

GENERAL SPRAYING PRACTICES



CIVILIAN CONSERVATION CORPS



UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

CIVILIAN CONSERVATION CORPS

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TREE PRESERVATION BULLETIN NO. 6

**GENERAL
SPRAYING
PRACTICES**

BY

A. ROBERT THOMPSON, FORESTER

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**GRADUATE SCHOOL OF LAND, AGRICULTURE
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CIVILIAN CONSERVATION CORPS

ROBERT FECHNER, DIRECTOR



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GENERAL SPRAYING PRACTICES

By A. Robert Thompson, Forester.

Part G of Chapter III, Standard Practices

Tree Preservation Bulletin Series

Introduction

The control of insects and diseases which attack the shade trees and shrubs in eastern national parks, monuments, and cemeteries is one of the most important and persistent tree preservation problems which faces the Service. To facilitate control operations several high-powered sprayers have been acquired recently and are strategically located so that each may serve a number of parks.

The ramifications of the fields of entomology and forest pathology are, of course, too broad to be more than mentioned in this short publication which was prepared to give eastern National Park Service field officers a brief summary of modern spraying practices used for the control of insects and diseases affecting ornamental trees and shrubs.

There is no claim for originality in the presentation of this material; indeed, all available sources were consulted in an endeavor to assemble the best and most recent information on the subject. Grateful acknowledgment is made of the valuable criticism and suggestions given during the review of the manuscript of this bulletin by the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, and by Mr. Norman Armstrong and Mr. Theodore Reuman, Arborists.

It will be noted that much of the information is briefed and that many common pests have been deleted in the control charts. Data concerning spraying equipment have also been omitted. These condensations and omissions have been deliberate in an attempt to present sufficient practical information in concise form to enable field officers and technicians to solve pest control problems which affect the ornamental trees and shrubs which are considered most important from an eastern Park Service viewpoint.

Those interested in more complete information will find a list of references at the end of this bulletin. It is urged that field officers make fullest possible use of such collateral material and also that they communicate with the Branch of Forestry on special problems. As knowledge of Park Service pest problems increases control charts will be modified. It is also planned that a number of bulletins to be issued in the Chapter II series will give more complete information regarding the most important insects and diseases affecting eastern National Park Service areas.

Section I. Insect Control

Years ago, before natural ecological relationships had been disturbed to any great degree, there were comparatively few insects whose depredations seriously affected mankind from an economic standpoint. However, as the balance of nature gradually was upset in many ways normal insect control factors also were changed so that today one of the most serious problems facing us is the control of countless varieties of insects. The problem has been accelerated by the introduction into this country of many exotic forms of plant material which carry insects and diseases of minor importance in the country of origin but which under our conditions often become serious if not fatal enemies to our vegetation.

In order to combat the attacks of insects several methods of control have been developed. Among the methods which have been successfully used are spraying and dusting from both the ground and from airplane, trapping, poison baiting, repelling, gassing, and the dissemination of natural enemies and parasites.

The type of control with which we are immediately concerned is the application of chemicals which have been found effective when used as insecticides.

Types of control materials

Materials may be divided into six general groups according to the method in which they are used to control insects. These groups and their uses are as follows:

1. Stomach poisons.--These are used to combat insects which feed by chewing and swallowing their food. They are applied as sprays or dusts to food plants prior to or during feeding periods.

2. Contact insecticides.--Such materials are used to combat insects which feed by sucking plant juices. They may be applied as sprays or dusts directly to the insect in egg, larval, pupal, or adult stages.

3. Fumigants.--Gas-forming materials which kill insects by fumes. Usually they are used in confined places.

4. Repellents.--Such materials are used to prevent insects from alighting upon or feeding upon trees or from ovipositing. Repellency may be due to odor or physical character such as stickiness.

5. Attractants.--These are materials which are especially attractive to insects. They are used commonly in poison baits.

6. Spreaders, stickers, wetting agents, etc.--Such materials are used with insecticides to increase the effec-

tiveness of the insecticides by making them stick, wet, or spread better. Wetting agents increase the efficiency of contact sprays, and stickers and spreaders are useful with stomach poisons.

Stomach poisons

Lead arsenate.--For Park Service purposes lead arsenate may be used generally for the control of leaf-eating insects on shade trees. Standard formulae Nos. 1, 2, 3, or 10 are recommended.

