions.

3. Chlordane: This insecticide is a chlorinated hydrocarbon similar to aldrin and dieldrin. Chlordane is available in the following three forms for treating tree 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**	1½ 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.

WARNINGS:

- Avoid heavy application to tender (young) trees, especially when using chlordane emulsions.
- Avoid breathing chlordane sprays or dusts.
- If emulsions or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- Read the label on the package. Follow the directions.

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.

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 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. If 2 gallons of oil containing 2 pounds of DDT are applied to an acre, apply 1 gallon along the rows and 1 gallon across the rows. **USE ONLY AS SUGGESTED FOR EACH INSECT. SEE SECTION I.**

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.**

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.

WARNINGS:

- Avoid heavy applications to tender (young) trees, especially when using dieldrin emulsions.
- Use dieldrin granules only for soil insects.
- Avoid breathing dieldrin sprays or dusts.
- If emulsions or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- Read the label on the package. Follow the directions.

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.

WARNINGS:

- Avoid heavy application to tender (young) trees especially when using heptachlor emulsions.
- Avoid breathing heptachlor sprays and dusts.
- If emulsions and concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- **Read the label on the package. Follow the directions.**

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 sug-

gestions 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 Milk	1 quart	2 teaspoons 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.

WARNINGS:

- Use and handle lead arsenate with care, especially the concentrated form.
- If wettable powder or dust is spilled on the skin, wash it off thoroughly.
- When applying this material, avoid breathing the dust or spray.
- Avoid storing lead arsenate where children can be harmed by it.
- **Read the label on the package. Follow the directions.**

8. Lindane: This material is a chlorinated hydrocarbon as is DDT. 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.

WARNINGS:

- Use and handle lindane with care, especially the liquid concentrates.
- If concentrated liquids or powders are spilled on the skin, wash them off thoroughly and immediately.
- When applying this material, avoid breathing the dust or spray.
- People with sinus trouble may find lindane especially annoying.
- Avoid storing this material where children can be harmed by it.
- **Read the label on the package. Follow the directions.**

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 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.

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.

WARNINGS:

- Avoid breathing malathion sprays or dust.
- If emulsions or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.
- **Read the label on the package. Follow the directions.**

10. Nicotine sulfate, 40 percent: This contact spray is used with soap or other alkaline activating agents such as spray lime.

Regular dilutions of **nicotine sulfate** and **soap** are given in the following table:

No.	Ingredients*	Amount per 100 gallons of water	Amount per gallon of water
10a	Nicotine sulfate (40 percent liquid) Soap*	1 pint** 5 pounds	1 teaspoon 1 cubic inch or 1 tablespoon

*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.

Use enough old-fashioned laundry soap to make the water soapy, but don't overdo it. Waters vary as to the amount of soap needed to make them soapy. One-half pound of old-fashioned laundry soap is generally suggested for 25 gallons of water. Dissolve the soap and mix it with the water before adding the nicotine sulfate.

Regular dilutions of **nicotine sulfate** and **summer oils** are given in the following table:

No.	Ingredients*	Amount per 100 gallons of water	Amount per gallon of water
10b	Nicotine sulfate (40 percent liquid) Summer oil*	1 pint** ½ gallon**	1 teaspoon 4 teaspoons

*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.

Summer oils are light, chemically-treated oils of about 70 to 80 viscosity by the Saybolt test. They are sold under trade names ready for dilution with water, and are commonly applied at the rate of ½ to 1 gallon per 100 gallons of spray. A partial list of commercial oils, alphabetically arranged, includes Casco, Medina, Orthol-K, Summer Mulsion, Superla, Verdol, and Volck. They are sometimes used as spreader-stickers with other sprays, usually at the rate of 1 or 2 quarts to 100 gallons of spray. **Many plants will not tolerate oils; however, pines and spruce will tolerate oils if used as directed.** Oils are incompatible with sulfur.

Apply summer oils with nicotine sulfate only when there is a definite suggestion for their use in the tables of this bulletin or after receiving specific directions.

