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Michigan State University Extension Service

F. C. Strong, Botany and Plant Pathology; Walter Morofsky, Ray L. Janes, Entomology;

Arthur E. Mitchell, Horticulture

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Controlling
INSECTS AND DISEASES
ON
ORNAMENTAL TREES

Prepared by
Departments of Entomology, Botany and Pathology,
and Horticulture

MICHIGAN STATE UNIVERSITY :: EXTENSION SERVICE
EAST LANSING

Control of Insects and Diseases on Ornamental Trees

By WALTER F. MOROFSKY¹, RAY L. JANES², FORREST C. STRONG³, and ARTHUR E. MITCHELL⁴

This bulletin makes no effort to catalog all the diseases and insects which may affect ornamental trees. Descriptions of the pests and their injuries are as brief as possible. Presentation of treatments is also streamlined. The control methods suggested are those which have been successful with readily available materials and machinery.

Insect and disease control information is by alphabetical arrangement of host plants. Treatment is usually indicated in the description of the pest, with fuller descriptions of the chemicals, dosages, dilutions, mixing, etc., on pages 25 to 38.

Several general considerations in spraying must be kept in mind at all times. The more important are:

1. Do not apply dormant oil sprays when there is danger of the spray freezing before it dries.
2. Do not spray with a summer oil when the temperature is 80° F. or above, or when there are indications that such a condition may develop.
3. Do not apply any spray when the temperature is 85° F. or above. Nicotine and other sprays directed solely at aphids are possible exceptions.

4. Do not apply PDB in cottonseed or vegetable salad oil during the summer months when there is danger of the temperature going above 80° F. for any prolonged period.
5. Be certain to have a perfect emulsion and see that the spray hose does not contain a concentrated dose when you start the application of oil.
6. When you cannot identify the insect or disease, send insect samples to the Entomology Department, and disease samples to the Botany and Plant Pathology Department, Michigan State University.

Many insecticides and fungicides have a tendency to stain wood, painted surfaces, or stone. Consider this when you spray ornamental plantings near buildings, fences and other structures. If a structure is thoroughly wetted before and thoroughly washed down after an application, the damage caused by the stains will be lessened.

NOTE: All insecticides and fungicides are poisonous in varying degrees. Some are very dangerous to use. These materials should be handled 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 and fungicides. State and federal literature also contains valuable information on the use of these chemicals.

¹ Professor of Entomology.

² Associate Professor (Extension) of Entomology.

³ Assistant Professor of Botany and Plant Pathology.

⁴ Professor of Horticulture.

All-Purpose Spray

Occasionally, it is desirable to use several materials in one spray for the attempted control of several insects and diseases on the same ornamental tree. This type of mixture is called an all-purpose spray. While a spray of this type is convenient from the user's standpoint, it does not always give satisfactory control of the insects and diseases affecting ornamental trees. Nurserymen should use the suggested materials as outlined for each ornamental tree in the tables, pages 2 to 24. Householders can usually get reasonable control of insects and diseases by treating four times with an all-purpose spray. Make the first treatment in the middle of May and repeat the first and third weeks of June and the first week of July. But householders will also get best results by following the treatments given in the tables for each ornamental tree. Listed in the following table are the materials to use in an all-purpose spray:

Materials	Amount to 100 gallons of water	Amount to 1 gallon of water
50% DDT wettable powder	2 pounds	2 tablespoons
25% malathion wettable powder	2½ pounds	2½ tablespoons
50% captan* wettable powder	2 pounds	2 tablespoons

*If rusts are a problem, use 1½ pounds of ferbam to 100 gallons of water (1½ tablespoons to 1 gallon) instead of captan.

All-purpose insecticide and fungicide dusts are not generally suited for treating ornamental trees.

Machinery

The insect and disease control you get will not only depend upon the insecticides and fungicides you select **BUT ALSO UPON THE SPRAYER or DUSTER YOU USE.** It is impossible to spray satisfactorily a 50-foot tree with a 3-gallon knapsack sprayer. Small hand

equipment can be used effectively for treating small trees, but power equipment will be needed for medium to large trees.

NOTE: Use oil-resistant spray hose and gaskets when applying dormant or summer oils.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL*
ARBORVITAE (Thuja)	
Lecanium scales	Usually Taxus Lecanium. The female scale is yellowish-brown, soft-bodied, and oval in shape. It is $\frac{1}{16}$ to $\frac{1}{8}$ inch long. The male scales are smaller, flattened, oblong, and almost transparent. Spray with DDT (17) or malathion (14) June 20 and again July 1. For other insects injuring arborvitae, see Cedar.
Twig browning and shedding (Cladoptosis)	Whole twigs throughout tree turn brown and later drop off. Caused by dry soil (drought). Control by watering (32).
BIRCH (Betula)	
Imported birch leaf miner	Blotch mines on terminal leaves of young trees and water sprouts. Two broods, mid-June and late August. Spray with lindane (16) or DDT (17) when blotches first appear.
Bronze birch borer	Trees attacked from top. Spiral ridges on bark of branches and trunks. <i>Maintain vigor of trees.</i> Spray trunks with DDT (17) or lead arsenate (8) in late May or early June with two applications, 14 days apart.
Birch leaf skeletonizer	Skeletonize foliage in late summer. Use DDT (17) or lead arsenate (8). Spray undersides of leaves in late July.
Nectria canker	Catface cankers on branches and trunk. Remove and burn affected branches. Treat larger cankers (34).

*Control measures in these tables are given in code numbers in parentheses. The numbers refer to detailed information under corresponding numbers in the last part of the bulletin.

CATALPA (Catalpa)

Catalpa mealy bug.....	Cottony excretions on bark, axils of twigs, and foliage. Two or three generations. Use malathion (14), two treatments 10 days apart.
Catalpa Sphinx.....	Trees defoliated by greenish or brownish caterpillars, 2¼ inches long. Two broods, one in June and another in August or September. Handpick. Use lead arsenate (8) or DDT (17), preferably when the worms are small.
Leaf spots.....	Mostly circular brown spots. Sanitation (37). Spray with Bordeaux mixture (1) or proprietary copper compounds (2) or organic fungicide (7) three times at 14-day intervals, beginning when leaves start to grow.
Wilt.....	Sudden wilting of leaves, followed by death of affected branches. Cause suspected to be <i>Verticillium</i> sp. Remove affected branches and burn. Fertilize (38) and water tree (32).

**CEDAR, WHITE AND RED
(Chamaecyparis and Juniperus)**

Red spider.....	Also attacks arborvitae, causes foliage to turn gray or bronze, usually in July and August. Spray with ovex (20) or Aramite (19) or malathion (14) or rotenone (13).
Spruce mite.....	Common on Juniper. Bronzed or off-colored foliage. Presence of mites, eggs, and webbing. Use dormant treatment of liquid lime-sulfur (23) before growth starts. Summer treatments in July and August of ovex (20) or malathion (14) or Aramite (19) or rotenone (13).
Aphids.....	Accumulations of honeydew usually accompanied by sooty fungus. Use malathion (14) or nicotine sulfate (11) and soap (30). See section (41) for the removal of sooty mold from foliage.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
CEDAR, WHITE AND RED—Con't. (Chamaecyparis and Juniperus)	
Juniper scale	A circular, grayish-white shield with a yellow center on foliage; attacks Juniper. Spray in early spring before growth starts with liquid lime-sulfur (23) or spray with malathion (14) or DDT (17) June 20, July 1, and again July 10.
Juniper webworm	Needles webbed together, forming a nest 2 to 3 inches long and usually containing small, greenish caterpillars. Spray when larvae are active with lead arsenate (8) or DDT (17). Apply in late April, 10 days later, and again in October. (These sprays are only effective when applied with pressure.)
Rusts	Small, woody galls on twigs of Junipers which develop gelatinous orange horns in April or May. Do not grow red cedar within 500 feet of hawthorn or native flowering apples unless there is a barrier of houses or trees between. Use Acti-dione (4) on Junipers when horns first appear on galls, generally late in April.
Twig blight	Twigs and branches killed back. Prune out and burn affected branches. Spray with Bordeaux mixture (1) or proprietary copper compounds (2) in the spring and summer when new tip growth is developing.
Twig browning (Cladoptosis)	Whole twigs throughout tree turn brown and later drop off. Common white cedar. Caused by dry soil conditions. Control by watering (32).
Winter drying	See Pines.

