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Controlling Diseases and Insects on Ornamental Shrubs

Michigan State University Extension Service

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EXTENSION BULLETIN 270

Controlling
DISEASES AND INSECTS
ON
ORNAMENTAL SHRUBS

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

MICHIGAN STATE COLLEGE
COOPERATIVE EXTENSION SERVICE
EAST LANSING

QUANTITIES OF COMMON INSECTICIDES REQUIRED FOR SMALL AMOUNTS OF SPRAYS BASED ON GENERALLY ACCEPTED FORMULAS

MATERIALS*	1 GALLON	3 GALLONS	100 GALLONS
Calcium arsenate	3½ tablespoons	11 tablespoons or ⅔ cup	4 pounds
Lead arsenate	3 tablespoons	9 tablespoons or ½ cup	4 pounds
Derris powder (4-percent rotenone)	5 tablespoons	1 cup	5 pounds
Copper sulfate (powdered)	2 tablespoons	6 tablespoons	4 pounds
Fermate or Karbam	1½ tablespoons	4½ tablespoons	1½ pounds
DDT (50-percent wettable)	3 tablespoons	9 tablespoons	3 pounds
Hydrated lime	1 cup	3 cups	4 pounds

EQUIVALENT QUANTITIES OF LIQUID MATERIALS WHEN MIXED BY PARTS

DILUTIONS				
WATER*	1-400	1-800	1-1000	1-1600
100 gallons	1 quart	1 pint	1½ cups	½ pint, 1 cup
25 gallons	1 cup	½ cup	⅓ cup	¼ cup
5 gallons	3 tablespoons	5 teaspoons	4 teaspoons	2½ teaspoons
1 gallon	2 teaspoons	1 teaspoon	¾ teaspoon	2 teaspoon

*These quantities are based on standard measuring cups and spoons level full.
 Approximate equivalents for use in measuring liquid insecticides and fungicides:
 3 teaspoons = 1 tablespoon 16 tablespoons = 1 cup 1 pint = 2 cups
 2 tablespoons = 1 fluid ounce 16 fluid ounces = 1 pint or pound 8 pints = 1 gallon

APPROXIMATELY EQUIVALENT QUANTITIES OF DRY INSECTICIDAL MATERIALS FOR VARIOUS QUANTITIES OF WATER

WATER	QUANTITIES OF MATERIALS					
100 gallons	1 pound	2 pounds	3 pounds	4 pounds	5 pounds	6 pounds
25 gallons	4 ounces	8 ounces	12 ounces	1 pound	1 pound, 4 ounces	1 pound, 8 ounces
5 gallons	4 tablespoons	8 tablespoons	¾ cup	1 cup	4 ounces	5 ounces
1 gallon	2 teaspoons	5 teaspoons	7 teaspoons	3 tablespoons	4 tablespoons	5 tablespoons

The number of tablespoons per ounce of dry fungicides and insecticides varies so greatly that it is impossible to give accurate measures in teaspoons, tablespoons, or cups. 5-6 tablespoons equal approximately one ounce at different rates. The amounts given in teaspoons, tablespoons, and cups are the averages of a number of materials. If there is any information on the package as to dosage for small amounts of spray, follow manufacturer's directions. If there are no accompanying directions for mixing small quantities, use the table above.

Control of Diseases and Insects on Ornamental Shrubs

By C. E. WILDON and A. E. MITCHELL, Department of Horticulture; RAY HUTSON and E. I. McDANIEL, Department of Entomology; RAY NELSON and F. C. STRONG, Department of Botany and Plant Pathology

There is no effort in this bulletin to catalog all the diseases and insects which may affect shrubs. Descriptions of the pests and their injuries is brief. Presentation of treatments is also streamlined. The control methods suggested are those which have been successful with readily available materials and machinery.

The presentation of the information on diseases and insects and their treatment is by alphabetical arrangement of host plants. As a usual thing treatments are indicated in the writeup on the pest with fuller directions as to dosage, dilutions, mixing, etc., on pages 25 to 37.

There are several general considerations in spraying which must be kept in mind at all times. The more important are set forth in the next few paragraphs.

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

4. Be certain to have a perfect emulsion and that the spray hose does not contain a concentrated dose when starting the application of oil.
5. PDB in cottonseed oil should not be applied during the summer months when there is danger of the temperature going above 80° F. for any prolonged period.
6. Lead and calcium arsenates are interchangeable for all situations requiring arsenates in this bulletin, except for turf treatments. See (10), page 29.
7. When insect or disease cannot be identified send insect samples to Entomology Department and disease samples to Botany Department, Michigan State College.

WARNING

Many insecticides and fungicides have a tendency to stain wood, painted surfaces, or stone. This must be taken into consideration when spraying in cities on ornamental plantings. Where a structure is thoroughly wetted before and thoroughly washed down after an application, the damage caused by stains will be lessened. Fermate or Karbam ordinarily will not cause damage in this way.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
ALDER (Alnus)	
Alder Blight Aphid.....	Conspicuous cottony masses on underside of alder stems in early fall—Alternate host soft maple spring and summer. Wash insects off with water under pressure. Use nicotine sulfate and soap or other spreader (18), or DDT plus fixed nicotine (15c).
Alder Leaf Miner.....	Large blotch mines on foliage in mid-summer. Use nicotine sulfate and soap (18), or other spreader, or DDT plus fixed nicotine (15c).
Alder Flea Beetle.....	Foliage skeletonized in July or August by a small bluish flea beetle or by black tubercled grubs. Use lead arsenate or Cryolite in early spring (9, 10), or DDT plus fixed nicotine (15c).
Canker.....	Dead areas of bark at bases of trunk and branches. Girdles and kills shrubs. Cut out affected branches or entire stem and burn.
Powdery Mildew.....	See Lilac.
Catkin Galls.....	Catkins distorted, swollen, and reddish. Prune out affected twig ends.
ALMOND, FLOWERING (Prunus triloba)	
Blossom Blight and Die-back	Flowers blighted, leaves and twigs may turn brown and die. Prune out affected branches and destroy. If severe, spray with fixed copper (5) or wettable sulfur (6).
Crown Gall.....	Woody galls on roots. Use clean, healthy trees. If galls are removed before planting dip roots in disinfectant (34).

BARBERRY (Berberis)

Webworm.....	Caterpillars protected in a nest defoliating plants in late June. Use lead arsenate (10) or calcium arsenate (10) in June. Fixed nicotine plus DDT (15c).
Aphids.....	Small yellowish-green aphids on leaves or tender shoots. Use nicotine sulfate and soap when aphids appear. Nicotine (18), rotenone (12), or pyrethrum (19), spray or dust, or DDT plus fixed nicotine (15c), or organic phosphate (14).
Wilt.....	Leaves wilt, branches or whole plant may die. Characteristic green streaks in wood. Prune out diseased parts. If plant is killed, do not replace unless 3 feet wide by 1 foot deep volume of soil is replaced by new soil.
Bacterial Leaf Spot.....	Spray with bordeaux mixture (1a).
Rust.....	Circular orange spots on leaves. Attacks only common barberry which should be destroyed since rust spreads to wheat and other cereals killing plants or causing great reduction in grain yields. DOES NOT ATTACK JAPANESE BARBERRY AND MANY HYBRIDS.

