$1.60

For Commercial Fruit Growers

Fruit Pesticide Handbook

1985

Extension Bulletin E-154, February 1985, Revised Annually — Destroy Earlier Editions
Cooperative Extension Service • Michigan State University

SPECIAL WARNING

Pesticide Drift and Contamination of Food and Feed Crops

There is always a possibility of drift and injury to neighboring crops and premises from both aircraft and conventional ground spray and dust applications. Hay and pasture crops, for example, grown near orchards treated with pesticides may contain illegal chemical residues, particularly chlorinated hydrocarbons. Since few chemicals have a tolerance established for hay crops and there is a ZERO TOLERANCE for any pesticide in milk, extreme caution must be exercised to avoid pesticide contamination of forage and pasture crops. Chlorinated hydrocarbons are particularly hazardous since they are stored in animal fat and are secreted in the milk. Chlorinated hydrocarbon insecticides include: dieldrin, kelthane, methoxychlor and thiodan.

Where the possibility of pesticide drift is present, growers should use phosphate or carbamate insecticides in their spray program but only those registered for use on forage and pasture crops. The reason for this is that they degrade faster and are not generally stored in the body, so they do not impose a long term hazard.

Protect the Bees

The transfer of pollen from one flower to another by bees is a basic requirement for the production of practically all fruit. It is to the fruit grower's benefit to use sprays in such a way that the least possible number of bees are killed. This is a good policy of cooperation with the beekeepers and it also conserves the bumble bee and other wild bee populations that serve you free of charge.

"Do not spray plants in bloom" is the basic rule in protecting bees. This applies not only to the fruit bloom but also to dandelions and clovers that may be reached by the spray. Mowing dandelions, yellow rocket and clovers in the fruit area helps. Also, do not let puddles of spray accumulate on the ground where bees might drink it. If beekeepers supply fresh water near the bee hives, this hazard is reduced. Where there is a choice, use insecticides least harmful to bees. The table on page **51** rates the toxicity of most of the common insecticides to bees and will serve as a guide to choose the least hazardous material.

The pest control methods in this publication are merely guides to aid each grower in preparing his own pest control program. The same insects and diseases are not always present or economically important in all orchards and small fruit plantings. Thus, during any single season, each grower has to adjust his pest control program to fit his specific conditions.

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no indorsement by the Cooperative Extension Service is implied.

MICHIGAN STATE UNIVERSITY
ES
COOPERATIVE EXTENSION SERVICE

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824.

2:85 – 5M – Revision, Destroy Previous Editions
TCM, Ad. $1.60, For Sale Only. File 27.2

1985 Fruit Pesticide Handbook

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The authors express their appreciation for the valuable help and suggestions received from district horticultural agents, county agricultural agents, and Extension and Research personnel in the Departments of Horticulture, Entomology, and Botany and Plant Pathology.

MUCH GOES INTO THE PLANNING of an economical and effective spraying program. In fruit growing, a successful pest control schedule must be based on a knowledge of:

(1) the life history of the important insects and diseases likely to be encountered;

(2) the various kinds of pesticide chemicals available, and their proper use; and

(3) susceptibility of the different kinds and varieties of fruit to insect, disease and spray injury.

In order to provide more complete reference information, publications dealing with fruit pests and use of pesticides have been written by members of the Departments of Entomology, Botany and Plant Pathology and Horticulture at Michigan State University. These are:

1. *Diseases of Tree Fruits* by A. L. Jones and T. B. Sutton, North Central Regional Extension Publication No. 45. ($1.75)

2. *Vineyard Preparation for Nematode and Virus Disease Control* by D. C. Ramsdell and G. W. Bird, Extension Bulletin E-806. (Free)

3. *Tractor-mounted Air Blast Sprayers* by D. C. Ramsdell, Extension Bulletin E-840. (Free)

4. *Diagnosis and Prevention of Herbicide Injury* by R. H. Lockerman, A. R. Putnam, R. P. Rice, and M. F. Meggitt, Extension Bulletin E-809. ($1.00)

5. *Pesticides: How They Work and Treatments for Human Poisonings* by D. C. Cress and Dr. Regine Aronow, Extension Bulletin E-789. (Free)