CHERRY, FLOWERING (Prunus sp.)

San Jose scale.....	Circular grayish shield $\frac{1}{16}$ inch in diameter on trunks and branches. Use dormant lime-sulfur (23) or 3 percent dormant oil (24). In the crawler stage, use two or three applications of malathion (14) at 10-day intervals beginning June 10.
Pear slug.....	Leaves skeletonized by slug-like larvae. Use lead arsenate (8) in the early spring, or spray, when present, with DDT (17) or nicotine sulfate (11) plus soap (30).
Peachtree borer.....	Masses of gum and frass about bases of trees. Remove by hand. Completely spray base of trees from July 15 to August 1 with DDT wettable powder (17), two applications, 10 days apart.
Oriental fruit moth.....	Tender terminal growths mined by larvae. Partial control may be had using DDT (17) before damage is seen. Spray about June 15 and 10 days later.
Tent caterpillar.....	Large tents containing caterpillars formed in axils of branches in early spring. Destroy nests. Use lead arsenate (8) or DDT (17) when caterpillars are young (small).
Flatheaded apple tree borer	Flat, legless grub tunneling under bark, often girdling transplants. Protect trees with crepe paper (36); or paint opening to tunnels with PDB in cottonseed or vegetable salad oil (26); or inject 5 percent DDT fly spray (17a). <i>Maintain vigor of trees</i> (32 and 38).
Leaf spot.....	Circular brown spots which later drop out, leaving holes in leaves. Leaves also turn yellow and drop. Apply four sprays at 14-day intervals, using either proprietary copper compounds (2) or organic fungicides such as ferbam (6) or captan (5) or Acti-dione (4).
Witches' broom.....	Dwarfing and deformation of branches producing small, compact, broomlike growths. Use dormant lime-sulfur spray (23). Cut out and burn brooms.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
CHERRY, FLOWERING (<i>Prunus</i> sp.)—Con't.	
Powdery mildew.....	White moldy growth over leaf surfaces. Sulfur spray (3) will prevent appearance and will check spread after it appears.
CHESTNUT, AMERICAN (<i>Castanea</i>)	
Blight.....	Leaves wilt, turn brown, and remain on branches after cankers have girdled and killed the branches. Trees eventually die. As soon as the disease is definitely identified, cut down the tree and burn the branches and trunk. Debark the stump to prevent sprout growth. Replace with resistant hybrid chestnuts.
CRAB, FLOWERING (<i>Malus</i>)	
Mealy bug.....	See Catalpa.
Roundheaded apple tree borer	Tunnels into trunk near ground level, pushing out quantities of chewings. Two-year life cycle. Adults in early summer. Inject 5 percent DDT fly spray (17a). Paint with PDB in cottonseed or vegetable salad oil (26) in fall or spring.
Flatheaded apple tree borer	Flat, legless grub tunneling under bark, often girdling transplants. Protect trees with crepe paper (36); or paint opening to tunnels with PDB in cottonseed or vegetable salad oil (26); or inject 5 percent DDT fly spray (17a). <i>Maintain vigor of trees</i> (32 and 38).
Aphids.....	Woolly aphids congregating on trunk and limbs. See Cedar.

Oystershell scale.....	Brownish shields resembling minute oystershells on trunk and branches. Use DDT (17) or malathion (14) in late May, June 5, and again June 15, if necessary.
San Jose scale.....	Circular gray shield, $\frac{1}{16}$ inch in diameter, on leaves, trunk and branches. For control, see Cherry.
European red mite.....	Rusty brown foliage and small foliage in midsummer. Reddish pinpoint eggs on bark and smaller twigs in fall and winter. Use malathion (14) or Aramite (19) or ovex (20) during July and August.
Leafhoppers.....	Several species. They remove sap from the leaves, causing a white, stippled appearance, or curl the terminal leaves of the new growth. Use DDT (17) or methoxychlor (18) or malathion (14).
Cankerworms	See Elm.
Tent caterpillar.....	See Cherry.
Tussock moth.....	See Horsechestnut.
Fall webworm.....	See Poplar.
Pear leaf blister mite.....	See Mountain Ash.
Clover mite.....	Reddish eggs on bark and twigs in fall and winter. Enter houses mainly during spring and fall. Seldom a problem on trees in Michigan during summer. For foliage treatment, use malathion (14) or ovex (20) or Aramite (19). To keep these mites from entering the house, use ovex (20) or malathion (14) around shrubs near house and on foundation. Repeat treatments as necessary.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
CRAB, FLOWERING (<i>Malus</i>)—Con't.	
Red-humped caterpillar.	Gregarious caterpillars feeding on foliage in midsummer. Head and hump on fourth abdominal segment bright red, rear of abdomen humped. Handpick; use lead arsenate (8) or DDT (17).
Green aphids.	Several species. Use nicotine sulfate (11) plus soap (30) or malathion (14). Treat when aphids appear.
Red spider.	Infests undersides of leaves, causing off-colored unthrifty appearance. Sometimes mites and eggs present, protected by webbing. Use ovex (20) or Aramite (19) or malathion (14) or rotenone (13). Treatments necessary in midsummer during dry seasons.
Leaf spots.	Brown to blackish spots on leaves. At 10- to 14-day intervals apply three sprays of Bordeaux mixture (1) or proprietary copper compounds (2) or proprietary organic compounds (7). Begin treatments when flower buds are in the pink.
Fire blight.	Sudden withering of new twig growth, flowers blighted, holdover cankers on branches and trunk. Prune off blighted branches 6 inches below visible extension of disease. Sterilize pruning tools after each cut (31). Treat holdover cankers (35).
Crown gall.	Woody galls on roots. Use clean, healthy trees. If galls are removed before planting, dip roots in disinfectant (33).
Rust.	Yellow spots on leaves. Twigs sometimes affected and become swollen. Fruit also may be attacked. Spray with ferbam (6) or Bordeaux mixture (1) or proprietary copper compounds (2) at 7-day intervals, beginning last week of April and continuing to June 1. See Cedar for further information.

ELM (*Ulmus*)

Cankerworm.....	Measuring worms defoliating trees in early spring. Apply lead arsenate (8) or DDT (17) when leaves are a quarter grown.
Elm leaf beetle.....	Bronzed striped beetles $\frac{1}{4}$ inch long, defoliating trees. Two broods; first brood when leaves are one-fourth grown, second about third week in August. Use DDT (17) or lead arsenate (8), 4 pounds with sticker (29) to 100 gallons of water in spring when leaves are a quarter grown and again in midsummer, if present.
Woolly aphid.....	Rolled and distorted leaves containing aphids covered with cottony excretions. Use nicotine sulfate (11) and soap (30) or malathion (14).
European elm scale.....	Softbodied chocolate-brown scales surrounded with a fringe of white wax. On trunks and limbs. One generation each year. Use dormant oil 3-percent (24). For summer sprays, use nicotine sulfate (11) plus soap (30), or malathion (14) when young are crawling in late June or early July.
Elm bark beetles..... (See Dutch elm disease)	Short brood chambers under bark, girdled trunks or limbs. Mature trees attacked. <i>Maintain vigor of trees.</i> Prune out all old and dying branches. Remove dying trees. Spray trunk and limbs of healthy trees with special DDT emulsion in dormant period and again in July. In the July spray, add malathion emulsion (14) for mites. For dosage rates see Dutch elm disease folder F-195.
Gypsy moth.....	Also feeds on many species of trees and shrubs. Hairy, gray worm with blue and red dots on back. Use DDT (17) or lead arsenate (8) when larvae appear in early spring, usually May.
Tussock moth.....	See Horsechestnut.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
ELM (Ulmus)—Con't.	
Leaf spots	Small, brown to black areas on leaves. Sanitation (37). Spray with proprietary copper compounds (2) or organic mercury fungicides (7) three times at 14-day intervals beginning when leaves first start to grow.
Dutch elm disease (See elm bark beetles)	Wilting of leaves, dying of entire branches. Tree dies in short time. This disease can be kept under reasonable control by a continuous sanitation and spraying program. See Michigan State University Extension Folder F-195 for information on its control. For definite diagnosis of the disease: Send pieces 7 inches long and 1/2 to 1 inch in diameter from dying but not dead branches to the D. E. D. & Oak Wilt Laboratory, Botany and Plant Pathology Department, Michigan State University, East Lansing. See also elm bark beetle control.
Phloem necrosis	This disease has not been found as yet in Michigan. Its symptoms are yellowing of leaves and dying of branches. Tree soon dies. Caused by virus. Expert needed to diagnose disease. Notify agricultural agent or Michigan State University of suspected cases.
Wilts: Verticillium and Dothiorella	Similar symptoms to foregoing two diseases. Remove dead and dying branches and burn. Sterilize tools between cuts (31). Fertilize (38) and water (32). For diagnosis, send samples from dying but not dead branches to Botany and Plant Pathology Department, Michigan State University, East Lansing.
Wetwood and slime flux . . .	Continuous or intermittent oozing from wounds or cracks in trunk or branches. The watery material soon becomes foul-smelling and may kill the bark. Wash off external accumulation with water. Place drain pipe in trunk (40) below wound.