BITTERSWEET (Celastrus)

Aphids.....	See Barberry.
Euonymus Scale.....	See Euonymus.
Two-marked Tree Hopper.....	Cottony white masses of eggs on twigs in late summer. Egg-masses spectacular but unimportant. No control necessary.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
BUCKTHORN (Rhamnus)	
Rust	Small orange spots on leaves. Causes little injury to this shrub but disease spreads to oats in nearby fields, causing considerable injury. Destroy plant if leaves become covered with rust spots.
BUTTONBUSH (Cephalanthus)	
Leaf Spot	Various small brown-to-black dead areas on leaves. If severe, spray with proprietary copper (5) or Fermate or Karbam (4a) 3 times at 14-day intervals, beginning when leaves start.
CLEMATIS	
Blister Beetles	Plant attacked by a large number of greedy beetles, flowers preferred, but they will defoliate. Hand-pick. Readily repelled by any spray or dust. Use lead arsenate or calcium arsenate in bordeaux (1, 10).
Clematis Borer	Larva of clear winged moth in fleshy roots of clematis. Remove by hand. Inject DDT (15a) in oil.
Tarnished Plant Bug	Sucks sap from leaves and terminals, deforming or killing new growth. Use DDT plus fixed nicotine (15c). See Barberry Aphid.

Leaf Spot and Stem Rot...	Greenhouse ; brown areas on leaves with red margins. Lesions on stems near ground. Girdles stem and kills it. Out-of-doors; lesions on stems only. Pick off and destroy diseased leaves. Spray with bordeaux (1a) or wettable sulfur (5) or dust with sulfur (8) for stem lesions.
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COTONEASTER

Lace Bug.....	Spotting and discoloration of foliage and the presence of lace winged insects on the undersides of the leaves. Use nicotine sulfate and soap (18) or nicotine sulfate with a special spreader (28), or DDT (15), or (15c).
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Oystershell Scale.....	Brownish shields resembling minute oystershells on trunk and branches. Use DN Dormant (22).
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Roundheaded Apple-tree Borer.	Tunnels into trunk near ground level, pushing out quantities of chewings, 2-year life-cycle. Adults in early summer. Inject DDT (15a). Paint with PDB in cottonseed oil in fall or spring (27).
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San Jose Scale.....	Circular grayish shield 1/16-inch in diameter on leaves, trunk and branches. Use dormant lime-sulfur (2, 24), or dormant oil 3 percent (23).
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Fireblight.....	Twigs killed back. Prune out blighted twigs, well below injured parts. Disinfect pruning tool after each cut (35).
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Leaf Spot.....	Reddish-brown areas with dark borders. Spray with proprietary copper (5) at 14-day intervals, beginning when leaves are 1/4 inch long.
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INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
CURRENT, FLOWERING (Ribes)	
Aphids	Small greenish-yellow plant lice on the lower surface, causing leaf curl. (See Barberry).
Currant Borer	Larvae tunnel down canes causing them to appear unthrifty and die. Trim and burn infested canes where first discovered.
Fourlined Plant Bug	Nymphs and adults deform the leaves and the tender growth by removing sap and killing plant tissue. Use nicotine sulfate and soap (18, 31) or other contact sprays or dusts (19, 20) or DDT (15) before nymphs mature. See Barberry Aphids.
Imported Currant Sawfly	Eggs laid along main veins and smooth pale green larvae with numerous black spots strip the foliage. 2 broods a year. Any of the contact sprays or dusts (15b, 18, 19, 20, 31) when larvae are present.
San Jose Scale	See Cotoneaster.
Cane Blight	Canes blighted and die back. Cut off and burn infected canes.
Leaf Spot	Small brown-to-black circular areas on leaves and sometimes on fruit and canes. Spray with proprietary copper (5) 3 times at 14-day intervals, or apply copper dusts (7) 4 times at 10-day intervals, beginning when leaves are 1/4 inch long.
Rust	Tiny yellow spots on leaves. Little injury to currants, but disease also attacks branches and trunks of white pines killing them. Do not grow currants within 900 feet of white pine trees. It is illegal to grow common black currants in Michigan.

DOGWOOD (Cornus)

Clearwing Moth.....	Larvae tunnel under bark along edges of scar tissue, causing distortion and mutilation of twigs. Cut and burn infected twigs.
Cottony Maple Scale.....	See Euonymus.
Flatheaded Apple-tree Borer.	Flat legless grub tunneling under bark often girdling transplanted trees and woody shrubs. Use crepe paper (37), or PDB in cottonseed oil (27), DDT (15a).
Pitted Ambrosia Beetle....	Wilted or dead shrubs which readily break at ground level, containing a series of blackened, closely set, nearly horizontal galleries. Often a problem where trees are mulched. Does not affect trees grown in the open.
San Jose Scale.....	See Cotoneaster.
Twig Girdler.....	Larvae mine terminal twigs, making opening along the way through which frass and chewings are pushed out and finally girdling twig. Cut and burn infested twigs.
Leaf Spot.....	Grayish or brownish dead areas on leaves. Spray with proprietary copper (5) once when leaves are full grown.
Powdery Mildew.....	See Lilac.
Twig Blight.....	Twigs killed back from tip. Prune out blighted twigs well below injury. Fertilize to increase vigor (36).

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
DUTCHMAN'S PIPE VINE (Aristolochia)	
Pipe Vine Caterpillar.....	Brown caterpillars of a swallow-tail butterfly, with two rows of coral red dots along the back and with fleshy filaments at either end. Gregarious. Hand pick. Use lead arsenate (10), or contact sprays or dusts (15b, 18, 19, 20, 28, 31).
Sphinx Caterpillars.....	Large, smooth, dark green caterpillars with a large false eye on the rear end. Seldom important. Hand-pick.
Leaf Spot	Circular to angular brown areas on leaves. Spray with proprietary copper (5) or wettable sulfur (6) or Fermate or Karbam (4a) at 14-day intervals, beginning when leaves are 1/4 inch long.
EUONYMUS	
Aphids.....	See Barberry.
Cottony Maple Scale.....	White cottony mass protruding from under and out behind a brown scale on twigs in June. Sodium lauryl sulfate (28) or nicotine sulfate and soap (18, 31) when the young are moving to the leaves, or DDT (15c).
Euonymus Scale.....	Elongated brownish gray scales together with smaller elongated white scales. Leaves and twigs infested. Sodium lauryl sulfate (28), liquid soap plus nicotine (31) in mid-summer or 2-percent summer oil (21) in the spring or fall.
Crown Gall.....	Woody galls on roots and branches. If numerous, destroy plant. If few, cut off galls and dip roots (34) when transplanting. Disinfect pruning tools (35).
Powdery Mildew.....	See Lilac.

FIRETHORN (Pyracantha)

- Fireblight..... Leaves near growing tips suddenly wilt, turn brown or black. Twigs killed back. Flowers killed. **Prune out blighted twigs well below injured parts. Disinfect pruning tool between cuts (35).**
- Scab..... Black sooty areas on leaves, later turn brown and leaves drop off. Scabby lesions on twigs. **Spray with lime-sulfur (2) when dormant. Repeat summer strength lime-sulfur (2) just before flowers open, and repeat twice at 14-day intervals.**

FORSYTHIA

- Fourlined Plant Bug See Currant.
- Die-back..... Blossoms and flower stalks turn brown and die. **Prune out affected twigs and burn.**

GRAPE (Vitis)

- Cottony Maple Scale..... See Euonymus.
- Eight-spotted Forester..... Reddish black ringed caterpillar, gregarious, defoliating vines. **Two broods. Use lead arsenate (10) or DDT plus fixed nicotine (15c). Hand-pick.**
- European Fruit Lecanium... A convex reddish brown soft scale about 1/8-inch in diameter. Usually congregated in large numbers on stems. Young in June. Of little economic importance. **Use dormant oil (23), or DDT plus fixed nicotine (15c).**
- Grape Flea Beetle..... Metallic greenish-blue beetle 1/5 inch long on buds in the spring or young grubs feeding on surfaces of leaves. One generation each year. **Use lead arsenate (10), or DDT plus fixed nicotine (15c) when beetles attack buds.**