6. *Tree Fruit Insects* by J. F. Brunner and A. J. Howitt, North Central Regional Publication No. 63. ($3.50)

7. *Strawberry Diseases in Michigan* by D. C. Ramsdell, (Extension Bulletin E-1728), *Raspberry Diseases in Michigan* by S. K. Perry & D. C. Ramsdell, (Extension Bulletin E-1730), *Blueberry Diseases in Michigan* by D. C. Ramsdell, (Extension Bulletin E-1731) and *Common Diseases of the Grapevine in Michigan* by D. C. Ramsdell, (Extension Bulletin E-1732).

The chemicals included in each fruit pesticide schedule in this publication have been suggested only at the times they may be used without danger of excessive residues (not to exceed established tolerances) on harvested fruit. The allowable chemical residue and required waiting period between last application and harvest are given for each chemical in the table on page **101.**

PESTICIDE SAFETY TIPS

- Always read the label before buying or using pestisides. Use pesticides only for the purpose(s) listed and in the manner directed.
- Pesticides that require special protective clothing or equipment should be used only by trained, experienced applicators.
- Do not apply more than the specified amount of pesticide. Overdoses can harm you and the environment.
- Keep pesticides away from food and dishes.
- Keep children and pets away from pesticides and sprayed areas.
- Do not smoke or eat while applying pesticides.
- Avoid inhalation of pesticides.
- Never spray outdoors on a windy day.
- When you mix pesticides, do it carefully to avoid splashing.
- Avoid breaks or spills of pesticide containers.
- If you spill a pesticide on your skin or on your clothing, wash with detergent and water and change your clothing immediately.
- Store pesticides under lock in the original containers with proper labels. Never transfer a pesticide to a container that would attract children, such as a soft drink bottle.

I. *For information regarding proper cholinesterase testing, have your doctor contact:*

Epidemiologic Studies Project
Michigan Dept. of Public Health
3500 N. Logan
Lansing, Michigan 48914

Telephone:
Arthur W. Bloomer, Director
Office (Lansing) (517) 373-2037
Home (Grand Ledge) (517) 626-6583

II. *In the event of any gross environmental contamination by pesticides, such as an accidental spill or fire, contact:*

Michigan Department of Agriculture
(517) 373-1087

III. *For information in your area regarding disposal of chemicals and pesticides, contact:*

Jerry Fore
(517) 322-1315
(Michigan Dept. of Natural
Resources, Solid Waste Disposal)

IV. *In the event of an accident on highway, railway or waterway, involving chemicals, contact:*

CHEMTREC
(24 hours a day – 7 days a week)
(800) 424-9300

• Dispose of empty containers safely. Wrap single containers of home use products in several layers of newspaper, tie securely and place in a covered trash can. Never burn boxes or sacks. In the case of farm or ranch use, single containers may be buried where water supplies will not be contaminated. Dispose of large quantities in special incinerators or special landfills.

• Wash with soap and water after using pesticides, and launder clothes before wearing again.

• If someone swallows a pesticide, check the label for first aid treatment. Call or go to the doctor or the hospital immediately and keep the pesticide label with you.

POISON CONTROL CENTERS

(Provides poison information services, treatment of poisoning cases, and clinical toxicology laboratory service)

ADRIAN

Emma L. Bixby Hospital
818 Riverside Avenue 49221
(517) 263-2412

Thomas R. Arnold, R.Ph.

ANN ARBOR

Univ. of Mich. Medical Ctr.
Outpatient Bldg. C4027
1405 E. Ann Street 48104
(313) 764-5102

Patricia O'Connor, M.D.
James Mackenzie, M.D.

BATTLE CREEK

Community Hospital
183 West Street 49016
(616) 963-5521

Dan Hurd, R.Ph.

BAY CITY

Bay Medical Center
100 15th Street 48706
(517) 892-6589

Pete Berlin, R.Ph.

COLDWATER

Community Health Center of Branch County
274 E. Chicago Street 49036
(517) 278-7361

John Heffelfinger, M.D.