WARNINGS:

- Nicotine sulfate is a dangerous material to handle, especially in the concentrated form. This material can be especially dangerous when used in a mist-blower.
- If this material is spilled on the hands or skin, wash it off **IMMEDIATELY WITH SOAP AND WATER.**
- Nicotine dusts are not generally used on Christmas trees.
- **Read the label on the package. Follow the directions.**

11. Ovex: This material is a long-lasting miticide. It has very little value against insects. Ovex kills both mites and their eggs. **Dogwood, flowering crabs, holly, hardy privet, hawthorn, certain varieties of roses, and barberry are quite sensitive to ovex.** Use it with caution on these plants.

You can buy ovex in two forms for control of mites damaging Christmas trees. The following table lists the formulations:

No.	Ovex formulations*	Amount per 100 gallons of water	Amount per gallon of water
11a	50 percent wettable powder**	1 pound	1 tablespoon
11b	5 percent dust (Use as bought)	.....	.....

*USE ONLY AS SUGGESTED FOR MITE CONTROL. 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.

WARNINGS:

- Avoid inhaling dust or spray mist.
- This miticide may cause skin irritation if it comes in contact with the hands, face, and body.
- If ovex is accidentally spilled on the skin, wash it off immediately and thoroughly with soap and water.
- **Read the label on the package. Follow the directions.**

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 European pine shoot 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 per cent 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. of 25 percent DDT emulsion
2X	2 gal. of 25 percent DDT emulsion
3X	3 gal. of 25 percent DDT emulsion
4X*	4 gal. of 25 percent DDT emulsion
5X	5 gal. of 25 percent DDT emulsion
6X	6 gal. of 25 percent DDT emulsion
7X	7 gal. of 25 percent 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. (In this bulletin, DDT is the only insecticide suggested for airplane application.)

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.

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.

A good reference bulletin is **Controlling Insects and Diseases on Ornamental Trees**, Extension Bulletin E-269 (Third Revision), Bulletin Office, Michigan State University, East Lansing, Michigan.

MICHIGAN POISON CONTROL CENTERS

City	Name of center and street address	Telephone	Name of director
Ann Arbor	Poison Control Center University Hospital 1313 E. Ann Street	Normandy 3-1531	George H. Lowery, M.D.
Detroit	Poison Information Center Registrar's Office Herman Kiefer Hospital 1151 Taylor Avenue	Trinity 2-3334	Paul T. Salchow, M.D. William G. Fredrick, M.D.
Coldwater	Poison Control Center Community Health Center of Branch County 274 E. Chicago Street	296	John Etsweiler
Grand Rapids	Poison Control Center Butterworth Hospital 300 Bostwick N.E.	Glendale 1-3591	Mark W. Dick, M.D.
Grand Rapids	Poison Control Center Blodgett Memorial Hospital 1800 Wealthy S.E.	Glendale 6-5301	John Montgomery, M.D.
Grand Rapids	Poison Control Center St. Mary's Hospital 250 Cherry St., S.E.	Glendale 9-3131	Craig E. Booher, M.D.
Midland	Poison Control Center Midland Hospital 4005 Orchard Drive	TE 5-6771 ³	G. Fred Moench, M.D.
Pontiac	Poison Control Center St. Joseph Mercy Hospital 900 Woodward Avenue	Federal 4-3511	Robert J. Mason, M.D.

INDEX

Warnings	2
Identification Keys	3, 4
Introduction	5
Nomenclature	6, 7
Spray Program	7, 8
Anomala Beetle	9
Aphids	9
Bark Beetles	10
Cooley Spruce Gall Aphid.....	11
Eastern Spruce Gall Aphid.....	12
European Pine Sawfly	13
European Pine Shoot Moth.....	13
Grasshoppers	15
Jack Pine Budworm	16
Mites	17
Pine Needle Scale	17
Pine Root Collar Weevil.....	18
Pine Tube Moth	19
Pine Spittlebug	19
Pitch Blister Moth	20
Red-Headed Pine Sawfly	21
Saratoga Spittlebug	22
Strawberry Root Weevil	22
White Grubs or June Beetles.....	23
White Pine Weevil	24
Other Insects	26
Frost Damage	27
Insecticides: aldrin, Aramite, chlordane, DDT, dieldrin, heptachlor, lead arsenate, lindane, malathion, nicotine sulfate 40 percent, ovex	28-38
Equipment	39-41
Other References	41
Poison Control Centers	42

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