Lead arsenate may be combined safely with nicotine sulfate, bordeaux mixture, or oils; but it should rarely be used with soap because of the possible burning action of the arsenic freed by this combination. Care should be exercised to prevent poisoning of foods and drinking water of man and animals. The quantity of lead arsenate used may be varied if necessary from 3 to 8 pounds per 100 gallons of water. The effectiveness of lead arsenate is greatly increased by the addition of a sticker or spreader.

Summer contact insecticides

Nicotine.--This material usually is supplied as nicotine sulfate containing 40 percent nicotine. It is available also as free nicotine, usually containing 40, 50, or 95 percent nicotine. Standard formulae for general use are Nos. 4 and 10 as required.

Nicotine sulfate may be combined safely with arsenate of lead as a combination spray. The addition of soap or miscible oil as a wetting agent will increase the effectiveness of nicotine sulfate from $1\frac{1}{2}$ to 2 times.

Derris insecticides.--Rotenone is one of the most important derivatives of dried derris root which should contain 16 to 20 percent rotenone and other toxic materials to be effective. Rotenone often is sold in combination with pyrethrum with an oil base. The material is effective where arsenicals would be dangerous to use. It is not toxic to man or animals. The effectiveness lasts 4 to 5 days after which the application should be repeated.

Pyrethrum.--This material is made by extracting the toxic agents from pyrethrum flowers. It is non-poisonous to animals and man and useful where such considerations are important. Its efficiency is increased by using soap or other wetting agent in the spray mixture. It may be applied as a dust or spray.

Summer white oils.--Such materials are made from petroleum oils with unsaturated hydrocarbons removed. They are chemically inert and effective as wetting agents against summer stages of scale insects, mealy bugs, and spider mites. They are used in 1 or 2 percent solution. Their toxicity may be increased by

adding nicotine, pyrethrum, or derris root extracts. They are unsafe on sugar maple, Japanese maple, beech, butternut, and black walnut.

Sulfur.--Sulfur is useful as a spray or dust against summer stages of red spider, spider mites, etc.

Dormant contact sprays

Miscible oil.--Petroleum oils. These are used as dormant sprays to control scale and as a general cleanup against winter stages of wide variety of insects. They may be used safely on most trees but not on sugar maple, Japanese maple, beech, butternut, or black walnut. They should not be applied when temperature is likely to drop below 40 degrees F. Care always should be taken to assure a perfect emulsion. When the solution has lain in hose or tank for some time it should be pumped back through the tank to avoid a separation of the emulsion.

Lime sulfur.--Concentrated lime sulfur and lime sulfur wash are effective against many armored scales and as fungicides. They should not be allowed to contact painted surfaces because of the resulting discoloration.

Dilution Table for Contact Sprays

Amount of finished spray	Amount of spray material to use with water for these dilutions			
	1 to 200	1 to 400	1 to 600	1 to 800
	.5%	.25%	.166%	.125%
1 qt.	1 tsp.	1/2 tsp.	1/3 tsp.	1/4 tsp.
1 gal.	4 tsps.	2 tsps.	1-1/2 tsps.	1 tsp.
5 gals.	3-1/5 ozs.	1-3/5 ozs.	1 oz.	4/5 oz.
50 gals.	1 qt.	1 pt.	3/4 pt.	1/2 pt.
100 gals.	2 qts.	1 qt.	1-1/2 pts.	1 pt.
400 gals.	8 qts.	1 gal.	6 pts.	2 qts.

Equivalent weights and measures

4 teaspoons = 1 tablespoon
2 tablespoons = 1 fluid ounce

16 fluid ounces = 1 pint
8 pints = 1 gallon

Fumigants

Calcium cyanide.--This material develops hydrocyanic gas which is a deadly poison and must be used with extreme care. It may be inserted in galleries of wood-boring insects and the openings plugged. It should be used very carefully according to directions.

Paradichlorobenzene.--This is a white crystalline material and is a specific control for peach tree borer. It volatilizes slowly.

Carbon bisulfide.--This is a liquid which produces a volatile gas which is heavier than air and highly flammable. It is used for injection into galleries of wood-boring insects after which the openings should be plugged. It is used also for killing ants by injecting into the nests.

Repellents

Bordeaux mixture.--This material is a fungicide which is repellent to many insects such as leaf hoppers and flea beetles. It is made up of copper sulfate and lime.

Nicotine.--Various nicotine compounds are repellent to insects. Tobacco dust is sometimes mixed with the soil around plant roots to repel insects. Nicotine sulfate combined with bentonite, or free nicotine combined with various acids produce compounds that act as repellents by slowly giving off nicotine. Usually it is used as nicotine sulfate containing a solution of 40 percent nicotine.