HACKBERRY (Celtis)	
Aphids	Aphids infesting leaves. Use nicotine sulfate (11) plus soap (30), or malathion (14) as a dust or spray. For woolly aphid control, see Cedar.
Witches' broom	Deformed terminals often developing broomlike growth. Remove deformities as soon as they appear. Use dormant lime-sulfur (23) before buds begin to grow.
Chlorosis	Leaves become yellowish-green, especially between veins. Have soil tested (39). Usually requires treatment to make it more acid in reaction (39).
HAWTHORN (Crataegus)	
Hawthorn lace bug	Faded foliage with black specks on undersides of leaves. Presence of lace bug $\frac{1}{8}$ inch long. Use nicotine sulfate (11) and soap (30) or malathion (14) or pyrethrum (12).
Roundheaded apple tree borer	See Flowering crab.
Spotted apple tree borer . . .	Work and life history similar to that of roundheaded apple tree borer but actively restricted to limbs and larger branches. See roundheaded apple tree borer under Flowering crab.
Flatheaded apple tree borer	See Flowering crab.
Leaf blight	Small, angular, reddish-brown to black spots. Susceptible trees such as "Paul's Scarlet Thorn" often defoliated by August. Apply three or four sprays of proprietary copper compounds (2) or organic mercury fungicides (7) at 10-day intervals, beginning about July 1. Also practice sanitation (37).

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
HAWTHORN (Crataegus)—Con't.	
Rust.....	Orange spots on leaves. Avoid growing near red cedars and dwarf junipers. See Flowering crab for control.
HICKORY (Carya)	
Hickory bark beetle.....	Vertical galleries about an inch long in the inner bark and sapwood, with smaller tunnels radiating out at right angles. Usually mature trees. <i>Maintain vigor of trees.</i> Remove and burn infested trees before adults emerge. Spray trunks and larger limbs with DDT (17), mid-June and again July 1.
Hickory-gall aphid.....	Globular galls on stems and new shoots. Cause deformed growth. Use DN dormant (22). For treatments after growth starts, use nicotine sulfate (11) plus soap (30) or malathion (14). Spray as soon as aphids appear.
Fall webworm.....	See Poplar.
Tussock moths.....	See Horsechestnut.
Walnut caterpillars.....	See Walnut.
Leaf spots.....	Small to large, circular to angular, dead, brown areas on leaves. Sanitation (37). Spray with Bordeaux mixture (1) three times at 10-day intervals, beginning as soon as leaves start to grow.

HORSECHESTNUT (Aesculus)

Tussock moth	Tussock-bearing (tufts of hair on the back) caterpillars 1½ inches long defoliating trees. Weathered cocoons on trunks or branches in winter. Handpick cocoons fall and winter, or spray with lead arsenate (8) or DDT (17) before caterpillars are ½ inch long.
Leaf blotch	Large irregular brown areas. Sanitation (37). Spray with proprietary copper compounds (2) or wettable sulfur (3) or organic mercury (7) three times at 10-day intervals, beginning when leaves start growth in spring.
Leaf scorch	Browning of tips, edges and between vein areas of the leaves. Water (32). Evidence of soil moisture deficiency.

JUNIPER (Juniperus)

See Cedar.

LINDEN (Tilia)

Aphid	See Maple.
Leaf miner	Mines and skeletonizes leaves of trees in August or early September. Use lindane (16) or DDT (17) in mid-July when first blotches appear.
Sooty mold	See Maple.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
LOCUST, BLACK (Robinia)	
Leaf miner.....	Blisterlike galls or skeletonized leaves in midsummer. Use lindane (16) or DDT (17) as soon as leaves develop full size.
Silver-spotted skipper....	Leaflets fastened together forming a nest. Use lead arsenate (8) or DDT (17) before nest has formed. Handpick.
Locust borer.....	Accumulation of sawdust on trunk and about base of tree in June and July. Spray trunk with DDT (17) when goldenrod is in full bloom, or inject PDB in cottonseed or vegetable salad oil (26) into the tunnel openings in May. <i>Maintain vigor of trees</i> (32 and 38).
MAPLE (Acer)	
Bladder gall.....	Small globular galls on upper surface of leaves. Responds to dormant lime-sulfur (23) or malathion (14) treatment applied in April before buds break.
Flatheaded apple tree borer	Flat, legless, flatheaded grub excavating cavities under bark, often girdling young trees. To prevent borers, wrap trunk with crepe paper impregnated with asphalt (36). To kill borers in trunk, inject 5 percent DDT in oil (17a) into the tunnels. <i>Maintain vigor of trees</i> (32 and 38).
Sugar maple borer.....	Dead limbs among leafy branches. Mutilation of trunks and larger limbs. Check spring and summer for borers; spray with DDT (17) when the borer adults are flying, usually the first part of July.

Aphids	Small greenish aphids on undersides of the leaves of Norway maples. Dripping of leaves and accumulation of honeydew. Wash with water under pressure. Spray as for aphids on Flowering crab.
Cottony maple scale	Cottony masses protruding from brown scales on twigs in June. Use dormant lime-sulfur (23). Treat with malathion (14) June 20 to July 10 when the crawlers are moving about. Repeat treatment at 10-day intervals. Note: These suggestions work best on individual trees. For maples on parkways and in parks, spraying may do more harm than good by killing off the parasites which kill the aphids.
Tar spot	Black, tarlike spots on leaves. Sanitation (37). Spray with proprietary copper compounds (2) or wettable sulfur (3) or organic mercury (7) three times at 10-day intervals beginning when leaves start to grow.
Leaf spots	Brown spots or blotches on leaf surfaces, sometimes on veins. Spray as for tar spot.
Leaf scorch	Brown, dead areas along edges of leaves and between the veins. Evidence of soil moisture deficiency. Water (32).
Wilt (Verticillium)	Leaves wilt, curl and dry. Whole branches die. Branches killed in the winter become evident in the spring. Remove and burn dead and dying branches. Fertilize (38) and water (32) affected trees.
Sooty mold	Black, sooty mold covering leaves and sometimes twigs and branches. Follows aphid attacks. Control aphids (see Flowering crab). Remove sooty mold (41).