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
GRAPE (Vitis)—Con.	
Grape Berrymoth.....	Spring brood web together and partially destroy buds and blossoms, spoiling bunches. Second and third brood develop inside fruit, causing purplish spots on green fruit and frequently causing ripe fruit to split open. Berries webbed together. Spray just as buds open with proprietary copper (1½ cup) plus lead arsenate (½ cup) in 5 gallons water and again just as berries touch in clusters, using proprietary copper (1½ cup). Use nicotine sulfate (2 tablespoonfuls), lead arsenate (½ cup) or DDT (15) (1 cup) in 5 gallons of water.
Grape Leafhopper.....	Brown foliage. Premature falling of leaves. Presence of adults and nymphs on undersides of leaves. Two broods per year. Use nicotine sulfate in bordeaux (1, 18) within 2 weeks after bloom, or pyrethrum as a dust or spray (1a), or DDT (15).
Grape Root-worm.....	Grayish brown beetles ¼ inch long eating chain-like holes in the leaves in July, larvae feed on roots. Where larvae are numerous, foliage turns yellow. Use lead arsenate (10), or DDT (15).
Rose Chafer.....	Long legged, grayish-brown beetles about ½ inch long. Appear in swarms about the time the grapes are in bloom. Use pyrethrum as a dust or spray (19), or DDT (15).
Sphinx Caterpillars.....	Several species. Large caterpillars 2 to 3 inches long with either a false eye spot or a prominent horn on rear end. Defoliate vines. Hand-pick. Use lead arsenate (10), or DDT (15), when larvae are small.
Spotted Vine Beetle.....	Large light-brown glossy beetle with black spots. Defoliate vines. Hand-pick. Use lead arsenate (10), or DDT (15).
Downy Mildew.....	Greenish-yellow patches on leaves becoming brown. Leaves drop off. Spray with proprietary copper (5), as for leaf spot.

Leaf Spot and Black Rot. . .	A small dark brown spot and a grayish spot with dark red border appear on leaves but cause more injury to fruit. Spray with proprietary copper (5) or Fermate or Karbam (4a) 3 times, just before bloom, just after bloom, and just before berries touch.
Powdery Mildew.	See Lilac.
GRASS	
	See Turf.
HAZEL (Corylus)	
Aphids.	See Barberry.
Bud Gall.	Galls caused by mites on terminal and lateral buds. Use dormant spray of lime-sulfur (2). Prune out infested twigs.
Knot.	Small longitudinal cracked ridges in bark. Soon girdle and kill twig, branch, or stem. Prune out and burn dead and dying parts. Use dormant spray of lime-sulfur (2).
HONEYSUCKLE (Lonicera)	
Aphids.	See Barberry.
Clearwing Moth.	See Snowberry.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
HONEYSUCKLE (<i>Lonicera</i>)—Con.	
Leaf Roller.....	Rolls foliage of Tartarian honeysuckle and caterpillar feeds within the rolled leaf. Use lead arsenate (10) before the leaves curl.
Sawflies.....	Dull gray larvae defoliating climbing and bush honeysuckle. Lead arsenate (10). When larvae are over half-grown, spray with nicotine sulfate and soap (18, 31), or pyrethrum (19), or rotenone (20), or substitute dust (18, 19, 20), or DDT plus fixed nicotine (15c).
Canker.....	Twigs and stems killed back. Tiny reddish bodies soon appear on killed parts. Prune out and burn dead and dying parts.
Leaf Spot.....	Various-sized brown areas on leaves. If serious the previous year, spray with proprietary copper (5) or wettable sulfur (6) 3 times at 14-day intervals, beginning when leaves first appear.
HYDRANGEA	
Rose Chafer.....	See Grape.
Red Spider.....	Infest undersides of leaves, foliage pale under-sized and falling prematurely, mites and eggs of mite may be present on the underside of the leaves—often protected by webs. Spray or dust with rotenone (20), rotenone-sulfonated castor oil spray (20), or organic phosphates (14).

Tarnished Plant Bug.....	See Clematis.
Brown Bacterial Blight....	Flower clusters and young leaves of tree hydrangeas wilt and turn brown. Root rot may occur in very wet weather. No control.
Chlorosis.....	Yellowish-green coloring of leaves. Soil too alkaline. Test soil (38).
Leaf Spot.....	Brown spotting of leaves. Flowers killed if severely attacked. Spray with proprietary copper (5) or wettable sulfur (6).
Powdery Mildew.....	See Lilac.
Sunscauld.....	During periods of very hot weather, new leaves may sunburn. Resembles frost or spray injury.

IVY, AMERICAN, BOSTON AND VIRGINIA CREEPER (Parthenocissus)*

Eight-spotted Forester.....	See Grape.
Leaf Hoppers.....	See Grape.
Sphinx Caterpillar.....	See Dutchman's Pipe Vine.
Diseases.....	See Grape for all diseases.

* Syn. Ampelopsis

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
IVY, ENGLISH (Hedera)	
Mite	See Privet.
Leaf Spot	See Grape.
Leaf Spot, Bacterial	Small light green, water-soaked spots which turn brown. Stems may be killed back. Avoid high temperatures, moist conditions and unnecessary watering of foliage. Spray with proprietary copper (5). Avoid planting on sites where high temperatures and moist conditions are likely and refrain from unnecessary watering of foliage.
KERRIA	
Canker and Leaf Spot	Distinct oval, brownish cankers on stems. These enlarge and girdle stems. Brown spotting of leaves. Prune out diseased stems. Spray with proprietary copper (5), or wettable sulfur (6), 3 times at 14-day intervals, or copper dust (7), or sulfur dust (8) 4 times at 10-day intervals, beginning when leaves are 1/4 inch long.
LILAC (Syringa)	
Borer	Borers in stems around graft scars or near the ground level. Use PDB in cottonseed oil (27), or DDT (15a).
Leaf Miner	Young caterpillar works first as a leaf miner later comes to the surface and webbing leaves together feeds as a leaf skeletonizer. Use nicotine sulfate summer oil, plus lead arsenate (10), or fixed nicotine plus DDT (15c).
Oystershell Scale	See Cotoneaster.
San Jose Scale	See Cotoneaster.

Blight, Bacterial.....	Spots and blotches on leaves. Young leaves soon turn black and die. Twigs killed back. Black streaks on succulent stem growth, sunken cankers on older stems and branches. Flower clusters wilt and turn brown. Thin out plants to give better aeration. Prune out diseased parts. Disinfect pruning tools between cuts (35). Spray 3 times at 7-day intervals with bordeaux mixture 2-2-50 (1a) as soon as buds start opening.
Graft Blight.....	Practically all lilacs grafted on privet stock develop this non-parasitic trouble. Leaves yellow along margins and between veins, are smaller and likely to be brittle to the touch. Shrub stunted. Will not recover unless scion part develops its own roots. Set plant with graft union below soil surface.
Phytophthora Blight.....	Similar to bacterial blight except lesions brown, and shoots are killed to ground. Prune out blighted twigs and shoots well below injured parts. Spray (1a) as for bacterial blight above.
Powdery Mildew.....	Greyish powdery, moldy patches covering leaves. Usually appears late in summer on Lilac, but on other plants may appear earlier in growing season. Spray with wettable sulfur (6), or with sulfur dust (8) 3 times at 14-day intervals beginning August 1st.