Other materials used as repellents for certain insects include pine tars, paradichlorobenzene, naphthalene, derris, cube, pyrethrum, and lime.

Attractants

Attractants are used for insect control with some form of food which is poisoned, or with trap equipment. For instance, the Japanese beetle is attracted to the combination odor of geraniol and eugenol. This material is placed in traps to catch the insects or is sprayed upon poisoned foliage.

Spreaders, stickers, and wetting agents

Soap.--Soap is good as a wetting agent and spreads well but is of no value as a sticker since it washes off readily. It usually is unsafe for use with arsenicals but is excellent with nicotine compounds.

Oils.--These are useful as stickers and spreaders. Miscible oils at 0.5 percent, unemulsified fish oil, and linseed oil at 0.25 percent are useful as stickers with arsenate of lead for shade tree spraying.

Casein.--This material is used in the form of calcium caseinate as a spreader and sticker at the rate of 1 to 2 pounds to 100 gallons of spray mixture in shade tree spraying.

Blood albumin.--Powdered blood albumin spreader used at the rate of 4 ounces to 100 gallons of water is one of the newer important spreaders coming into use.

Flour.--Ordinary wheat flour is an excellent spreader and sticker. It is used at the rate of 2 to 4 pounds to 100 gallons of spray and should be mixed into a thin paste before putting

in the spray tank.

Alcohol.--The sulfonated alcohols can be used with hard water without causing insoluble soap materials. They are useful as wetting and spreading agents.

Barrier bands.--The use of sticky trap material as barrier bands on trees is a practice now going out of general use due to the increased use and efficiency of power sprayers. Use of barrier bands is not approved for general National Park Service use.

Section II. Leaf and Twig Disease Control

Fungus diseases may be disseminated in several ways: (1) Transmission by spores. (2) Transmission by vegetative method, i.e., by the growth of the fungus mycelium which is present in the seed or other part of a plant. The mycelium (thread-like growth) remains dormant until the plant starts to grow and then grows along with it. (3) Sclerotia or masses of mycelium are also formed in the protoplasm of bulbs, tubers, etc.

It is with the first method of fungus dissemination that we are concerned in this bulletin, since the other methods do not lend themselves to control by spraying. Fungus spores may be carried by wind, rain, insects, birds, animals, and man.

Fungicides are solutions or powders applied to plants for the purpose of checking diseases caused by parasitic plants. To be of the greatest value a fungicide for shade trees should possess the following characteristics:

1. Should destroy the fungus without injury to the host.
2. Be easy to prepare and apply.
3. Be economical in cost.
4. Persist for some time on the plant in a toxic condition.

It should be kept in mind that fungicides are preventive in action and not curative. Once a parasitic plant has become well established in the host, spraying with fungicides can have little or no value. To be effective in controlling many diseases, spraying often should be preceded by a thorough sanitation program. Such a program would include the pruning, raking, and burning of infected twigs and leaves. These measures are of great aid in controlling such diseases as sycamore and oak anthracnose, horsechestnut leaf blotch, fire blight, etc.

Usually it is necessary to apply three or more successive sprays in order to prevent infection by various leaf and twig diseases. In most cases the first spray should be applied when the buds are breaking; the second about 10 days later when the leaves are $\frac{1}{3}$ to $\frac{1}{2}$ grown; the third when the leaves are full sized. Local conditions will govern the necessity of additional spray applications which may be required because of rainy weather, etc.

As a general rule the spores of leaf and twig diseases are given broad dissemination by rain which washes the spores down the twigs and branches to new spots of infection susceptibility; hence, it is important that fungicides be applied both before and after rains.

Important fungicides

Bordeaux mixture.--The most efficient of the fungicides for shade tree spraying. It is fully effective only if fresh. It can be homemade of copper sulfate crystals and lime but the process is somewhat inconvenient. A quick bordeaux may be made by using finely ground copper sulfate and hydrated lime as follows: Wash through the strainer the required amount of freshly ground hydrated lime, fill the sprayer tank half full, and then wash in the finely ground copper sulfate with the remainder of the water required. The usual mixture is 8 pounds of copper sulfate and 8 pounds of hydrated lime to 100 gallons of water.

Commercial bordeaux may be purchased ready mixed, but such mixtures are more costly and less effective than the mixture made on the job as stated above.

Bordeaux mixture should not be used on fruit trees.