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
MOUNTAIN ASH (Sorbus)	
San Jose scale	See Cherry.
Pear leaf blister mite	Brownish blisters on undersides of leaves. Defoliates trees. Use dormant lime-sulfur (23) or spray with Aramite (19) or ovex (20) in the spring as leaves develop or in the fall when the first cool days arrive.
Shot-hole borer	Galleries under bark, often girdling trunks, limbs, or twigs. Beetles emerge through holes in bark. <i>Maintain vigor of trees</i> (32 and 38). Remove and burn infested trees, and spray trunks June 10 and 20 and again August 20 with 6 pounds of 50 percent wettable DDT (17) or 3 pounds of 25 percent wettable lindane (16) to 100 gallons.
Fire blight	Sudden dying back of growing tips. Cracked bark on larger branches and trunk are holdover cankers. Cut out blighted branches at least a foot below diseased parts and burn. Sterilize pruning tools between cuts (31). Treat holdover cankers (35).
Canker	Sunken oval areas on branches and trunk. Stems girdled, killing parts above. Cut off affected branches below cankered areas and burn. If the disease is on the trunk, treat (34).
Rust	Orange spots on leaves. Avoid growing near red cedars and dwarf junipers. See Flowering crab for control.
OAK (Quercus)	
Twig pruner	Small, clean-cut twigs on ground in midsummer, or dead twigs clinging to tree. Collect and burn fallen twigs.

June beetles.....	During the spring trees are defoliated at night by brown beetles. Use lead arsenate (8) or DDT (17) when beetles first appear (the preferred time to treat) or just before leaves become full grown.
Flatheaded apple tree borer	See Maple.
Red-humped caterpillar....	See Flowering crab.
Oak galls.....	Many conspicuous galls on leaves. Many kinds made by different insects. Usually unimportant. Galls on branches and twigs important. Prune and burn. Spray with 6 pounds of 50 percent wettable DDT powder (17) to 100 gallons of water the last week of March or when growth starts if it is not freezing, and again 10 days later.
Leaf miners.....	Several species. Remove fallen leaves in fall (37). Spray with lindane (16) or DDT (17) in spring before growth starts.
Fall webworm.....	See Poplar.
Leaf blight.....	Brown areas at leaf tips and on veins. Twigs killed back occasionally. Appears in spring and early summer. Sanitation (37). Spray with wettable sulfur (3) or organic mercury (7), three times at 10-day intervals, beginning when leaves start to grow.
Oak wilt.....	Leaves turn pale, hang down, become dry and straw colored. Heavy leaf fall may occur. Trees of the red oak type die quickly. Trees of the white oak type may live 2 or 3 years. Trenching and cutting roots between diseased and adjacent healthy oaks advised for shade trees before cutting down and removing. Report dying of oak trees to City Forester, District Forester or County Agricultural Agent before attempting control.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
OAK (<i>Quercus</i>)—Con't.	
Leaf scorch	Brown areas along edges and between veins of leaves. Dry soil conditions. Water (32).
Leaf yellowing (chlorosis) . .	Yellowish-green coloration of leaves especially between veins. Have soil tested. If soil is alkaline, treat (39).
PINE (<i>Pinus</i>)	
Sawflies	Several species. Larvae bunch together in groups. Defoliate trees in early spring and midsummer. Use lead arsenate (8) or DDT (17) or rotenone (13) when larvae are present. As a preventive measure, lead arsenate or DDT may be used before growth of needles starts.
European pine shoot moth.	Terminals tunneled by larvae in late spring deforming trees and producing characteristic stag-horn growth. Spray shoots with DDT (17) last week in June and 10 days later.
Pine bark beetle	Short brood chambers with numerous larval galleries under bark. Adults emerge through holes in the bark. <i>Maintain vigor of tree.</i> See Shot-hole borer under Mountain Ash.
Pine needle scale	Elongated white shield scales on foliage. Off-color foliage. Growth stunted. Use liquid lime-sulfur (23) in early spring before growth starts or malathion (14) or DDT (17) in late May or early June and again in July. Repeat with malathion or DDT in 10 days. In summer, use liquid soap (30) plus nicotine sulfate (11).

Pine bark aphid.....	White cottony masses on bark, trunk or limbs. Use nicotine sulfate (11), 2 pints in 100 gallons of soapy water (30) in early spring. If aphids persist into summer, use malathion (14) or DDT (17) or nicotine sulfate (11) in soapy water (30).
Spittle bug.....	Masses of froth or spittle on twigs in early spring. Spray into froth with lindane (16) or DDT (17) or rotenone (13).
White-pine weevil.....	Prefers white pine; also damages jack, red, and Scotch pine and Norway spruce 4 to 15 feet tall. First evidence of damage: tiny glistening drops of resin on the bark, indicating weevil feeding or egg laying. Feeding larvae girdle the terminal which withers, bends over and dies. Adult emergence holes apparent in year-old growth. Spray terminal shoots in spring when the adults appear, usually in late April. Use 3 pounds of 50 percent wettable DDT powder (17) or 4 pounds of lead arsenate (8) plus a sticker (29), to 100 gallons of water. Remove and burn tips well below dead part (at least to second whorl in late July).
Blister rust.....	WHITE PINE ONLY. Cankers on branches and trunk. Stems girdled, eventually killing the tree. Do not grow white pine within 900 feet of currants or gooseberries, nor within 1 mile of black currants. Contact White Pine Blister Rust Control Office, Lansing, Michigan, for information.
Needle scorch.....	ALL PINES. Terminal half or more of needles turn yellow, then brown. Drought conditions in summer or, sometimes, in spring. Severe drought injury resembles winter drying. Water (32) in summer and also in autumn before soil freezes.
Winter drying.....	ALL CONIFERS. Foliage turns brown in March or April. Trees during first few years after planting often suffer when planted in exposed or in sunny, sheltered locations if their root systems do not extend below the frost line. Soak soil with water before ground freezes in autumn. Mulching reduces depth to which frost penetrates. Use only old, well-rotted mulch.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
PINE (Pinus)—Con't.	
Needle rust	RED PINE. Tiny, pale yellow blisters on needles in June. This disease may stunt young pine. Disease also affects goldenrod and wild aster. Control not considered necessary.
Twig blight	AUSTRIAN, SCOTCH, MUGHO PINES. Twigs killed back at tip and turn brown. Prune off diseased tips. Spray with proprietary copper compounds (2) at 10-day intervals in spring while new growth is developing.
POPLAR (Populus)	
Mottled willow borer	See Willow.
Poplar sawfly	Orange-yellowish larvae with black spots. They group together in bunches. There are two broods. Defoliate trees. Use lead arsenate (8) before larvae appear. Apply contact sprays or dusts such as DDT (17) or malathion (14) or rotenone (13) when larvae are present.
Fall webworm	Hairy caterpillars feeding together within webs. Nests terminal in midsummer. Trim out nests while small. Spray lead arsenate (8) or DDT (17) into nests.
Oystershell scale	Brownish shields resembling minute oystershells on trunk and branches. Use DDT (17) or malathion (14). Apply in late May, June 5, and again June 15, if necessary.
Leaf spots	Small, brown areas on leaves. Sanitation (37). Sprays usually not considered necessary.

Cankers	Dead oval area on branches and trunk, sunken or with cracks at margins. Branches die. Tree becomes scraggy in appearance. Spraying with lime-sulfur (23) aids in checking spread of disease. Almost useless to attempt cutting out cankers.
Wetwood wilt	Wilting of leaves and dying of branches. Tree soon dies. No known control. Remove and burn tree to avoid spread of disease.

SPRUCE (*Picea*)

Spruce mite	Foliage grayish or with bronzed cast. Spray with malathion (14) or ovex (20) or Aramite (19) or rotenone (13) during July and August.
Eastern spruce gall aphid	Pineapple-shaped galls at the bases of new growths on Norway, white, black and red spruce. Adults late July or August. Use malathion (14) or nicotine sulfate (11) and soap (30), or lindane (16) when aphids appear on the foliage, usually in late April or May. Remove and destroy the galls in July before they open.
Cooley spruce gall aphid	Curve-shaped galls similar to Eastern spruce gall aphid but longer and less compact. Cooley spruce gall aphid infests Colorado blue spruce, Sitka and Englemann spruce. Life history is complicated. Only present when Douglas fir is grown near susceptible spruces. Spray spruce trees in late April or early May as for Eastern spruce gall aphid. Spray Douglas fir with the same materials when aphids are present.
Spruce tortrix	Nests made by several needles matted together on lower inside branches. They contain larvae and pupae. (See juniper webworm under Cedar.)
Spruce sawfly	Masses of dark green larvae with dark, longitudinal stripes. Defoliate trees. (See pine sawflies.)