MOCK ORANGE (Philadelphus)

Leaf Spot	Brown circular areas on leaves. Spray with proprietary copper (5) or wettable sulfur (6) 3 times at 14-day intervals beginning when leaves are $\frac{1}{4}$ inch long.
Nectria Canker.....	Twigs and branches killed back. Tiny reddish bodies appear soon on dead bark. Prune out dead twigs and branches and burn.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
PACHYSANDRA	
Euonymus Scale.....	See Euonymus.
San Jose Scale.....	See Cotoneaster.
PEA SHRUB (Caragana)	
Cankers.....	Twigs and branches killed back. Prune out and burn dead and dying parts.
Hairy Root.....	Stunted weak growth, abnormal number of fine, unbranched rootless arising just below soil level of main root. Do not plant or if planted, remove and destroy affected plants.
Leaf Spot.....	Small circular dead brown areas on leaves. If abundant previous year, spray with proprietary copper (5) or wettable sulfur (6) or Fermate or Karbam (4a) 3 times at 14-day intervals, beginning when leaves are $\frac{1}{4}$ inch long.
PRIVET (Ligustrum)	
Caution: DDT defoliates privet.	
Leaf Roller.....	Terminal leaves webbed together in early spring by small caterpillars. Trim and burn nests before adults appear.
Lilac Borers.....	See Lilacs.

Leaf Roller.....	Terminal leaves webbed together in early spring by small caterpillars. Trim and burn nests before adults appear.
Lilac Borers.....	See Lilacs.

Mite.....	Attack tender terminals of California privet in early spring. Stunts growth, causes leaves to thicken and curl. Trim out infested terminals. Use rotenone-sulfonated castor oil (20), or organic phosphate (14).
Thrips.....	Stunted growth, off-color foliage with minute black spots on undersides of leaves. Use rotenone-sulfonated castor oil (20), or tartar emetic (13), or nicotine sulfate and soap (18, 31).
Leaf Spot	Various-sized brownish areas on leaves. If abundant and injurious previous season, spray, using proprietary copper (5) as for twig blight, or Fermate or Karbam (4a).
Powdery Mildew.....	See Lilac.
Twig Blight.....	Twig tips blighted. Leaves cling to dead twigs. Use dormant spray of lime-sulfur (2) followed by three sprays of proprietary copper (5), or wettable sulfur (6), 3 times at 14-day intervals, beginning when leaves are 1/4 inch long. California privet is not reliably hardy in Michigan.

QUINCE, JAPANESE (Chaenomeles)*

Aphids.....	See Barberry.
San Jose Scale.....	See Cotoneaster.
Fire Blight.....	See Firethorn.
Rust.....	Large circular, roughened spots on fruit. Yellowish spots on leaves. Do not grow near dwarf

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
RASPBERRY, FLOWERING (Rubus)	
Powdery Mildew.....	See Lilac.
Mosaic.....	Leaf development is delayed. Leaves mottled dark and light green. Canes stunted. Dig up and destroy affected plants.
REDBUD (Cercis)	
Leaf Spot.....	Irregular to circular rusty brown lesions, becoming grayish. Twigs may have similar lesions. If serious the previous year, spray with proprietary copper (5), or wettable sulfur (6), or Fermate or Karbam (4a), 3 times at 14-day intervals beginning when leaves are 1/4 inch long.
ROSE	
Aphids.....	See Barberry.
Red Spider.....	See Hydrangea.
Rose Chafer.....	See Grape.

Sawfly Slugs	Greenish slug-like larvae, skeletonizing foliage. Use any of the following contact sprays and dusts (10, 15, 15b, 18, 19, 20, 28, 31), or organic phosphates (14).
Leaf Hoppers	Numerous white spots or stippling on the upper surfaces of the leaves and accumulations of cast skins on the undersides of the leaves. See grape leafhopper.
Thrips	See Turf.
Black Spot	Black spots with feathered margins on both sides of leaves. Leaves turn yellow and drop off. Dust with sulfur (8) or spray with wettable sulfur (6) or use Fermate or Karbam (4a). Give light applications and apply as often as twice weekly. Practice Sanitation (37).
Chlorosis, Nutritional	Yellow-green pattern or mosaic caused by deficiency of nitrogen, magnesium, manganese, or other nutrients, or by excesses of potash, lime, or other nutrients. Test soil and follow recommended treatment (38).
Chlorosis, Virus	Leaves mottled light and dark green, and distorted. Plant dwarfed. Flowers imperfect on short stems. Dig out and destroy affected plants.
Crown Gall	Woody galls on roots, also on above-ground stems. Cut out affected canes. Disinfect ground with formalin (4b). If on roots, remove and destroy plant.
Powdery Mildew	See Lilac, but apply sprays or dust beginning in early June.
Rust	Orange-yellow spots on leaves which become black later in season. Swollen orange areas on veins, petioles, and stems. Use lime-sulfur dormant spray (2), and dust weekly with sulfur (8), or spray with Fermate and Karbam (4a). Prune out affected parts of diseased canes.
Viruses	Besides the virus chlorosis, there are several other diseases of rose caused by viruses which exhibit symptoms of wilting, mottled and ring patterns on leaves, dwarfing of plant, injury to flower buds and distortion of leaves. Requires an expert to identify and differentiate them. Remove and destroy affected plants as soon as disease is identified.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
ROSE OF SHARON (Hibiscus)	
Corn Earworm	Caterpillars feeding in the flowers. Use pyrethrum (19) or DDT (15, 15b) as a dust or spray.
Fourlined Plant Bug	See Currant.
SNOWBALL (Viburnum)	
See Viburnum.	
SNOWBERRY (Symphoricarpos)	
Aphids	See Barberry
Clearwing Moth	A greenish or brownish caterpillar 1½ inches long when mature, rear end ornamented with a horn. Two broods per season. Defoliates plants. Hand-pick. Use lead arsenate (10), or DDT (15, 15b).
San Jose Scale	See Cotoneaster.
Leaf Spot	Small dark purplish spots with gray centers on leaves, fruit and stems. May cause distortion of leaves and fruit. Another similar disease appears as brown lesions on the fruit which shrivel and dry up. Use dormant spray (2). Prune out diseased branches. Spray with proprietary copper (5) 3 times at 14-day intervals or dust with copper (7) 4 times at 10-day intervals, beginning when leaves are ¼ inch long.
Powdery Mildew	See Lilac.

TURF

Earthworms.....	Common angle worms. Conspicuous piles of soil about opening of tunnels. Use mercuric chloride (3b).
Thrips.....	Several species. Feed on grass and migrate to shrubs. Use DDT (15, 15b).
Leaf Hoppers.....	Many species. Stipple or deform foliage. Use dust (18, 19, 20), or bordeaux spray (1), or proprietary copper (5), or nicotine sulfate and soap (18, 31), or rotenone (20), or pyrethrum (19), or DDT (15, 15b).
Chinch Bugs.....	Isolated dead brown patches here and there on lawns swarming with black and white insects about $\frac{1}{8}$ inch long. Use nicotine sulfate and soap (18, 31), or nicotine dust (18), or pyrethrum (19).
Grasshoppers.....	Nymphs and adults occasional pests destroying lawns, shrubs, and flowers. Poison bait (11), Chlordane (17).
Army Worms and Other Cutworms.	Several species. May eat grass down to roots, also attack flowers and shrubs. Active at night. Infestations start from low areas. Poison bait (11), DDT (15, 15b), Chlordane (17).
Webworms.....	Larvae construct nests with webs in the soil, often making root-like tube at ground level. Injure grass roots. Use pyrethrum (19).
White Grubs.....	Stout curved white larvae with brown heads and six prominent legs. Several species. Grubs feed on roots of grass often severing the grass roots and making it possible to roll back the grass like a carpet. Presence of holes made by skunks or other animals in the search for grubs. Use lead arsenate in the soil to control grubs or spray foliage when adults appear (10).