Lime sulfur.--This compound is obtainable in liquid commercial concentrated form, dry powdered form, as well as by home manufacture. It is used in concentrated form usually at 2 gallons to 100 gallons of water and is useful principally in orchard spraying in place of bordeaux. Lime sulfur is unpleasant to use since it has an offensive odor, is corrosive to the skin, and causes discoloration of painted surfaces.

Lime sulfur is now obtainable in dry powder form which is useful because of convenience. This is efficient as a summer spray at the rate of 6 pounds per 100 gallons.

Sulfur.--It is useful either as a dust or a spray. To use as a spray it may be made wettable as follows: Mix dry 16 pounds of dusting sulfur, 8 pounds of hydrated lime, and 1/2 pound of calcium caseinate. Add this mixture to 100 gallons of water while being agitated.

It also is possible to obtain prepared wettable sulfur ready to place in spray tank. Sulfur sprays give excellent protection from fungi and are useful in the control of spider mites, red spider, etc., on conifers.

Section III. National Park Service Standard Formulae

The following formulae will be considered standard for National Park Service use in eastern areas where insect and fungus control measures are necessary. If it appears desirable to use other formulae in special cases approval first should be obtained from the Branch of Forestry:

<u>S. F. No. 1.</u> (Stomach poison)	
Arsenate of lead	- 4 pounds
Calcium caseinate	- 1 pound
Water	- 100 gallons
<u>S. F. No. 2.</u> (Stomach poison)	
Arsenate of lead	- 4 pounds
Fish oil or linseed oil	- 1 pound (1 pint)
Water	- 100 gallons
<u>S. F. No. 3.</u> (Stomach poison)	
Arsenate of lead	- 4 pounds
Powdered blood albumin spreader	- 4 ounces
Water	- 100 gallons
<u>S. F. No. 4.</u> (Contact spray)	
40 percent nicotine sulfate	- 1 pint
Soap	- 4 pounds
Water	- 100 gallons
<u>S. F. No. 5.</u> (Dormant - conifers)	
40 percent nicotine sulfate	- 1 pint
Miscible oil	- 2 gallons
Water	- 100 gallons
<u>S. F. No. 6.</u> (Dormant - deciduous)	
Miscible oil	- 6 gallons
Water	- 100 gallons
<u>S. F. No. 7.</u> (Dormant - armored scale)	
Commercial lime sulfur wash	- 11 gallons
Water	- 100 gallons
<u>S. F. No. 8.</u> (Summer - combination)	
Commercial lime sulfur wash	- 3 gallons
Arsenate of lead	- 4 pounds
Calcium caseinate	- 8 ounces
Water	- 100 gallons
<u>S. F. No. 9.</u> (Summer - contact)	
Wettable sulfur	- 10 pounds
Water	- 100 gallons
<u>S. F. No. 10.</u> (Poison - contact combination)	
Arsenate of lead	- 4 pounds
40 percent nicotine sulfate	- 1 pint
Calcium caseinate	- 1 pound
Water	- 100 gallons
<u>S. F. No. 11.</u> (Fungicide - bordeaux mixture)	
Powdered copper sulfate	- 8 pounds
Powdered hydrated lime	- 8 pounds
Water	- 100 gallons

S. F. No. 12. (Dormant fungicide)

Concentrated lime sulfur	- 2 gallons
Water	- 100 gallons

S. F. No. 13. (Summer fungicide)

Dry lime sulfur	- 6 pounds
Water	- 100 gallons

S. F. No. 14. (Fungicide - contact insecticide)

Mix)Dusting sulfur	- 16 pounds
dry)Hydrated lime	- 8 pounds
)Calcium caseinate	- 1/2 pound
Water	- 100 gallons

If necessary, when spraying for two or more classes of insects or fungi, the following combinations of spray material are considered safe:

Miscible oil and	)bordeaux mixture
	)arsenate of lead
	)nicotine sulfate
Nicotine sulfate and	)lime sulfur
	)bordeaux mixture
	)soap
Lead arsenate and	)bordeaux mixture
	)lime sulfur
	)nicotine sulfate

The following combinations are unsafe either mixed together or as successive sprays:

Miscible oil and lime sulfur
Lead arsenate and soap

Section IV. General Spraying RulesDo's

1. Know what you are spraying for and the proper formula to use.
2. Poisons are effective only when eaten by insects. This means a thorough coating of the surface of the leaf upon which the insect feeds.
3. Contact sprays are effective only when the insects are individually hit with spray. This means thorough soaking of the tree.
4. Be careful with spray materials. Arsenate is a deadly poison, and you can receive serious injury or discomfort from almost any material. Wear a raincoat, hat, and goggles if possible when spraying. Avoid leaving insecticides and containers

around where they are accessible to animals or children.