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
SPRUCE (Picea)—Con't.	
Spruce budworm.....	Terminal nests of several leaves, giving a reddish or brownish cast. Spray with DDT (17) to cover terminal growth early in spring when new growth starts. Repeat in 10 days.
Canker.....	Lower branches die back. White gummy deposits common on branches. Prune out affected branches when bark is dry and burn.
SYCAMORE (Platanus)	
Lace bug.....	Tiny insects with lacelike wings and sucking mouthparts feeding on undersides of leaves. Use nicotine sulfate (11), 2 pints to 100 gallons of water, plus soap (30) or malathion (14). Spray in midsummer.
Tussock moth.....	See Horsechestnut.
Leaf and twig blight.....	Large, brown, dead areas along veins. Leaves fall. Twigs killed in spring and leaves shrivel, appearing as if frost-killed. Sanitation (37). Spray with organic mercury (7) or proprietary copper compounds (2) three times at 10-day intervals beginning when leaves start. Prune out affected branches in young trees.
WALNUT (Juglans)	
Caterpillars.....	Trees defoliated in August or September by gregarious, nest-building hairy caterpillars. Trim out nests when small. Spray with lead arsenate (8) or DDT (17) in July or early August.

Leaf spot.....	Small circular to angular brown, dead areas on leaves. Abundant late in season. Common cause of early autumnal defoliation. Spray with proprietary copper compounds (2) or organic mercury (7) three times at 10-day intervals, beginning when leaves start to grow. Sanitation (37).
Canker.....	Small to large oval sunken areas with callus-ridge border on big branches and main stem. Often open wounds from rotting of exposed wood. Remove affected branches and treat cankers on main trunk (34).

WILLOW (Salix)

Spotted leaf beetle.....	Reddish black-spotted beetles about 1/4-inch long defoliating trees in midsummer. Use lead arsenate (8) or DDT (17) when larvae first appear.
Tent caterpillar.....	See Cherry.
Mottled willow borer.....	Swollen galls and knotty growths on limbs and branches splitting bark. Adults in July and August. Completely spray trunk and limbs with 6 pounds of 50 percent wettable DDT powder (17) or 3 pounds of 25 percent wettable lindane powder (16) to 100 gallons of water as soon as adults appear.
Cone gall.....	Terminal grayish-brown cone-shaped galls about 1 inch long. No control required. However, pruning out the galls may help to improve the looks of the tree. Burn the removed galls.
Oystershell scale.....	See Poplar.
Poplar sawfly.....	See Poplar.



INSECTS AND DISEASES

CHARACTERISTICS AND CONTROL

WILLOW (*Salix*)—Con't.

Aphid.....	Quantities of honeydew dripping from tree from July to late summer. Presence of large, black aphids. Use malathion (14) or lindane (16) or nicotine sulfate (11) and soap (30).
Fall webworm.....	See Poplar.
Willow scab.....	Leaf and twig blight. May appear in this state and will cause considerable injury. Spray with Bordeaux mixture (1) or proprietary copper compounds (2) three times at 10-day intervals, beginning when leaves first start to grow.
Canker.....	Oval sunken areas on branches and main stem. May girdle and kill branches or stem. Treat cankers on trunk (34).
Crown gall.....	Woody galls on branches as well as roots. Remove and burn young trees. Older trees may survive an attack of the disease without being greatly injured.
Rust.....	Tiny orange and black raised spots on leaves. Occurs late in growing season. Control not necessary.

Spraying and Dusting Materials*

Spraying and dusting materials can be divided into three groups according to the purposes for which they are used: (A) Fungicides, materials for control of diseases; (B) insecticides, materials for control of insects; (C) accessory materials used as disinfectants, spreaders, stickers, wetting agents, and correctives.

The information given in this section of the bulletin on spraying materials normally indicates the amount (dosage) of chemical used to 1 or 100 gallons of water. However, if you are interested in quantities of sprays other than those listed, use the following table:

Water	Quantities of materials**		
100 gallons.....	1 pound	2 pounds	3 pounds
50 gallons.....	½ pound	1 pound	1½ pounds
25 gallons.....	¼ pound	½ pound	¾ pound
10 gallons.....	10 tbsp.	¼ pound	6 ounces
5 gallons.....	5 tbsp.	10 tbsp.	15 tbsp.
1 gallon.....	1 tbsp.	2 tbsp.	3 tbsp.

**See the writeups on the various insecticides and fungicides for the correct amount of chemical to use to 100 gallons of water.

FUNGICIDES

In general, spraying materials for control of diseases contain either copper, sulfur, or recently developed or-

*Control measures throughout the preceding portion of this bulletin are given code numbers in parentheses. These numbers refer to corresponding numbers on this and following pages.

ganic fungicidal chemicals. Dusts are not normally used for control of shade tree diseases.

1. Bordeaux mixture: This is still one of the most effective and longlasting of the fungicides. However, it discolors foliage whitish-blue and is generally undesirable on ornamental trees. If one wishes to use it, directions for preparation of a 8-12-100 Bordeaux mixture are as follows:

1. Add 65 gallons of water to spray tank.
2. Keep water well stirred or agitated while mixing the chemicals.
3. Add slowly 8 pounds of the powdered or snow form of copper sulfate.
4. For 100-gallon quantities, make a thin paste of 12 pounds of fresh spray lime or fresh hydrated-lime, then add to the water in the tank.
5. Fill tank to 100-gallon mark.
6. Apply at once, keeping mixture agitated constantly.

NOTE: If 50 gallons of Bordeaux mixture are desired, use one-half the amount given for 100 gallons.

See Section 2 for further information on copper fungicides.

2. Proprietary copper compounds: These are manufactured proprietary copper fungicides, containing copper in a form (low solubility) that generally does not injure foliage. They last a shorter period of time than Bordeaux mixture. Some of the trade names of these proprietary copper compounds are: Basi-Cop, Cupro-K, Compound A, Oxobordeaux, Spray Cop, Tennessee 26, Tennessee 34, Cop-O-Zinc, Crag 658, and C-O-C-S.

These materials contain different amounts of copper and must be used according to the manufacturer's directions on the package.

3. Wettable sulfurs: Wettable sulfurs contain finely divided particles of elemental sulfur to which a wetting agent has been added. Wettable sulfurs are sold under various trade names. A partial list of these sulfurs includes: Dritomic, Flotox, Kolofog, Magnetic 95, Mike, Sulfix, and Sulforon. They vary in sulfur content and particle size. The products containing the largest amount of sulfur and the smallest sized particles are the most effective. In general, use 5 to 8 pounds of wettable sulfur to 100 gallons of water. The amount used will depend upon the sulfur product you buy.

Wettable sulfurs are protective fungicides and the plants must be kept covered during infection periods (rainy or wet weather). If sulfur is applied when the temperature is above 85° F., foliage injury may occur.

Organic fungicides. Within the past few years, organic fungicides have become available for control of certain diseases of ornamental trees. They are:

4. Acti-dione: This is a proprietary antibiotic chemical which prevents the development in the spring of the gelatinous horns of the red cedar-apple rust fungus on the galls of the red cedar. It is applied to red cedar trees at the rate of 1 gram to 2½ gallons of water when the horns on the galls are about 1/16 inch long and BEFORE they have become gelatinized and swelled. The time of application is usually during the last week of April in southern Michigan.

Acti-dione is packaged in tablet form. One 380 milligram tablet in 1 gallon of water is equal to 1 gram to 2½ gallons of water. These amounts are equivalent to 100 parts per million.

5. Captan: This material is a new organic fungicide. It normally does not injure ornamental trees when used according to directions. Captan is safe enough to use providing the mists are not breathed. Careless contact with the skin may cause irritation.