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
TURF—Con.	
Bees.....	Solitary bees tunneling or burrowing in soil, especially terraced lawns, killing large areas of grass. Spray bees during heat of day with fly spray. Use soil fumigation with calcium cyanide (25), or injection of DDT (15a).
Ants.....	Several species. Colonies found in lawn or nest under plants. Inject calcium cyanide (25), or DDT (15c) on lawns, into holes used by ants (26). Treat nests under plants with nicotine sulfate and soap (18, 31), or DDT (15b) or Chlordane (17).
Brown Patch.....	Large browned or blackened areas of grass. May have thin, moldy covering. Develops under conditions of high humidity and warm weather. Use an organic mercury (marketed under various proprietary names) according to directions on the package, or corrosive sublimate (mercuric chloride) and calomel (mercurous chloride) 2-1 mixture (3a).
Dollar Spot.....	Similar in appearance to Brown Patch but smaller spots. Most common during wet weather, late in season. Use an organic mercury (marketed under various proprietary names) according to directions on the package, or corrosive sublimate (mercuric chloride) and calomel (mercurous chloride) 2-1 mixture (3a).
Snow Mold.....	Circular diseased and dead patches of grass, from a few inches in diameter up to several square feet of area. Grass matted together with white or faintly pink moldy appearance. Appears in spring soon after snow melts. Most common in low wet places on lawns. Use corrosive sublimate (mercuric chloride) 3½ ounces per 1000 square feet applied in late autumn, or an organic mercury as directed on package.

SPIRAEA	
Aphid	See Barberry.
Leaf Roller	Larvae forming terminal nests on new shoots webbing the leaves together. Clip off nests before adults emerge. Spray with lead arsenate (10) in July.
VIBURNUM	
Aphid	Small greenish aphids attacking new leaves as they open causing them to curl. Deform tender growth. Use DN Dormant (22). See Barberry.
WISTERIA	
Silver-spotted Skipper	Several leaves fastened together, forming a case in which a solitary caterpillar feeds. Hand-pick. Use lead arsenate (10), or DDT (15, 15b).
WITCH-HAZEL (Hamamelis)	
Witch-hazel Cone-gall	Conical galls on upper surfaces of foliage with openings on lower surfaces. Mid-summer broods migrate to birch and fall brood returns to witch-hazel and deposits eggs near the bud scales. No control. Try aphid treatments as for Barberry.

INSECTS AND DISEASES	CHARACTERISTICS AND CONTROL
WITCH-HAZEL (Hamamelis)—Con.	
Spiny Witch-hazel Gall....	A globular gall with spines. The deformity is due to aphids in flower buds. Mid-summer brood migrates to birch, fall generation returns to witch-hazel. No control. Try aphid treatments as for Barberry.
Leaf Blotch.....	Reddish brown blotches. Considerable leaf drop. Spray with proprietary copper (5) or wettable sulfur (6) 3 times at 14-day intervals beginning when leaves are 1/4 inch long.
Powdery Mildew.....	See Lilac.
YEW (Taxus)	
Mealy Bug.....	Cottony masses on twigs and foliage. Accumulation of honey dew on foliage. Use nicotine sulfate plus summer oil (18, 21), DDT plus fixed nicotine (15c). Sprays must be applied with pressure.
Strawberry Root Weevil...	Small grubs girdling roots and destroying root hairs. Use poison bait to kill adults (11) and lead arsenate in soil to kill larvae (10).
Die-back	Growing tips turn yellow first. Whole plant yellows and dies. Roots show decay. Test soil (38) with Soiltex and follow indicated treatment. If soil is too acid (pH 4.0 to 5.5) add lime according to recommendation of soil specialist to bring pH to about 6.0. Improve soil drainage.

Disease and Insect Control

Disease and insect control materials can be divided into three groups according to the purpose for which they are used. (A) fungicides, materials used to control diseases; (B) insecticides, materials used to control insects; (C) accessory materials, materials used as spreaders, stickers, and correctives.

FUNGICIDES

In general, spraying, dusting and disinfecting materials used to control diseases contain either copper, sulfur, or mercury. Some of the common fungicides used are:

SPRAYING MATERIALS

1a. Bordeaux mixture—Bordeaux mixture is a mixture of copper sulfate and lime. It is used for the control of a number of foliage diseases on shrubs. Bordeaux is being replaced as a fungicide in sprays by proprietary copper compounds because of the ease of mixing and storing of the latter materials. The formula for bordeaux varies in the amount of copper sulfate and lime depending upon the disease to be controlled. The formula 4-6-50 is in common use for the control of disease on shrubs. In a formula for bordeaux the first figure always stands for the amount of copper sulfate in pounds, the second figure for the amount of fresh

hydrated spray lime in pounds, and the third figure for the amount of water in gallons.

Copper sulfate is obtainable in three grades, based on particle size. These grades are referred to by the trade as powdered, snow, and small and large crystals. The powdered and snow grades are recommended for convenience in the preparation of bordeaux.

Only fresh hydrated lime prepared for spraying purposes should be used in the preparation of bordeaux. Mason's hydrated and agricultural lime are not satisfactory.

To make a 4-6-50 bordeaux:

1. Fill the tank about $\frac{2}{3}$ full with water.
2. Have agitator in operation.
3. Make the 6 pounds of spray lime into a thin paste and wash through a strainer.
4. Dissolve the 4 pounds of copper sulfate in 2 to 3 gallons of water and add it slowly to the lime solution.
5. Add water to make 50 gallons to allow 3 to 4 minutes for the copper sulfate and lime to react before using. Bordeaux should be used soon after mixing. Keep agitator in operation until the mixture is sprayed out.

1b. Bordeaux for disinfecting roots—Approximately 2 gallons of very strong bordeaux mixture is made by pouring a solution of copper sulfate $1\frac{1}{2}$ pounds in a gallon of water, into a mixture of 3 pounds of lime (hydrated) in a gallon of water. This formulation is used for dipping the roots of shrubs to protect against crown gall infection. Read section 34.

2. Lime-sulfur—Lime-sulfur contains sulfur combined with lime, and these products are known as calcium polysulfides. Lime-sulfur solutions stain paint and stone.

Lime-sulfur can be obtained in both the liquid and dry forms.

Liquid lime-sulfur is both an insecticide and a fungicide. It can be used to control certain scale insects and some diseases in the dormant period and to control certain plant diseases in the growing period. For dormant use, add 1 gallon of concentrated liquid lime-sulfur to 7 gallons of water. Dormant strength lime-sulfur is most often employed on shrubs which would be injured by oil sprays. Scales and mites on maple are controlled with this spray. It can be used on conifers for scale insects and gall making plant lice where staining does not matter. The usual dilution for the control of plant diseases in the growing period is 1 gallon to 50 gallons of water. Dissolved 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.

3. Mercury compounds—Mercury compounds are used for disinfecting tools, for seed, bulb and turf treatments, and against earthworms. They are violent **POISONS**.

Mercury bichloride—Mercury bichloride (corrosive sublimate) is used for disinfecting tools, for turf treatment, and against earthworms. It can be purchased in tablet or powdered form. For small quantities the tablet form is preferable. They can be purchased from drug, garden supply and other stores. Mercury bichloride (corrosive sublimate) is corrosive to metals, and should only be mixed in asphalt coated, enamel, glass, earthenware, or wood containers. **Corrosive sublimate is very poisonous when taken internally.** Care should be taken to store it out of the reach of children.

Mercurous chloride (calomel)—Mercurous chloride (calomel) is used in turf treatment. It can be purchased in tablet or powder form.

Proprietary mercury compounds are used for seed and turf treatment and are sold under various trade names such as Semesan, Ceresan, etc. They are to be used according to manufacturers' directions.