DETROIT

Children's Hospital
Southeast Regional Poison Ctr.
3901 Beaubien 48201
(313) 494-5711 or
(800) 462-6642

Regine Aronow, M.D.

FLINT

Hurley Hospital
6th Avenue and Begole 48502
(313) 766-0111

GRAND RAPIDS

Western Michigan Poison Ctr.
Blodgett Memorial Medical Ctr.
1840 Wealthy S.E. 49506
(800) 442-4571 or
(800) 632-2727

Walter D. Meester, M.D.
John Trestrail III, R.Ph.

JACKSON

W. A. Foote Memorial Hospital
205 N. East Street 49201
(517) 788-4816

Gregory Baumann, M.D.
Z. A. Brashares, M.D.

KALAMAZOO

Borgess Hospital
1521 Gull Road 49001
(616) 383-4815

Chuck Woroniecki, R.Ph.

Bronson Methodist Hospital
262 E. Lovell 49006
(616) 383-6409

M. Edward Spartz, Jr., R.Ph.

LANSING

St. Lawrence Hospital
1210 W. Saginaw 48914
(517) 372-5112 or 372-5113

Dale Boukma, R.Ph.

MARQUETTE

Upper Peninsula Regional Poison Center
Marquette General Hospital
420 E. Magnetic 49855
(800) 562-9723 or
(906) 228-9440

D. S. Koch, R.Ph.

MIDLAND

Midland Hospital
4005 Orchard Drive 48640
(517) 631-7700 ext. 304

Karen Lovelace, R.N.

PONTIAC

St. Joseph Mercy Hospital
900 Woodward 48503
(313) 858-7373 or 858-7374

Kim Sveska, R.Ph.

PORT HURON

Port Huron Hospital
1001 Kearney Street 48060
(313) 987-5555 — poison calls
(313) 987-5000 ext. 214 — information

Joseph S. Jehl, R.Ph.

SAGINAW

Saginaw General Hospital
1447 N. Harrison 48602
(517) 755-1111

Dale F. Schultz, R.Ph.

TRAVERSE CITY

Munson Medical Center
Sixth & Madison Streets 49684
(616) 947-6140

Clare Coles, R.Ph.

WESTLAND

Wayne County General Hospital
2345 Merriman Road 48185
(313) 722-3748
(8 am - 11 pm, M-F)
(313) 274-3000 ext. 6231
(11 pm - 8 am, M-F & weekends)

Kenneth Vaughn, M.D.

REMEMBER — ALWAYS READ THE LABEL **BEFORE** USING ANY PESTICIDE. DO NOT WAIT UNTIL SYMPTOMS APPEAR TO GET MEDICAL CARE.

NEMATODE CONTROL

By G. W. Bird
Departments of Entomology and of Botany and Plant Pathology

Plant parasitic nematodes cause significant economic losses in fruit production systems as plant pathogens, virus vectors, and predisposition agents. The objective of this chapter of E-154 is to provide Michigan fruit growers with information about nematodes and nematode control for tree fruit (pages 1-15) and small fruit production (pages 15-17).

Tree Fruit

Introduction

If a new, replanted, or existing orchard does not grow well, the problem may be caused by plant parasitic nematodes. Poor tree growth is the most obvious symptom of nematode problems. Aboveground parts of plants are stunted, have short internodes and small leaves. Root systems are small, discolored, and have poorly-developed feeder roots. Water and nutrient uptake are inadequate. Trees may die after the first or second growing season after planting, or they may remain severely stunted for years. Surviving trees may improve with age, but they rarely become as productive as healthy trees on sites without high population densities of plant parasitic nematodes.

Table 1. Plant parasitic nematodes associated with economic losses in Michigan tree fruit production systems.