Use 2 pounds of a 50 percent wettable captan powder to 100 gallons of water. It may be mixed in the spray tank with most insecticides. It should not, however, be used with alkaline materials such as Bordeaux and lead arsenate.

6. Ferbam: This organic fungicide has one drawback; it is black in color. When applied to the foliage of ornamental trees, it leaves a dark deposit which you may find objectionable. Otherwise it is an effective fungicide. Normally, it does not injure trees when used accord-

ing to directions. Ferbam is a relatively nonpoisonous material, but the mists should not be breathed or allowed to come in prolonged contact with the skin.

Use 2 pounds of a 76 percent wettable ferbam powder to 100 gallons of water for most leaf diseases.

It is especially effective for control of rust on flowering apple and hawthorn. For this purpose, use 1½ pounds of 76 percent wettable ferbam powder or ½ pound of ferbam plus 3 pounds of wettable sulfur to 100 gallons of water.

Ferbam may be safely used with most insecticides. However, do not mix it with lime, copper or mercury compounds.

7. Organic mercury compounds: There are several organic mercury compounds that may be used on ornamental trees for control of leaf diseases. These materials may be purchased by trade names such as Puratized Agricultural Spray, Phix, and Tag 331. They are colorless when mixed with water for spraying and can be used throughout the growing season. Organic mercury compounds are very poisonous. The concentrated liquid and wettable powders should not be spilled on the skin, in the eyes, or breathed. Care should also be taken when applying sprays to trees.

Use 1 pint of the 7.5 percent Puratized Agricultural Spray or 1 pint of 10 percent Tag 331 to 100 gallons of water. Phix, 22 percent strength, is used at the rate of ¼ pound to 100 gallons of water. These materials

should not be used when the temperature is above 90 degrees Fahrenheit. Do not use them after applications of ferbam.

INSECTICIDES

Materials used to control insects can be divided into three groups: (a) Stomach poisons—those used to control leaf-eating pests such as caterpillars, beetles, and slugs; (b) contact insecticides—those used to control sucking pests such as mites, aphids, and leafhoppers; and (c) fumigants—materials which control insects by giving off poisonous gases.

NOTE: All insecticides are poisonous in varying degrees to man. Therefore, they should be handled carefully so that they will not poison livestock, children or the user. Read the label carefully on the package for instructions on how to use insecticides. State and federal literature also contains valuable information on how to use insecticides properly.

STOMACH POISONS

Stomach poisons in general use today contain arsenic, fluorine, or rotenone.

NOTE: Lead arsenate, calcium arsenate and cryolite are effective only against chewing-type insects. Rotenone may be used for control of either chewing or sucking type insects.

8. Lead arsenate: Lead arsenate 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. It is compatible with fungicides, contact insecticides, and many stickers, spreaders and wetting agents. 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 the following table:

Ingredients	Amount to 100 gallons of water	Amount to 1 gallon of water
Lead arsenate (100% wettable powder).....	3 pounds	3 tablespoons
Summer oil.....	1 quart	
Milk.....		½ cup

Calcium arsenate may be substituted for lead arsenate as a stomach poison but is not so desirable because of the danger of arsenical injury to plants.

9. Fluorine compounds: Fluorine compounds are sold under various trade names. Cryolite is the most prevalent form of the fluoride compounds. It is not used to any extent on ornamental trees.

10. Rotenone: Rotenone is a compound contained in the roots of derris and cube as well as other similar tropical plants belonging to the pea (pulse) family. It can be used both as a stomach poison and as a contact insecticide. It may be purchased as a powder or as a liquid formulation for spraying. Rotenone is also available in dust preparations. There are a number of proprietary rotenone-containing materials on the market. Rotenone is comparatively nonpoisonous to warm-blooded animals. For further information on this material and for the amounts to use in sprays and dusts, see rotenone (13) under contact insecticides.

CONTACT INSECTICIDES

11. 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:

Ingredients	Amount to 100 gallons of water	Amount to 1 gallon of water
Nicotine sulfate (40% liquid).....	1 pint	1 teaspoon
Soap*.....	5 pounds*	1 cubic inch or 1 tablespoon

*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. For further instructions on how to use soaps, read Section 30.

Regular dilutions of nicotine sulfate and summer oils (21) are given in the following table:

Ingredients	Amount to 100 gallons of water	Amount to 1 gallon of water
Nicotine sulfate (40% liquid).....	1 pint	1 teaspoon
Summer oil*.....	½ gallon	4 teaspoons

*For further instructions on how to use summer oils, read Section 21.

11a. A special nicotine spray may be used for summer control of various scales on cedars and pines. Use nicotine sulfate 40 percent (11), 2 tablespoons and liquid soap (30), 1 quart to 10 gallons of water.

11b. Fixed nicotine and 50 percent wettable DDT powder, 3 pounds of each to 100 gallons of water, is an effective spray against many hard-to-kill insects. An equally effective factory-processed fixed nicotine-DDT product is available in some areas.

NOTE: Nicotine sulfate is a dangerous material to handle, especially in the concentrated form. If this material is spilled on the hands or skin, wash it off **IMMEDIATELY** with soap and water. Dusts of nicotine are not generally used on ornamental trees.

12. Pyrethrum: Pyrethrum is a product prepared largely from the flower heads of certain plants of the

Chrysanthemum family. It can be used to control aphids, leafhoppers and many other insects.

Pyrethrum is effective as a spray or dust in the forms given in the following table:

Pyrethrum formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
1% liquid concentrate....	1 pint	1 teaspoon
1/10 of 1% dusts** (use as purchased).....		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.
**Pyrethrum dusts may be purchased also in fifteen-hundredths (0.15) or two-tenths (0.2) percent strengths. For hard-to-control insects such as aphids, these stronger dusts are advisable.

NOTE: Pyrethrum deteriorates rapidly once it is applied to plants. Therefore, care should be taken to apply it directly to the insects being controlled. Pyrethrum is comparatively harmless to warm-blooded animals. People suffering from asthma may find this material annoying.

13. Rotenone: Rotenone-containing sprays are suggested for the control of mites, thrips, aphids, other soft-bodied insects and numerous worms and some beetles. To be really effective, rotenone should be applied directly to the insects and mites being controlled. Its one important weakness is that it does not remain effective very long—about 1 to 4 days depending on the weather and how difficult the insects are to control. Temperatures below 70° and above 95° F. reduce the effectiveness of

this material. Rotenone is not too dangerous to handle for it is relatively nonpoisonous to man.

Rotenone may be purchased in three forms for use on trees. However, rotenone liquid sprays are not as effective as the wettable powders or dusts. The following table lists the common rotenone formulations:

Rotenone formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
4% wettable powder**...	3¾ pounds	4 tablespoons
5% wettable powder**...	3 pounds	3 tablespoons
1% liquid concentrate....	1 pint	1 teaspoon
¾ or 1% dust (use as purchased).....

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

**If rotenone wettable powders do not produce foaming of the water when mixed with it, add a commercial or mild soap wetting agent. Use only enough wetting agent to produce a slight foaming of the water. See Sections 29 and 30 for further details on this problem.

To prepare a rotenone-containing spray:

1. Add about two-thirds of the amount of water to be used to the spray tank.
2. Make the powder into a thin paste with water and add to the water in the tank.
3. Add wetting agent, if needed, to the rotenone-water mixture until it foams slightly.
4. Add water to make the required amount of spray. Keep well agitated. Two or more applications

should be made at 10-day intervals for most insects.

For further information on rotenone, see the section (10) about this material under stomach poisons.

14. 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 IS EITHER 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 has been 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 a great deal on the type of spraying or dusting equipment you have. For the most part, however, sprays tend to be better than dusts for treating ornamental trees. Malathion is available in three different formulations, as given in the following table:

Malathion formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
25% wettable powder....	2½ pounds	3 tablespoons
50% emulsion.....	2 pints	2 teaspoons
5% dust (use as purchased).....

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

As with all insecticides, malathion should be applied carefully to the insects or mites being controlled.