5. Always wash powdered materials through the strainer box on the sprayer. Such practice avoids lumps.

6. Keep agitator working when mixing spray materials.

7. When using arsenate of lead and lime sulfur together be sure to add 2 pounds of calcium caseinate to 100 gallons of spray.

8. Always use a sticking and spreading agent with poison sprays, and a wetting agent with nicotine sprays.

9. Always keep statues, walks, buildings, and shrubs wet down with water if a spray which might discolor is being applied nearby.

10. If rain follows a spray operation before the spray material has thoroughly dried respraying may be necessary.

11. Spraying equipment is expensive. Take care of it. Mechanical adjustments should be made only by skilled mechanics.

12. Spraying equipment must never be used for anything but insect or disease control operations.

13. Clean out the spray tank and hose thoroughly when changing spray mixtures during the day and before putting equipment away for the night.

Don't's

1. Don't use arsenate of lead and soap together or spray plants separately with soap if arsenicals were used earlier.

Why?--The free arsenic which is precipitated may burn the foliage.

2. Don't spray stone fruits with heavy applications of lead arsenate or any fruits with bordeaux mixture.

Why?--Lead arsenate may injure stone fruits. Bordeaux mixture induces russetting of fruit.

3. Don't spray sugar maple, Japanese maple, butternut, beech, or black walnut with oil sprays.

Why?--Oil sprays may penetrate to and kill the cambium in these species.

4. Don't spray from a long line of hose in which the spray material has been allowed to lie until the hose contents have been pumped back through the solution tank and thoroughly agitated.

Why?--The emulsion may separate and cause injury.

5. Don't spray with oils when the temperature is below 40

degrees F. Spraying should be stopped soon enough in the afternoon on cold days so that the spray will dry before the temperature drops in the late afternoon.

Why?--Cold weather slows up the evaporation of the solution and may cause injury.

6. Don't attempt to change spray formulae without prior approval.

Why?--Unapproved formulae may be unsafe or useless.

7. Don't spray conifers in the fall with a dormant spray.

Why?--It may cause loss of bloom and other injury.

8. Don't spray any trees when the temperature is 90 degrees F. or higher, especially when the sun is shining.

Why?--Burning of the foliage may result.

9. Don't permit arsenical sprays to remain in the spray tank overnight. Leaving any spray solution in the tank for long periods or overnight is poor practice. Solutions which have stood for some time should be thoroughly agitated before spraying.

Why?--The spray materials may separate or be precipitated and difficult to bring into solution again.

10. Don't use combination sprays unless you are sure they are harmless to the trees and then only if two or more types of insects or fungi are to be controlled.

Why?--To do otherwise is wasteful and may be harmful.

11. Don't apply poison sprays after the trees start to drip.

Why?--This decreases the effectiveness of the material and wastes it.

12. Don't allow spray materials to pollute streams or ponds.

Why?--Insecticides and fungicides are deadly to fish.

13. Don't combine oils and lime sulfur in the same solution or follow one after the other.

Why?--The combination will cause definite injury to the tree.

Section V. General Control Charts

The insect and disease control charts which appear on the following pages are in no sense complete and should be considered merely a ready reference to assist in emergency control problems. It is expected that field officers will, when time permits, avail themselves of the more complete information found in standard tests and bulletins.

As information is gained on specific problems in individual park areas, such data may be written in the blank spaces on page 18 for future personal use.