3a. Turf treatment—Two parts, mercury chloride (corrosive sublimate) and 1 part, mercurous chloride (calomel) are mixed together and applied at the rate of 3 ounces per 1,000 square feet for control of brown patch and dollar spot on turf. The common way of using the 2-1 mixture of mercury bichloride and mercurous chloride is to thoroughly combine the proper dosage of the chemicals for 1,000 square feet with 2 cubic feet of dry screened sand or soil to enable uniform spreading, broadcast, and wash into the soil by heavy sprinkling. In extremely hot weather reduce dosage to 2 ounces per 1,000 square feet of turf.

This treatment also kills some earthworms. Read following paragraph for complete information.

3b. Earthworm control—If they become too numerous the most effective treatment for earthworms is the application of 3 ounces of mercury bichloride (corrosive sublimate) dissolved in 50 gallons of water per 1,000 feet. Treatment is made by sprinkling the required amount of mercury bichloride (corrosive sublimate) solution upon the indicated area of turf and then washing it in with at least twice as much (100 gallons) water.

An alternative treatment consists in thoroughly mixing 3 ounces of mercury bichloride with 2 cubic feet of screened dry top soil or sand, scattering uniformly on 1,000 square feet, and watering liberally.

Most earthworms in soil treated with mercury bichloride immediately come to the surface, and move about very uneasily until dead. Treatments in the

morning of a sunshiny day are usually more successful because the sun then helps to kill the worms.

Special treatments for earthworms are seldom needed if mercury bichloride is regularly used to keep turf diseases under control. Read paragraph on turf (3a).

4a. Organic fungicides—Within the past few years new promising organic fungicides have been made available for disease control. A partial list of these materials include such trade names as: Fermate, Karbam, Dithane, Parzate, Zerlate, Standard Puratized and Phygon. Of this group Fermate and Karbam (ferric-dimethyl dithiocarbamate) have been sufficiently tested to be recommended for the control of certain diseases on ornamental plants. Fermate and Karbam should be used at the rate of $1\frac{1}{2}$ pounds to 100 gallons of water to give adequate protection against plant diseases during the growing period. Hydrated lime should not be used with these two materials.

4b. Formalin—Formalin contains formaldehyde and is sold in most drug stores and in many establishments handling gardeners' and farmers' supplies for disinfecting seeds, tools, soil, etc. Read section 35 for directions on disinfecting pruning tools.

For disinfecting soil use formalin 1 part to 50 parts water. Apply at the rate of $\frac{1}{2}$ gallon per square foot with a sprinkling can. Cover treated area with paper, canvas or boards for 48 hours. Stir soil thoroughly to aerate it. Do not replant in treated soil for at least 10 days.

5. **Proprietary copper compounds**—Proprietary copper compounds (low soluble or fixed coppers) are manufactured copper fungicides containing copper in a relatively low soluble form. They are sold under various trade names. A partial list of these materials includes Basicop, Bordow, Cupro K, COCS, Oxobordeaux, Spraycop, Tennessee 26, Tennessee 34, and Tri-Basic. Proprietary copper materials can be used as substitutes for bordeaux in the control of a number of plant diseases. They are less injurious to plants, vary in copper content and should be used according to manufacturers' recommendations.

6. **Wettable sulfurs**—Wettable sulfurs contain finely divided particles of elemental sulfur to which a wetting agent has been added. They can be obtained in both the dry and paste forms. Wettable sulfurs are sold under various trade names. A partial list of wettable sulfurs includes Dritomic, Flotation paste, Flotox, Kolofog, Magnetic, Mike, Sulfix, Sulforon and 3 M. 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 the amount of the dry form to use is 1 to 1½ pounds to 20 gallons of water, or 5 to 8 pounds to 100 gallons of water. Wettable sulfurs are protective fungicides and the plants must be kept covered during infection period if good control is to be obtained.

DUSTING MATERIALS

7. **Copper dusts**—There are two kinds of copper dusts available as fungicides; (a) monohydrated copper sulfate-lime dust and (b) proprietary copper dusts. The monohydrated copper sulfate-lime dust is usually prepared by mixing 20 parts by weight of monohydrated copper sulfate and 80 parts of fresh hydrated spraying lime and is known as a 20-80 copper-lime dust. The proprietary copper dusts are prepared by mixing a proprietary copper material with some inert material as talc for a carrier. The proportion of proprietary copper compound to the diluent varies with the proprietary copper compound and the disease to be controlled. In general, the dust should contain 5- to 7-percent metallic copper. For example, a 5-percent metallic copper dust prepared from a proprietary copper compound containing 25-percent metallic copper and talc would contain 4 pounds of the copper compound and 16 pounds of talc.

8. **Sulfur dusts**—Sulfur dusts contain finely divided particles of elemental sulfur to which a conditioner has been added to make it flow readily. They are usually high in sulfur content and can be used as straight sulfur dusts or diluted with other materials.

INSECTICIDES

Materials used to control insects can be divided into 3 groups (a) stomach poisons—those used to control leaf eating insects, such as caterpillars, beetles, and

slugs; (b) contact insecticides—those used to control sucking insects such as mites, aphids, and leafhoppers; (c) fumigants—materials which control insects by giving off poisonous gases.

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

9. Fluorine compounds—Fluorine compounds chiefly cryolite, are sold under various trade names. They are not used to any extent on shrubs. One part cryolite mixed with one part flour or talc is commonly used as a dust against certain resistant beetles. Use as a spray by manufacturers' directions.

10. Lead arsenate—Lead arsenate is the most commonly used stomach poison 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 and spreaders.

RECOMMENDED MATERIALS	AMOUNT TO USE IN SMALL QUANTITIES	AMOUNT TO USE IN LARGE QUANTITIES
Lead arsenate.....	2 to 3 tablespoonfuls	3 pounds
Summer oil.....	1 quart
Milk.....	½ cup
Water.....	1 gallon	100 gallons

Calcium arsenate can be substituted for lead arsenate as a stomach poison except in treating turf, but is not as desirable because of the danger of arsenical injury to plants.

Lead arsenate-nicotine in summer oil—When used for the control of needle miners, spruce tortrix, juniper web worms or lilac leafminer, should be applied with a machine delivering the spray with at least 300-500 pounds pressure in order to penetrate. The following proportions are suggested.

INGREDIENTS	SMALL QUANTITIES	LARGE QUANTITIES
Lead arsenate.....	½ cup	3 pounds
Nicotine sulfate 40%....	2 tablespoonfuls	1½ pints
Summer oil.....	½ cup	2 quarts
Water.....	5 gallons	100 gallons

Read sections 18 and 21.

Lead arsenate in soil—Turf may be protected against the various root feeding grubs similar to the white grub by incorporating lead arsenate in the upper 3 inches of soil at the rate of 10 pounds per 1,000 square feet. Treatment is usually made while building a lawn by thoroughly screening together lead arsenate and dry

topsoil or sand in the proportion of 10 pounds lead arsenate to 2 cubic feet of topsoil or sand. The mixture is then spread evenly over the fitted ground at the stated rate, worked into the top three inches, the seed or stolons planted, or the sod laid.

Established turf is treated by spreading a lead arsenate-soil or lead arsenate-sand mixture evenly over the grassy surface as a topdressing and sprinkling, or allowing the rain, to wash it down about the grass roots. However, instead of using one application of lead arsenate on established turf at the rate of 10 pounds per 1,000 square feet, two applications made approximately 6 months apart, at the rate of 5 pounds of lead arsenate per 1,000 square feet should be made to avoid injury. This method is not so effective as grub proofing done when a lawn is made.

Extremely alkaline or extremely acid soils are harder to protect.

11. Poison bait—A number of different combinations are used as poison bait, each of which fits a particular need.

In mixing large quantities combine the poison, molasses, and salt in 6 gallons of water and work into the bran adding water until the bran is thoroughly wetted but not mushy and last of all add the banana oil or fruit.