Nematode	Parasitism	Mechanism
Root-lesion *(Pratylenchus penetrans)*	Migratory endoparasite	Pathogen
Dagger *(Xiphinema americanum)*	Ectoparasite	Virus vector Pathogen
Ring *(Criconemella xenoplax)*	Ectoparasite	Pathogen Predisposition agent
Root-knot *(Meloidogyne hapla)*	Sedentary endoparasite	Pathogen
Stubby-root *(Paratrichodorus minor)*	Ectoparasite	Pathogen
Lance *(Hoplolaimus galeatus)*	Ectoparasite	Pathogen
Needle *(Longidorus elongatus)*	Ectoparasite	Pathogen

Plant parastic nematodes recognized as causing economic losses in Michigan apple orchards are *Pratylenchus penetrans* (root-lesion), *Meloidogyne hapla* (northern root-knot), *Paratrichodorusminor* spp. (stubby-root), *Hoplolaimus galeatus* (lance), *Criconemella* spp. (ring), *Longidorus elongatus* (needle), and *Xiphinema americanum* complex (dagger) (Table 1). These nematodes either live and feed in roots (endoparasitic) or they live in orchard soil and feed from the surface of roots (ectoparasitic). Both types migrate through soil from root to root and can be moved from orchard to orchard on mechanical equipment, in rootstocks, or in irrigation water. Plant parasitic nematodes can also hinder the development of beneficial fungi necessary for normal tree growth.

Population densities of root-lesion, dagger, and ring nematodes frequently exceed damage thresholds in Michigan orchards. The dagger nematode vectors stem pitting and brown ring necrosis virus diseases, which are caused by the tomato ringspot virus. The ring nematode is a predisposition agent in stone fruit production.

Nematode Monitoring Procedures

Since plant parasitic nematodes are microscopic, the best way to determine if an orchard has a nematode problem or a potential problem is to examine the root system and submit soil and root samples to a nematology laboratory such as the MSU Nematode Diagnostic Laboratory.

When to Sample

Soil and root samples for nematode detection can be taken whenever the soil is not frozen. For best results, samples should not be taken until 30-45 days after annual root growth begins. Monitoring is divided into four categories: (1) orchard sites to be planted, (2) non-bearing orchards, (3) bearing orchards, and (4) orchards to be removed (Table 2).

Non-bearing sites must be sampled early to assess the need for a control procedure. Orchard sites to be

Table 2. Integrated nematode management monitoring schedule.

Non-bearing orchards
When? **April 1 - May 15**
What? Soil and root samples (see E-800)
Why? Management procedure selection*

Sites to be replanted the year after sampling
When? **June 15 - August 1**
What? Soil and root samples (see E-800)
Why? Management procedure selection*

Declining orchards

When? **August 1 - November 15**
What? Soil and root samples (see E-800)
Why? Orchard removal decision
Management procedure development*

Bearing orchards

When? As needed
What? Soil and root samples*
Why? Orchard management and record keeping
(Microcomputer Data-base Management)

*See Integrated Nematode Management Section.

planted the following year should be sampled before August 1 to allow time for nematode control before soil temperature decreases in the fall. Growers considering fall soil fumigation or nematicide application should take and submit samples between late July and mid-September.

How to Sample

Because of the microscopic nature of plant parasitic nematodes, a laboratory analysis of soil and root tissue is necessary for avoidance or detection of nematode problems. Sites to be sampled should be selected and subdivided as indicated in Table 3.

Because plant parasitic nematodes feed only on living tissues, soil and root samples should be taken from the margin of the problem area where the plants are still living (see Figure 4 & 5). Use a soil sampling tube, trowel, or narrow-bladed shovel. Take samples at a 2 to 12-inch depth with as many feeder roots as possible. Each submitted sample should consist of a pint to a quart of soil taken from a larger sample composed of 10-50 or more subsamples. The number of subsamples (soil cores or borings) needed depends on the ecological and physical parameters (Table 3) of the area being investigated. Mix subsamples in a clean pail or plastic bag. Only one quart needs to be submitted for nematode analysis.

Table 3. Nematode biological monitoring economic unit for sampling.

1. Select continuous area (Figure 1).
2. Map area and estimate size.
3. Subdivide based on cropping history (Figure 1).
4. Subdivide based on soil type (Figure 2).
5. Subdivide based on management unit objectives:
   - — Risk of known nematode infestation sites (Fig. 3).
   - — Cost of additional subdivisions
   - — Cost to take sample
   - — Cost to process sample
   - — Management implementation cost

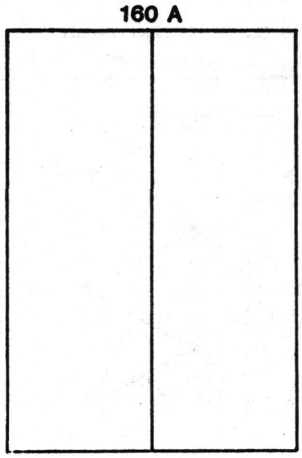


Figure 1.
Step 1: Select continuous area, map and estimate size, and subdivide based on cropping history.