PRINCIPAL INSECTS AND CONTROLLABLE DISEASES AFFECTING IMPORTANT TREES AND SHRUBS IN EASTERN NATIONAL PARKS

		GENERAL CONTROL NOTES	
TREE OR SHRUB	INSECT OR DISEASE	FORMULA	
Arbor-vitae Juniper Retinospora	Aphids	4	Early spring when insects appear. Use force. Usually apply in June. Remove and burn bags in winter. Apply dormant. 2% summer oil & nicotine also satisfactory. As larvae feed. Contact spray effective used with force. Apply June or early July as or before larvae enter leaves. Apply No. 5 dormant, or No. 9 in midsummer when hot. No control by spraying. Destroy alternate host of fungus.
	Bagworm	1,2, or 3	
	Juniper scale	5	
	Juniper webworm	1,2, or 3	
	Leaf-miner	10	
Ash	Red spider	5 or 9	Inject carbon bisulfide. Sanitation and stimulation. Use No. 6 dormant, No. 4 as young are crawling in spring. Prune back to sound wood. Sanitation. Increase vigor.
	Rusts	None	
Azalea, Laurel Rhododendron	Borers	None	Cut out and burn infested stems with the contained borers. Apply after insects hatch. Spray underside of the leaf.
	Oyster-shell scale Twig & branch canker	6 or 4 . None	
Beech	Borers	None	Spray early and thoroughly after insects appear. Use force. Associated with fungus disease. Oil dangerous on beech.
	Lace-bug	4	
Birch	Aphids	4	Spray with force. Several broods, Spray as necessary. Feed. Formulae 1,2, and 3 applied early June may help. No. 7 dormant, or No. 4 in August to kill eggs and larvae. Apply spring after eggs laid, before mines are 1/4" in di. As insects appear.
	Scale	7	
	Aphids	4	
	Bronze birch borer	None	
	Case bearer	7 or 4	
Boxwood	Sawfly (leaf-miner)	5	Before growth starts. Feed and water. Sanitation important. 1 1/2 pts. nicotine, 1 1/4 lbs. soap, 2 1/4 gals. molasses, 100 gals. water. Apply as young crawl in May or June. Timing very important.
	Skeletonizer	1,2, or 3	
Boxwood	Canker & leaf disease	11	
	Leaf-miner	Special	
	Oyster-shell scale	4	

TREE OR SHRUB	INSECT OR DISEASE	FORMULA	GENERAL CONTROL NOTES
Boxwood (cont.)	Psylla Red-spider	4 9	Apply when leaves first start curling. Apply when temperature is high. Oil unsafe on boxwood.
Butternut (Also see walnut and hickory)	Curculio Die-back disease Lace-bug Tree-hopper	None None 4 4	Destroy infested nuts. Cut and burn infested shoots. Increase vigor of tree. Prune diseased twigs. As soon as insects are noticed. Apply to underside of leaf. White froth on small stems. Spray early summer as noticed.
Catalpa	Leaf-spot disease Mealy-bug Sphinx	11 6 1,2, or 3	Late May. Use with nicotine, molasses, and soap if desired. Use considerable force. Brush bark with wire brush first. 2 broods. April and July. Spray when leaves are small.
Crepe-myrtle	Aphids	4	Spray thoroughly when noticed. Use force.
Elm	Aphids	4	Repeated applications as insects appear.
	Bagworm	1,2, or 3	Apply usually in June. Remove and burn bags in winter.
	Bark-beetle	None	Increase vigor. General sanitation.
	Borer	None	Cut, burn infested trees. To prevent attack, increase vigor.
	Canker-worms	1,2, or 3	Spray as soon as foliage becomes evident.
	Case-bearer	6 or 2	Use 6 dormant. Use 1, 2, or 3 in early spring.
	Cockscomb gall-aphid	6	Most effective treatment. Gallis appear in May on leaves.
	Dutch elm disease	None	Increase vigor. Sanitation. Remove infested trees.
	Fall webworm	1,2, or 3	As caterpillars commence feeding. June to August.
	Japanese beetle	Special	Use coated arsenate of lead with stickler.
	Leaf-beetle	1,2, or 3	Underside of leaves. Late May or early June.
	Leaf-miner	4	Spray early in June as mines are noticed.
	Leaf-spot diseases	11	After leaves are grown. 3 applications 2 weeks apart.
	Leopard moth	None	Inject carbon bisulfide in holes. Trap females.
	Sawfly	1,2, or 3	As larvae appear. June.