15. Parathion: In most respects, parathion is a better insect and mite control material than is malathion. However, parathion is a dangerous material to handle in the concentrated form (emulsions and wettable powders) and when it is being applied to plants in any form. Because of this, it is not generally suited for use by homeowners. **Nurserymen and other large-scale growers of trees may find it useful for insect control, PROVIDING THEY HAVE THE EQUIPMENT AND THE KNOWLEDGE OF HOW TO USE PARATHION SAFELY.** Read the label for definite instructions.

Parathion comes in three forms: (1) Powders for dusting; (2) wettable powders for spraying, and; (3) emulsions for spraying. However, because of the danger of using parathion emulsions, **we are suggesting that you use only a dust or a wettable powder spray of this material.** The following table lists the dust and wettable powdered formulations of parathion:

Parathion formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
15% wettable powder . . .	1 pound	1 tablespoon
1 or 2% dusts (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

The wettable powder sprays of parathion are more suited for treating ornamental trees than are the dusts.

16. 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 ornamental trees. As with all insecticides, lindane should be used and handled with care, especially the liquid concentrates. If concentrated liquids and 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 this material particularly annoying. Avoid storing this material where children can be harmed by it.

Lindane can be purchased in three forms for use on trees. The following table lists the common lindane formulations:

Lindane formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
25% wettable powder . . .	1½ pounds	1½ tablespoons
20% emulsion	1 pint	1 teaspoon
1% dust (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

A lindane emulsion spray is especially desirable for control of all kinds of leaf miners on shade and ornamental trees.



17. DDT: DDT is effective against a wide range of insects. It is particularly effective against leafhoppers, small beetles, caterpillars and bugs. DDT is a specific; it kills some aphids, others are unaffected. Certain leaf-rolling caterpillars are also unaffected. In the absence of knowledge as to the identity of an insect, DDT will sometimes give control, other times it will not.

DDT is a waxy substance and must be formulated correctly for use. Remember that DDT is not always a quick killer like pyrethrum or nicotine. Wettable powders are the safest form for foliage application. DDT is not compatible with lime-sulfur and alkalies, but may be used with Bordeaux, usually at increased dosages.

DDT may be purchased in four different forms for use on ornamental trees. The table in the next column list these DDT formulations.

Special DDT preparations are sometimes needed for control of certain insects. Two of these and their use are as follows:

17a. DDT 5 percent in oil solution (usually kerosene) is suggested for treating certain borers by injecting it into the holes made by the insects. A mechanic's oilcan is a convenient applicator.

NOTE: DDT oil sprays are too injurious to foliage for general application to trees.

17b. DDT 50 percent wettable powder and fixed nicotine (11b) makes a most effective combination. The

DDT formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
50% wettable powder	3 pounds	3 tablespoons
75% wettable powder	2 pounds	2 tablespoons
25% emulsion**	1½ pints	1½ teaspoons
5% dust*** (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

**When there is any question about spray injury to the trees, use DDT wettable powder instead of the emulsion.

***DDT dusts are not used generally for control of insects on ornamental trees. However, if you have the right kind of equipment for applying them, dusts are especially satisfactory for control of leaf-feeding insects.

nicotine gives a quick kill. The DDT in the combination is residual and the killing effect is prolonged by its presence. The fixed nicotine-DDT combination is especially good against insects feeding inside webbing. Three pounds of 50 percent wettable DDT powder and 3 pounds of fixed nicotine to 100 gallons of water make an effective and longlasting combination.

18. Methoxychlor: This material is closely related to DDT. As a general purpose insecticide, it is not as good as DDT. However, for certain insects as listed in the control sections, it is a good material to use. Generally, methoxychlor is safer to use at the time of application than DDT and many other similar insecticides.

Methoxychlor may be purchased in three forms for use on trees. The following table lists the common methoxychlor formulations:

Methoxychlor formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
50% wettable powder . . .	2½ pounds	2½ tablespoons
25% emulsion	2 quarts	4 teaspoons
5% dust (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

As with all insecticides, methoxychlor must be applied thoroughly for satisfactory insect control. For insects infesting an entire tree, it is necessary to spray the bottom, top and middle equally well.

19. Aramite: This material is a proprietary compound. It is effective against leaf-feeding mites but not against leafhoppers and aphids. Aramite may be used with most of the insecticides suggested in this bulletin except calcium arsenate, Bordeaux, and lime-sulfur. It is especially important that you do not mix aramite with dormant or summer dinitro compounds.

Aramite is broken down by sunlight. Therefore, in hot, dry weather its effectiveness does not last as long as when the summer weather is moderate. Careful spraying of the underside of the leaves must be done if satisfactory results are to be had.

Aramite may be purchased in two forms. The following table lists these formulations:

Aramite formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
15% wettable powder . . .	2 pounds	2 tablespoons
3% dust (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.

Aramite is a fairly safe material to use. However, breathing the sprays and dusts should be avoided. If spilled on the skin, wash off with soap and water.

20. Ovex: This material is a long-lasting chemical for mite control. It has very little value against insects. Ovex kills both mites and their eggs. It can be mixed with the insecticides suggested in this bulletin for use on ornamental trees. **Dogwood, holly and hardy privet are quite sensitive to Ovex.** It should be used with caution on these plants. On trees generally, use it only at recommended dosages.

This miticide may cause skin irritation if allowed to come in contact with the hands, face and body. If accidentally spilled on the skin, wash immediately and thoroughly with soap and water. Avoid inhaling dust or spray mists.

Ovex may be purchased in two forms for use on ornamental trees. The following table lists these formulations:

Ovex formulations*	Amount to 100 gallons of water	Amount to 1 gallon of water
50% wettable powder	1 pound**	1 tablespoon
5% dust (use as purchased)		

*USE ONLY ONE OF THE ABOVE FORMULATIONS AT A TIME.
 **If desired, 2 pounds of 50 percent wettable ovex may be used on evergreens. This amount would require 2 tablespoons to 1 gallon of water. Spray thoroughly and repeat in 10 days if necessary.

21. Summer oils: Summer oils are light, chemically-treated oils of approximately 70-80 viscosity by the Saybolt test. They are sold under trade names ready for dilution with water, and are commonly applied at the rate of 1/2 to 1 gallon to 100 gallons of spray. A partial list, 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. Oils are incompatible with sulfur. Read Section 11.

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

INSECTICIDES FOR DORMANT USE

The materials recommended for dormant use must be applied only while the trees are strictly dormant. Trees are considered dormant as long as the buds have not started to swell.

22. DN dormant: DN dormant sprays are sold with different percentages of DN and it is necessary to follow the manufacturer's directions. One and one-fourth pounds of 40 percent DN compound, or 1 pound of 50 percent DN compound to 100 gallons are required for aphid control. Where a 40 percent DN is used, 7 1/2 pounds are required to 100 gallons of water when applied to control oystershell scale since about 3 pounds of actual DN is required to get a reasonable kill.

23. Lime-sulfur: Lime-sulfur contains sulfur combined with lime. It is both an insecticide and a fungicide. On ornamental trees it is used primarily in the dormant period for certain scale insects and some diseases.

Lime-sulfur can be obtained in both liquid and dry forms. For dormant use, add 1 gallon of concentrated liquid lime-sulfur to 7 gallons of water. Dry lime-sulfur can be substituted for liquid lime-sulfur when used as a fungicide. In general, 1 pound of dry lime-sulfur is equal to 1 quart of liquid lime-sulfur.

NOTE: LIME-SULFUR STAINS WOOD, PAINTED SURFACES AND STONE. THIS MUST BE TAKEN INTO CONSIDERATION WHEN SPRAYING ORNA-

MENTAL PLANTINGS AROUND BUILDINGS AND OTHER STRUCTURES. IF A STRUCTURE IS THOROUGHLY WETTED BEFORE AND THOROUGHLY WASHED DOWN AFTER AN APPLICATION, THE DAMAGE CAUSED BY STAINS WILL BE LESS-ENED.