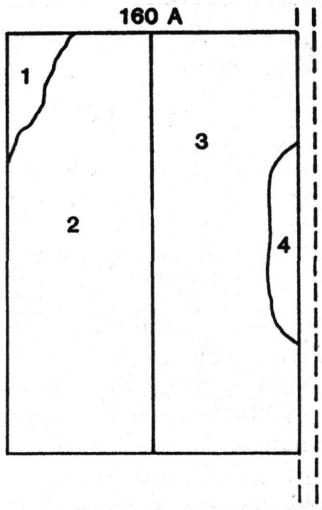


Figure 2.
Step 2: Subdivide based on soil types.

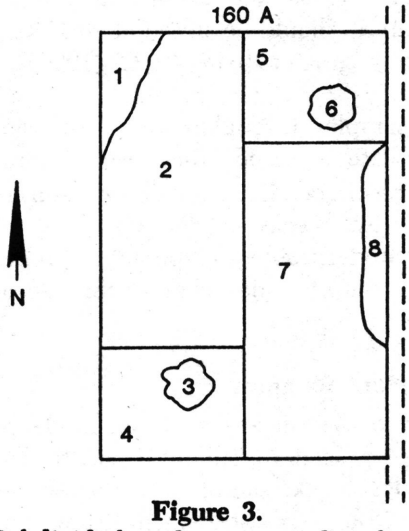


Figure 3.
Step 3: Subdivide based on nematode infestation and management units.

Figure 4.
Fallow fields or areas planted in a cover crop.

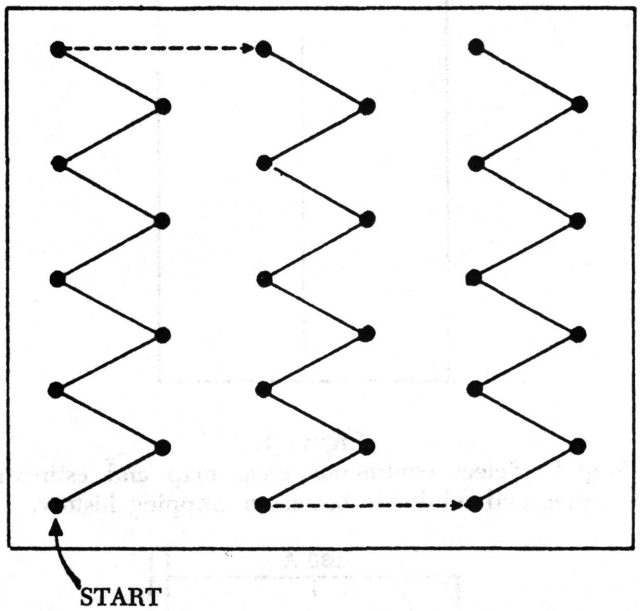
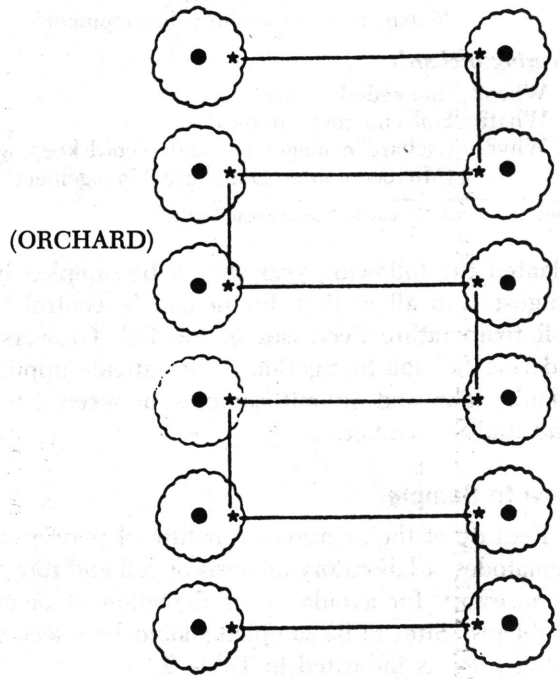
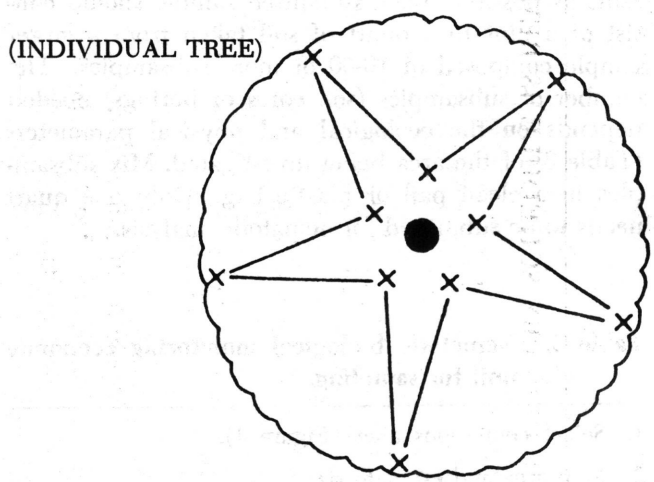