TREE OR SHRUB	INSECT OR DISEASE	FORMULA	GENERAL CONTROL NOTES
Elm (Cont.)	Scale	6 or 4	Use No. 6 dormant. Use No. 4 when young are crawling.
	Spiny elm caterpillar	1,2, or 3	As caterpillars commence feeding. May - June.
	Twig-girdler	1,2, or 3	As insects feed in late May. Collect and burn fallen twigs.
	Tussock-moth	1,2, or 3	After caterpillars start feeding. Destroy pupae and eggs.
Euonymus	Scale	6	Repeated spraying may be necessary. Difficult to control.
Fir, Douglas	Sitka spruce gall-aphid	4	Alternate generation on spruce
Hackberry	Caterpillars	1,2, or 3	As larvae appear and commence feeding on leaves.
	Leaf-spot disease	11	Repeated 3 or 4 times after leaves appear.
	Plant lice	Special	1½ pts. nicotine, 3 lbs. soap, 9 lbs. molasses, 40 gals. water.
	Scale	6	Several species, same control.
Hickory	Bark-beetle & borers	None	Cut, burn badly infested trees. Sanitation. Increase vigor.
	Fall webworm	1,2, or 3	As caterpillars commence feeding. June - August.
	Leaf-stem gall	Special	Buds $\frac{1}{2}$ ", $\frac{1}{2}$ pt. nic., $\frac{1}{2}$ lbs. soap, 9 lbs. molasses, 40 gals. water.
	Tussock-moth	1,2, or 3	As caterpillars appear. July - September.
	Twig-girdler, pruner	None	Collect and burn fallen twigs in winter.
	Walnut datana	1,2, or 3	As caterpillars appear. July - August.
Holly	Leaf-miner	4	Late May or early June. Pick, burn infested leaves.
Horse chestnut Buckeye	Bagworm	1,2, or 3	Apply usually in June. Remove and burn bags in winter.
	Japanese beetle	Special	Use coated arsenate of lead with sticker.
	Leaf-blotch	11	3 sprays 2 weeks apart. Start when leaves are half grown.
	Scale	6 or 4	Use 6 dormant. Use 4 when young are crawling.
	Tussock-moth	1,2, or 3	Apply early summer. Destroy eggs and cocoons in winter.

TREE OR SHRUB	INSECT OR DISEASE	FORMULA	GENERAL CONTROL NOTES
Larch	Case-bearer	6 or 2 1,2, or 3	Apply 6 dormant. 1, 2, or 3 early in the spring. Apply late June when larvae appear.
	Sawfly	6 or 4	Apply 6 dormant. 4 when young are hatching in May.
Lilac	Woolly aphid	10 None 6	Apply before leaves are curled in summer. Cut and burn infested shoots with contained larvae. May be necessary to use No. 4 when young are crawling.
	Leaf-miner	None	Destroy borers. Dig out or use carbon bisulfide.
Linden	Lilac borer	1,2, or 3 Special	Apply as or before various leaf chewers appear.
	Scale	11	Use coated lead arsenate with sticker.
	Borers	6 or 4	Use 3 or 4 applications at 2 week intervals.
	Japanese beetle	9	Use 6 dormant. Use 4 when young are crawling.
Locust	Oyster-shell scale		Use midsummer when high temperatures prevail.
	Red-spider		
Magnolia	Leaf-miner	1,2, or 3 Special	Spray just after leaves are developed.
	Locust borer		Use orthodichlorobenzene only with special approval.
	Magnolia scale	6	Apply dormant. Scale resembles tulip tree scale.
	Mealy-bug	6	Use force after brushing bark with wire brush.
Maple Box-elder	Aphids	4	Apply when insects are noticed on underside of leaves.
	Bagworm	1,2, or 3	When feeding begins. Pick and burn bags in winter.
	Callus borer	None	Dig out and destroy. Keep wounds disinfected and painted.
	Carpenter worm	None	Inject carbon bisulfide in galleries and plug.
	Caterpillars (several)	1,2, or 3	Apply arsenical poison sprays as larvae appear.
	Cottony scales	4	Apply as young crawl. Don't use oil on sugar or Jap. maples.
	Gloomy scale	6	Soft maples only. Don't use oil on sugar or Jap. maples.
	Japanese beetle	Special	Use coated lead arsenate with sticker.