MATERIALS	SMALL QUANTITIES	LARGE QUANTITIES
*White arsenic.....	4 ounces	5 pounds
Salt.....	4 ounces	5 pounds
Molasses.....	1 pint	2 gallons
Bran.....	5 pounds	100 pounds
**Water.....	Enough to make finished bait "form" when squeezed.	
Banana oil.....	3 ounces 1 orange or lemon ground.	

*Paris green or sodium fluosilicate may be substituted for white arsenic but **never** use lead arsenate in bait.

**For five pounds of bait the amount of water necessary varies from 3 to 4 pints; for 100 pounds bait from 7 to 10 gallons because bran differs in water-holding capacity.

The same procedure is followed with small quantities except that a quart of water will be enough to start the mixing.

To control grasshoppers spread the bait **in the forenoon** at the rate of 10 to 20 pounds per acre.

The same combination is used to control cutworms except the salt is omitted. To control cutworms spread bait late in the afternoon or early evening and use (10 pounds per 1/3 acre) 20 to 40 pounds per acre.

To control strawberry root weevil the same combination used to kill cutworms can be used profitably but better results will follow if oil of apple is substituted for banana oil. This bait should be so placed it

can be kept moistened, as under a board, sacks or in covered trenches. The beetles like to congregate in dark protected places and feed.

A very convenient bait for cutworms can be made by mixing: 2 pounds dandelions chopped fine, 1 ounce sodium fluosilicate, or Paris green or white arsenic.

Proper safety precautions in using poison bait.

1. In the garden, avoid permitting the bait to touch plants, otherwise, burning will follow.
2. Wash hands thoroughly after handling poison bait.
3. See that livestock do not gain access to the bait before it is spread.
4. Clean all utensils thoroughly and do not store or allow any accumulation of stored bait.

(No authentic cases of poisoning song or game birds are known.)

12. Rotenone—Rotenone is a compound found in the roots of derris and cube as well as other tropical plants. It can be used as a stomach poison and as a contact insecticide. It can be purchased in powdered form or as a liquid formulation. There are a number of proprietary rotenone containing materials on the market. They should be used according to manufacturers' recommendations. Rotenone is non-poisonous to warm-blooded animals. Read section 20.

13. Tartar emetic—Thrips on shrubs are readily killed by a spray of tartar emetic. The same spray

may be used on turf to prevent re-infestation of nearby plants from grass which often serves as a breeding place for thrips.

Tartar emetic is most effective against thrips when applied as a mist-like spray, that is, only enough spray to form small closely spaced droplets on the leaf surfaces.

Proprietary antimony compounds should be used at manufacturers' directions.

A knapsack sprayer gives about the proper coverage when a fine disk is used in the nozzle.

The common formula for thrip control is:

MATERIALS	LARGE QUANTITIES	SMALL QUANTITIES
Tartar emetic.....	2 pounds	1 ounce
Brown sugar.....	4 pounds	2 ounces
Water.....	100 gallons	3 gallons

Tartar emetic is a metallic poison and proper care in its use must be observed. Never use tartar emetic on foliage that is to be eaten.

CONTACT INSECTICIDES

14. Phosphates—Organic phosphates (HETP, TEP and Parathion) are very effective against small insects and mites. The only organic phosphate with a pronounced residual effect is Parathion. Parathion 15 per-

cent wettable powder one pound per 100 gallons has given excellent control of mites.

All organic phosphates insecticides are very poisonous and should be handled according to the printed directions of the manufacturer.

15. DDT, Dichlorodiphenyltrichloroethane, is effective against a wide range of insects. It is particularly effective against leafhoppers, small beetles, caterpillars and bugs. DDT kills some aphids, others are unaffected. Certain leafrolling caterpillars are also unaffected. In other words, it is a specific. DDT is not compatible with lime-sulfur and alkalis but may be used with bordeaux.

DDT is a waxy substance and must be formulated correctly for use. It is well to remember that DDT is not always a quick killer like pyrethrum and nicotine. Wettable powders are the safest form for foliage application.

(a) DDT 5 percent in oil solution is recommended for treating certain borers by injection into the holes made by the insects. A mechanics oil can is a convenient applicator.

DDT oil sprays are too erratic for general foliage application.

(b) DDT is ground with various talcs, clays, etc., to form wettable powders. DDT is safe on foliage in this form. Privet, bleeding heart, and delphinium are the only common garden ornamentals likely to be injured by it so far as known.

Two pounds of 50 percent wettable powder per 100

gallons of spray is a common dosage and is effective against a wide range of insects.

(c) DDT 50 percent wettable powder and fixed nicotine make a most effective combination. Nicotine gives quick kill and those insects not killed by it are irritated. 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 wettable powder DDT 50 percent and 3 pounds of fixed nicotine make an effective long lasting combination. DDT also kills certain beneficial insects such as bees, and the U. S. Public Health Service is investigating the health hazards involved. This agency advises caution in the use of the material until more is known concerning its effect on man and other warm-blooded animals.

16. Dicyclohexylamine salt of dinitro-ortho cyclohexylpheno (DN-111)—DN-111 is a specific for mites on foliage. It can be applied in sprays with lead arsenate and wettable sulfurs. It is incompatible with oils and alkalis. Use according to manufacturers' recommendations.

17. Chlordane is a most effective chemical for ant control. It is used sometimes against other insects. A 4-5 percent dust is the usual formulation for ant control.

18. Nicotine sulfate 40%—A contact spray of nicotine sulfate 40% is used with soap or other alkaline activating agents. Standard dilutions are 1 pint, plus 4 to 6 pounds of soap in 100 gallons of spray or 1 tea-

spoonful in warm soapsuds made by dissolving a one inch cube of soap in one gallon of water. Read sections 28 and 31. It is also used with summer oil at the rate of 1 pint nicotine and 1/2 gallon summer oil per 100 gallons. Read section 23.

One ounce of 40 percent nicotine sulphate plus one quart of liquid soap is very effective against scale crawlers. It can be used on evergreens in the summer without danger.

Nicotine dust, 4 percent, may be substituted when available for nicotine sprays. However, it is well to remember that care in application is very necessary.

19. Pyrethrum—Pyrethrum is a product prepared from the flower heads and stalks of certain plants of the chrysanthemum family. It can be used to control aphids and leafhoppers and when combined with a wetting agent, mannitan monolaurate,* will kill rose chafer. Pyrethrum is also effective as a dust against many insects. It is sold under various trade names and should be used according to manufacturers' recommendations. It is harmless to warm-blooded animals.

20. Rotenone—See rotenone under stomach poisons, Section 12. Rotenone containing sprays are recommended for the control of mites, thrips, aphids, and other soft-bodied insects. The following mixture is recommended for control of mites.

RECOMMENDED MATERIALS	AMOUNTS TO USE IN 3 GALLONS OF SPRAY	AMOUNTS TO USE IN 50 GALLONS OF SPRAY
Rotenone powder containing 4 percent rotenone.....	4 1/2 tablespoonfuls	10 ounces
Sulfonated castor oil (Turkey Red oil).....	12 tablespoonfuls	1 pint

1. Add about 2/3 of the water to the spray tank.
2. Add the sulfonated castor oil to the water and agitate.
3. Make the powder into a thin paste with water and add to the oil and water mixture.
4. Add water to make the required amount of spray. Keep well agitated. Two or more applications should be made at 10-day intervals.

21. Summer oils—Summer oils are light, chemically treated oils of approximately 70-80 seconds viscosity by the Saybolt at 100° F. They are sold under trade names ready for dilution with water and are commonly diluted at the rate of 1/2 or 1 gallon per 100 gallons of spray. A partial list 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 one or two quarts per 100 gallons of spray.