Figure 5.
Trees (take samples from feeder root zone).





Use a nematode sample container, as provided by the Cooperative Extension Service, or a plastic bag for nematode samples. Put samples in containers as soon as possible. Nematodes will die if the sample is allowed to dry, and it is important that nematodes are living when the sample arrives at the laboratory. Ideally, samples should be stored at 10-15 C (50-58 F). Temperatures greater than 40 C (100 F) will kill nematodes.

Submit samples through county extension offices or to a private nematode diagnostic laboratory. Results and recommendations will be returned in approximately two weeks.

If a nematode problem or potential problem exists, refer to the control section chapter for a recommendation.

Post-Treatment Samples

To analyze the success of a nematode population management procedure, submit a post-treatment sample for analysis. Take samples after seven weeks post-treatment. Obtain post-treatment assay forms from your extension office.

Integrated Nematode Management

Covercropping, fallowing, soil fumigation, non-fumigant nematicides, population monitoring, and tolerant cultivars are some management procedures used to prevent or alleviate nematode problems in Michigan fruit production. Purchasing stock grown in nematode-free or nematicide-treated soil is important to prevent nematode problems.

Before Removing Old Orchard

1. Examine the general top vigor and root condition of the trees.
2. Examine the soil structure for faulty drainage and hardpan.
3. Make a complete chemical analysis of the soil and foliage for pH and fertility.
4. Analyze the soil and roots of old trees for nematodes.
5. Make management recommendations if population densities are equal to or above action thresholds (Table 4).

Immediately After Removing Orchard

1. Work the soil and remove as many of the remaining roots as possible.
2. Fallow or plant a suitable covercrop (Sudan grass and sudax are the best cover crops for reducing potential root-lesion nematode-caused problems).
3. Do not plant new trees until *at least* one year (preferably two years) after removing the old orchard.

Table 4. Nematode population management action thresholds for Michigan tree fruit production systems.

Nematode	Sampling date action threshold/100 cm^3 soil + 1.0 g root			
	3/15-5/14	5/15-8/14	8/15-11/14	11/15-3/14
Root-lesion	15	20	30	30
Root-knot	10	15	25	20
Stubby-root	15	20	30	30
Dagger	1	1	1	1
Lance	10	15	20	20
Ring	100	150	150	200
Needle	5	15	20	10

In Autumn Before Planting New Trees

1. Work the soil and remove any remaining tree roots.
2. Subsoil if necessary.
3. Apply a soil fumigant or nematicide (Tables 5 & 6) if necessary.
4. Follow appropriate pH and fertilizer recommendations.