TREE OR SHRUB	INSECT OR DISEASE	FORMULA	GENERAL CONTROL NOTES
Maple Box-elder (cont.)	Leaf-galls	7	Apply during or just after blossoming.
	Leaf-spot diseases	11	Apply 2 or 3 sprays 2 weeks apart.
	Leopard moth	None	Inject carbon bisulfide. Cut, burn infested twigs in fall.
	Nectria canker	None	Trace out cankered wood and disinfect and keep painted.
	Nor. maple nepticula	6 or 4	Apply 6 dormant. Apply 4 in late May.
	Sugar maple borer	None	Cut out and destroy early in September.
	Terrapin scale	6 or 4	6 on soft maples. 4 on sugar maples when young crawl.
	Trumpet skeletonizer	1,2, or 3	Not serious. Apply spray as feeding begins. August.
	Twig-pruner	None	Collect, burn fallen twigs in winter with larvae inside.
	Verticillium wilt	None	Prune diseased limbs. Remove badly infected trees.
Mountain ash	Round-headed borer	None	Dig out. Inject carbon bisulfide in burrows and seal.
	Scurfy scale	6	Apply dormant.
Oak	Brown-tail moth	1,2, or 3	Apply before insect larvae commence feeding.
	Carpenter ant	None	Inject calcium cyanide and seal openings.
	Caterpillars (several)	1,2, or 3	Apply as or just before larvae appear.
	Gipsy moth	1,2, or 3	Also paint egg masses with creosote if practical.
	Golden oak-scale	6	Easily controlled with miscible oil applied dormant.
	Leaf-blotch disease	11	When leaves are $\frac{1}{2}$ size. 2 more sprays 2 weeks apart.
	Oak gall scale	6	Easily controlled with miscible oil applied dormant.
	Obscure scale	6	Easily controlled with miscible oil applied dormant.
	Red-spider	6 or 9	Use No. 6 dormant. Use No. 9 when weather is hot.
	Shoe-string root-rot	None	Increase vigor. Cut out. Control insects and diseases.
Pecan	Twig-pruner	None	Collect, burn fallen twigs in winter with larvae inside.
	2-lined chest. borer	None	Increase vigor. Remove badly attacked trees.
	Fall webworm	1,2, or 3	Apply late summer when insects appear.
	Obscure scale	6	Apply dormant.

GENERAL CONTROL NOTES		
TREE OR SHRUB	INSECT OR DISEASE	FORMULA
Pine	Bark beetles (several)	None
	Wt. pine blister-rust	None
	Eur. Pine-shoot moth	5
	Fall webworm	1,2, or 3
	Pine bark-aphid	5
	Pine needle scale	6
	Pitch-mass borer	None
Plane-tree (Sycamore)	Pine tube-moth	1,2, or 3
	Sawflies (several)	1,2, or 3
	Wt. pine weevil	7
	Lace-bug	6 or 4
Poplar	Leaf eating insects	1,2, or 3
	Leaf & twig-blight	11
	Borers	None
	Canker	None
Spruce	Caterpillars (several)	1,2, or 3
	Bud-scale	5 or 4
	Budworm	1,2, or 3
	Gall-aphid	5 or 4
Tulip (Yellow poplar)	Leaf-miner	1,2, or 3
	Red-spider	5 or 9
	Caterpillars (several)	1,2, or 3
	Tulip-tree scale	6

Cut and burn infested trees.
Remove Ribes bushes from nearby.
Late June, add lead arsenate. Remove and burn shoots.
Apply early before any damage is done.
Apply early May when young are crawling.
Before growth starts in the spring.
Dig off pitch masses, destroy larvae before pupation.
Apply early, before any feeding starts.
Apply early, before or as feeding starts.
Early spring. Cut, burn infested tips with larvae inside.

Apply No. 6 dormant. Apply No. 4 when insects appear.
Apply as leaf feeders are noticed.
4 sprays 10 days apart. Collect and burn twigs and leaves.

Cut out and kill larvae. Inject carbon bisulfide.
Prune infested limbs. Cut and burn badly infested trees.
Apply as or before larvae commence feeding.

Use 5 dormant. Use 4 in July when young are active.
Apply early spring.
Apply 5 dormant. Use 4 in August when galls break.
Apply early in June before feeding commences.
Use 5 dormant, Use 9 during hot summer.

As insects appear. Rarely abundant.
Apply thoroughly when tree is dormant.

TREE OR SHRUB	INSECT OR DISEASE	FORMULA	GENERAL CONTROL NOTES
Walnut	Caterpillars (several) Curculio Leaf-spot disease	1,2, or 3 None 11	As insects appear. Collect and destroy nuts. 3 applications 3 weeks apart. Start when leaves are $\frac{1}{2}$ size.
Willow	Borers Caterpillars (several) Leaf-beetle Sawflies (several) Willow blight	None 1,2, or 3 1,2, or 3 1,2, or 3 11	Dig out and kill. Calcium cyanide gas useful. Apply early and thoroughly to upper side of leaves. Apply early and thoroughly to lower side of leaves. Apply early and thoroughly to upper side of leaves. 4 to 5 applic. at 5 day intervals. Start before buds break.
Yew	Black vine weevil	None	Trap under boards laid on the ground or use poison bait.

Section VI. References

Those desiring more complete information regarding the control of insects and diseases affecting ornamental trees and shrubs will find the following references of interest. Each has been freely consulted in the preparation of this bulletin:

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