24. Dormant oils: Dormant oils for control of scales and mites which overwinter on ornamental trees are made from lubricating oils of slightly more than 100 viscosity (Saybolt at 100° F.) and 60 to 70 percent unsulfonated residue. A partial list of brand names for dormant oils includes Casco Dormant, Dendrol, Dormoil, Emulso, Kleenup Ready Mix, Peninsula, Stanolind, and Sunoco. When using commercial dormant oils, follow manufacturer's directions. Directions for home-mixed emulsions may be obtained from the Entomology Department, Michigan State University, East Lansing.

FUMIGANTS

25. Carbon tetrachloride: If only a few trees are to be treated, borers can be killed by injecting a few drops of carbon tetrachloride into the tunnels and plugging the openings with mud or grafting wax. Carbon tetrachloride is nonflammable, but don't breathe the fumes.

26. Paradichlorobenzene (PDB) in cottonseed oil or in vegetable salad oils: Dissolve PDB at the rate of

1 pound in 2 quarts of cottonseed oil or a vegetable salad oil. Apply with a brush over injured areas in early spring or late fall to control borers. PDB may be dissolved at the rate of 2 pounds to 1 gallon of commercial miscible oil such as Dendrol, Sunoco, etc., diluted with 30 gallons of water and applied to the infested areas as a spray. (For small amounts, use $\frac{1}{4}$ pound of PDB, 1 pint of miscible oil and 3 and $\frac{3}{4}$ gallons of water.)

ACCESSORY MATERIALS

These materials are used for numerous purposes. Some of them have been suggested for use in this bulletin. Others are listed because of continued grower interest.

27. Lime: Lime used for spraying and dusting is prepared specifically for this purpose. **Mason's hydrate or agricultural lime is not satisfactory.** Only fresh hydrated spray-lime should be used. Freshly hydrated lime usually keeps satisfactorily for 10 to 12 weeks if stored in a dry place and not exposed to the air.

28. Lead arsenate safener: Lead arsenate in the hot part of the summer tends to burn the leaves of some ornamental trees, especially those related to peaches and plums. A zinc-lime mixture is added to the lead arsenate spray to reduce lead arsenate burning.

The zinc sulfate-lime mixture is prepared as follows to make 100 gallons of spray. Smaller amounts of spray can be made by reducing the materials accordingly.

1. Dissolve 4 pounds of zinc sulfate in a bucket of water.
2. Begin filling the spray tank with water.
3. With the agitator running, add the zinc sulfate previously dissolved to the tank. Add enough water to make 75 gallons in the tank.
4. Wash 4 pounds of lime through the strainer or prepare it as thin paste and pour into the tank.
5. Increase the water to 100 gallons, and agitate a few minutes before adding the lead arsenate. If a fungicide is necessary, it should be added after the lead arsenate. Be sure the fungicide is compatible with the lead arsenate, lime, or both.

SPREADERS, STICKERS AND WETTING AGENTS

Stickers are materials used for the purpose of sticking insecticides and fungicides more firmly to plants and insects. The use of wetting agents makes it possible to mix with water materials that ordinarily would not do so. Spreaders increase the tightness of the spray film over both plants and animals.

A large number of spreaders, stickers and wetting agents have been developed for use with specific spray materials. Generally, these spreaders, stickers, and wetting agents are satisfactory when used for the purpose for which they were made.

29. Commercial spreaders and wetting agents:

Most wettable powders and emulsions purchased today contain enough wetting, spreading and sticking agents to make satisfactory sprays.

Sprays ready for use should foam slightly when agitated. If foaming is excessive, too much wetting agent has been used. On the other hand, if there is no foaming, a wetting and sticking agent should be added. But don't overdo it.

Commercial wetting and spreading agents are available where insecticides and fungicides are sold. When using these materials, read all directions carefully and follow them.

NOTE: Detergents and detergent soaps may be used as wetting agents. However, it should be noted that small amounts of these materials go a long way. Excessive foaming may be worse than not enough.

30. Soaps: A special use for soap is the activating of nicotine sulfate (11) sprays. 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.

SUPPLEMENTARY MEASURES

31. Disinfecting pruning tools: Thoroughly wet tools in formalin (1 part to 10 parts of water) or in denatured or plain radiator alcohol. Allow treated parts to dry before using again.

32. Watering trees or shrubs: Trees located on lawns and along streets often require watering in the summer. Soak the soil to a depth of about 2 feet by slow application of water through a porous hose or by sprinklers. Such waterings should not be made oftener than at 2-week intervals to allow necessary aeration of the soil between waterings.

33. Disinfecting roots for crown gall: Dip roots of young trees suspected of being contaminated with the crown gall organism in a strong Bordeaux mixture. Make this mixture by pouring a solution of copper sulfate, $1\frac{1}{2}$ pounds to 1 gallon of water, into another gallon of water containing 3 pounds of hydrated lime.

34. Canker treatment: Cut the bark 1 inch back from the edge of the canker, leaving an oval-shaped wound with pointed tips at the upper and lower ends. Disinfect the wound with denatured alcohol, radiator alcohol, or other suitable disinfectants. Paint over with asphalt or any other good wound dressing.

35. Treating for fire blight: The bacteria causing fire blight live overwinter in holdover cankers. The most effective time to treat cankers is during the dormant season. At this time, the bark should be removed for 3 inches above and below and 1 inch around the sides of any visible signs of the canker. Treat as for canker (34).

36. Wrapping as a protection against borers: Crepe wrapping paper consists of two layers of crepe paper

cemented together with asphalt. It can be purchased in rolls 4 to 6 inches wide and several hundred feet long, and is recommended for the protection of transplanted trees. Wrap the trees before borers have laid their eggs in the bark. Overlap the paper to form a complete barrier and tie in place with loops of binder twine. (Binder twine will break before it girdles a tree.)

37. Sanitation: Sanitation is simply good "tree housekeeping", and its practice will aid materially in insect and disease control. The collection, removal, and burning of dead leaves and other plant parts which may harbor disease-producing fungi or bacteria will aid in the control of most diseases. In some cases, it is the only means of keeping diseases in check.

NOTE: Leaves may be composted instead of burned if piled in alternate layers with soil. Add a high nitrogen fertilizer at the rate of 100 pounds to each 125 cubic feet of compost. Add also 25 pounds of finely ground limestone. Be sure that no leaves are left exposed. Cover them completely with soil.

38. Fertilizing trees: General recommendations for deciduous trees is the application in the spring of a complete, commercial fertilizer of about a 10-8-6 formulation at the rate of 3 pounds per inch of diameter of the tree. This is applied through soil auger holes bored 15 inches into the soil. These holes should be located most abundantly out at the edge of branch spread.

Enough holes should be bored to allow $\frac{1}{4}$ pound of fertilizer to each hole.

For conifers, apply about $\frac{1}{4}$ pound of the fertilizer mentioned above for each inch of trunk diameter.

Application should be made every second or third year. In cases of suspected fertility deficiencies, consult your county agricultural agent.

39. Soil testing. To determine if soil is too alkaline, test with Soiltext. Excess alkalinity can be neutralized by applications of ammonium sulfate, sulfur, aluminum sulfate, or Sesquetrene. For further information on soil testing, consult your county agricultural agent.

40. Treatment for wetwood: To reduce or stop the outflow of sap from tree trunks, bore a 1-inch hole into

the trunk below the place where the sap oozes out. The holes should extend inward until approximately within 2 inches of the other side of stem. The holes should be slanted upward enough to drain well. Screw or drive a 3- or 4-inch length of pipe, sized to fit bored hole, into the wood for about 1 inch. This hole, with pipe to drain sap away from the bark and to relieve the gas pressure, can usually be placed on the back side of the tree to be out of the way.

41. Removing sooty mold: Use one of the detergents (29) for this purpose. They are used at the rate of 4 ounces to 100 gallons of water. Best results follow where the spray is applied with pressure. Trees should be rinsed with water to remove the material within 24 hours after application. Dilute any accumulation of the detergent on the grass to prevent burning.

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