Spring Preparation and Planting

1. Aerate soil if fumigant was applied.
2. Follow appropriate fertilizer, watering, and planting recommendations.
3. Plant trees grown only in nematode-free, fumigated, or nematicide-treated soils.
4. Plant trees in holes allowing unrestricted growth of root systems.

Maintenance of Non-Bearing Trees

1. When appropriate, plant and maintain a covercrop between rows.
2. Maintain a good weed control program.
3. Control nematodes when necessary (Table 6).

Soil Fumigants

Soil fumigants are pesticides that move through the soil as a gas. Most are halogenated hydrocarbon compounds formulated and sold as gases, gels, volatile liquids, emulsifiable concentrates, or granules. Pests die from absorbing or ingesting the gas. Nematodes, weeds, fungi, and insects can be controlled by fumigants, but all soil fumigants are not active against all pests. Several soil fumigant changes have taken place in recent years. The EDB registration was suspended on 9/28/83, and on-farm supplies had to be used by 9/1/84. D-D was not manufactured after 1983, and the formulation of Vorlex changed in 1984.

Gaseous and liquid formulations of soil fumigants are frequently recommended to control plant parasitic nematodes in Michigan orchards. Gaseous formulations of soil fumigants are sold in 1- or 2-pound seamless cans or pressurized cylinders similar to the acetylene tanks used in welding. Liquid fumigants are sold in 5-, 30-, or 55-gallon metal or pastic drums. The liquid volatilizes and becomes gas when injected into the soil.

Factors Influencing Fumigant Action

For satisfactory nematode control, soil fumigants must be injected into properly prepared soil. Factors such as soil structure, ground trash, soil moisture, soil temperature, soil type, time of application, soil sealing, exposure period, and soil aeration influence fumigant acton in soil. Therefore, each factor must be considered before beginning a soil fumigation operation. Most soil fumigants are relatively toxic to plants and are registered only for preplant use.

Soil Structure. Proper tilth is important for fumigant penetration. Compacted soil hinders good pest control. The soil should be free of clods and worked into a good seedbed condition.

Ground Trash. Excess debris, such as decaying plant material, hinders soil fumigation. Organic debris ab-

Table 5. Soil fumigant compounds, formulations, and toxicities.

Common Name	Trade Name	Chemical	Formulation	Toxicity VA[a]	Toxicity OA[b]
Methyl bromide	Brom-o-gas Meth-o-gas	Methyl bromide	Gas	200	—
Chloropicrin	Chlor-o-pic	Trichloronitromethane	Gas	20	—
Methyl bromide	Terr-o-gas	Methyl bromide + trichloronitromethane	Gas	—	—
1,3-D	Telone II	1,3-dichloropropene	Volatile liquid	500	250
1,3-D + chloropicrin	Telone C-17	1,3-dichloropropene + trichloronitromethane	Volatile liquid	—	—
1,3-D + MIC	Vorlex	1,3-dichloropropene + methyl isothiocyanate	Volatile liquid	—	100
VPM	Vapam	Sodium methyldithio-carbamate	Emulsifiable concentrate	—	820

[a]Vapor acute toxicity – the amount, in parts per million, in the air that could be fatal in a single exposure by inhalation.
[b]Oral acute toxicity – the amount, in milligrams per kilogram of body weight, that could be fatal in a single exposure by ingestion.

Table 6. Non-fumigant nematicides for Michigan apple, cherry, and peach production.

Common Name	Trade Name	Chemical	Formulation	Toxicity DA[a]	Toxicity OA[b]
Oxamyl	Vydate 2L Oxamyl 10G	Methyl N',N'-dimethyl-N-((methyl-carbamyl)oxy)-1-thio-oxamimidate	liquid 2 lb. gal.	2960	5.4
Phenamiphos	Nemacur 3S	Ethyl-3-methyl-4-(methylthio)phenyl (1-methylethyl) phosphoramidate	liquid 3 lb. gal.	154	24
Phenamiphos	Nemacur 15G	Ethyl-3-methyl-4-(methylthio)phenyl (1-methylethyl) phosphoramidate	granular	>2000	66
Carbofuran	Furadan 10G Furadan 3F				

[a]Dermal acute skin absorption, LD_{50} (male rabbits)
[b]Oral acute toxicity, LD_{50}, (male rats)

sorbs fumigants, preventing the chemical from penetrating the soil. Existing vegetation should be cut or chopped and worked into the soil three to six weeks before fumigation. Excess organic matter can also clog fumigation chisels.