*NNOP and Pyrospread contain this spreader.

Some shrubs will not tolerate oils. Oils are incompatible with sulfur.

INSECTICIDES FOR DORMANT USE

The materials recommended for dormant use must be applied while the shrubs are strictly dormant.

22. DN Dormant—DN Dormant sprays are sold with different percentages of DN and it is necessary to follow the manufacturers' directions. $1\frac{1}{4}$ pounds of 40-percent DN compound or 1 pound of 50-percent DN compound per 100 gallons of spray is required for aphid control. Where a 40 percent DN is used $7\frac{1}{2}$ pounds are required for each 100 gallons of water when applied to control oystershell scale since about 3 pounds of actual DN is required to get a commercial kill. **This compound stains paints, stone, concrete, clothes and skin.**

23. Dormant oils—Dormant oils used for control of scales and mites are made from lubricating oils of about 100 seconds viscosity (Saybolt at 100° F.) and 60-80 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 manufacturers' directions. Consult Extension Bulletin 154 for directions on home-made emulsions.

24. Lime-sulfur—See section 2.

25. Calcium cyanide—Calcium cyanide is used to control ants and ground bees. Inject granular calcium cyanide into ant hills or into nests of ground bees at intervals of 2-3 weeks during the growing season, and close the opening. Plants will be injured by this treatment if applied closer than 2 feet. **Cyanide is a deadly poison.** Observe manufacturers' **precautions** printed on can. See also section 26.

26. Carbon disulfide—Carbon disulfide is used to control borers, ants, and ground bees. Where only one or two shrubs are to be treated borers can be killed by injecting a few drops of carbon disulfide into the tunnels and plugging the openings with mud or grafting wax.

Carbon disulfide is also used to kill ants and bees in the soil. Where a teaspoonful of the liquid can be injected into the openings with an oil can and the opening plugged with soil a good kill will result but it will be necessary to follow-up the treatment at **weekly intervals** for two or three months. Carbon disulfide is inflammable, explosive and the fumes are poisonous.

27. Paradichlorobenzene (PDB) in cottonseed oil—For control of borers, dissolve PDB at the rate of 1 pound in 2 quarts cottonseed oil and apply with a brush over injured areas in early spring or late fall. PDB

may be dissolved at the rate of 2 pounds in 1 gallon of miscible oil and mixed with 30 parts of water and applied to the infested areas as a spray.

ACCESSORY MATERIALS

28. Commercial spreaders and stickers—There are upon the market a large number of spreaders and stickers developed for use with specific materials. Very commonly these spreaders and stickers are satisfactory when used for the purpose for which they were made. Often they work poorly if not used in just the way intended. When using commercial spreaders and stickers, read all directions carefully and follow them.

Sulfated alcohols—A number of sulfated alcohols are sold as spreaders, activators and extenders. Of these, sodium lauryl sulfate, commercially known as dreft, drene, etc., or the du Pont sticker-spreader can be used to remove honey dew from foliage. It is recommended at 4 ounces per 100 gallons and best results follow where the spray is applied at 200 to 300 pounds pressure. The shrubs should be rinsed with water to remove the material within 24 hours after application. Dilute any accumulation of sulfated alcohol on the grass to prevent damage.

29. Lime—Hydrated lime (chemical hydrate) is the only form of lime generally available for spraying and dusting purposes in Michigan. Lime used for spraying and dusting must be one prepared for this purpose.

Mason's hydrate and agricultural lime are not satisfactory. Only fresh lime should be used. Recently manufactured hydrate lime should be satisfactory for 10 to 12 weeks if stored in a dry place and not exposed to the air.

30. Lime-bentonite-sulfur—A spray containing 15 pounds hydrated lime and 5 pounds bentonite-sulfur to each 100 gallons of water, is recommended on trees and shrubs to repel rose chafer.

31. Soaps—The most important use of soap or soap-like compounds is as wetting and activating agents with nicotine sulfate. One-half pound of soap flakes or 1 pound of ordinary laundry soap or 1 ounce of dreft is generally recommended to 25 gallons of spray. Soaps must be thoroughly dissolved.

To keep down oystershell scale on a lilac bush until a dormant spray of oil or DN can be applied, scrub the infested branches thoroughly with a strong solution of laundry soap, 1 pound in 1 gallon of water as hot as can be borne by the hand. Use a scrubbing brush for best results.

Where soaps are used alone to remove honey dew or soot from conifers, the shrubs should be washed with clear water under pressure any time after the spray dries up to 24 hours after the application. In removing the material from the shrubs, see that enough water is used to prevent injury to the grass.

SUPPLEMENTARY MEASURES

32. **Soybean flour**—Soybean flour is used as a sticker and spreader with a number of materials. A special grade of flour is available for spraying purposes. In general it should be used at the rate of 1 ounce to 25 gallons or $\frac{1}{4}$ pound to 100 gallons of spray. A good method of adding it to the spray mixture is to make it into a thin paste before adding it to the spray solution in the tank.

33. **Zinc sulfate-lime mixture**—The flake form of zinc sulfate containing 25 percent zinc is the form recommended for spraying purposes.

A 4-4-100 zinc sulfate-lime mixture is recommended to prevent arsenical injury to peach and plum trees.

The zinc sulfate-lime mixture is prepared as follows:

1. Begin filling the spray tank with water.
2. With the agitator running, add the required amount of zinc-sulfate, previously dissolved in water, to the tank. Fill tank to about $\frac{2}{3}$ full.
3. Wash the required amount of lime through the strainer or make it up into a thin paste and pour into the tank.
4. Finish filling the tank and agitate a few minutes before adding the lead arsenate.

If a fungicide is necessary it should be added after the lead arsenate.

34. **Dipping roots for crown gall**—The roots of young shrubs suspected of contamination with the crown gall organism are sometimes treated by dipping in a strong solution of bordeaux. See 1b.

35. **Disinfecting pruning tools**—Dip in formalin 1 part in 10 parts of water or in a solution of corrosive sublimate (mercuric chloride) 1 to 500, or full strength denatured or radiator alcohol. Mercury bichloride (corrosive sublimate) tablets can be purchased at drug, garden supply and other stores and used to make up required quantities. Corrosive sublimate is corrosive to metals and should only be mixed in asphalt coated, enamel, glass, earthenware or wood containers. **Corrosive sublimate is very poisonous when taken internally.** Care should be taken to store it out of reach of children.

36. **Fertilizing shrubs**—Dependent on the findings of soil sample tests and directions of the Department of Soil Science, Michigan State College, East Lansing, Michigan.

In general use a complete fertilizer cultivated in at the rate of 3-5 pounds per 100 square feet. Each year dig or cultivate into the soil some organic matter. Mulching with peat or well rotted leaves is an excellent way to keep up fertility and to improve the physical condition of the soil.

37. Sanitation—Sanitation is simply good house-keeping 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 the fungus or bacillus causing disease will help in the control of most diseases. In some cases it is the only means of keeping disease in check. Where desired, the leaves may be composted instead of being burned.

Many injurious insects which overwinter in the shelter afforded by plant litter will be destroyed at the same time.

38. Soil testing—To determine if soil is too alkaline, test with Soiltext. Excess alkalinity can be neutralized by applications of ammonium sulfate, alumi-

num sulfate, or sulfur. To test soils for other nutritional disturbances consult county agricultural agent.

39. 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 certain transplanted shrubs. Wrap the shrubs before borers have laid their eggs in the bark. Overlap the paper to form a complete barrier and tie it in place with loops of binding twine (binding twine will break before it girdles a shrub). Only a few shrubs can be treated in this way.

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