Soil Moisture. Too much soil moisture prevents fumigant movement; however, with low soil moisture, fumigants escape from the soil too rapidly. Good seedbed condition is the proper soil moisture for fumigation.

Soil Temperature. Soil fumigants should be applied when the soil temperature at a depth of 6 to 8 inches is 50° to 80°F. Some fumigants may be applied when the soil temperature is between 40° and 50°F; resulting pest control, however, may not be as good. Fumigants will not volatilize and penetrate uniformly throughout the soil if the soil temperature is below 50°F. Above 80°F, the fumigant will volatilize too rapidly and be lost from the soil before the optimum exposure time for pest control.

Soil Type. The adsorption and absorption of soil fumigants in muck soils require a fumigant rate approximately two times that recommended for mineral soils.

Time of Application. Early fall is usually the best time to apply soil fumigants in Michigan. They can be applied in the spring but proper soil temperature, moisture, and structure is less likely at that time. If spring fumigation is followed by a period of cold, wet weather, the waiting period before planting must be extended to prevent the possibility of severe tree phytotoxicity.

Soil Sealing. The first several inches of the soil are the most difficult area for pest control; therefore, a temporary soil seal is necessary to maintain a lethal concentration of the fumigant. This can be achieved by cultipacking, rolling, dragging, or lightly irrigating the soil immediately after fumigation. With gases, such as methyl bromide, cover the treated area with a plastic tarpaulin either before or immediately after

fumigation. Some Michigan fruit growers use soil fumigants to control nematodes below the upper four inches of soil, and phosphate or carbamate nematicides to control nematodes close to the soil surface.

Exposure Period. An exposure period during which the soil is left undisturbed is necessary after fumigant application and sealing with most soil fumigants. The length of the exposure period depends on fumigant, rate, and environmental factors such as soil temperature and moisture. Read the pesticide label.

Soil Aeration. Fumigated soil should be aerated at the end of the fumigant exposure period. Till the soil to the depth of the fumigant treatment zone.

Phytotoxicity. Most soil fumigants are phytotoxic and, depending on the dosage, must be applied several weeks or months before a crop is planted. A few plants are so sensitive to specific soil fumigants that they cannot be planted for several years after treatment. The pesticide label will tell the potential phytotoxicity of a soil fumigant to a specific crop plant.

Application Types

Small Areas. Small areas in orchards can be treated with gaseous or liquid fumigants. If a gaseous formulation is used, the procedure is similar to that used for fumigating greenhouse soil. Dig a small ditch around the outside of the area to be treated, and bury the edges of the polyethylene or plastic-coated nylon tarpaulin covering the area. If using a volatile liquid or emulsifiable concentrate fumigant, inject the chemical to a depth of 6 to 8 inches below the soil surface and tightly seal the area.

Tree Sites. For individual sites, mark the center of the site and inject the fumigant into the soil. The size of the area depends on the size of the tree. Seal the injection hole(s) and use a cover if needed.

Orchard Treatments. Strip treatments are most economical. In most Michigan tree fruit orchards, a 7- to 8-foot strip is fumigated, and the trees are planted in the center of the strip. If the rows in the orchard are 24 feet apart, only one-third of the area is fumigated.

Subsoil Fumigation. Deep applications of soil fumigants are often made when treating individual tree sites. Fumigants are applied broadcast, strip, or row. Rates should be adjusted because a larger area is being treated. Deep application can be made with subsoil shanks.

Fumigation Equipment

Many Michigan growers rent fumigation equipment or obtain it on a loan basis from their fumigant supplier. Regardless of the fumigation equipment used, proper care is essential. Appropriate soil sealers or drags should follow or be attached to the fumigant applicator. All application equipment should be cleaned and stored with the system at least partially full of lightweight fuel oil.

Fumigant Formulations

Gaseous Formulations. Several devices are available for puncturing 1- or 2-pound seamless cans of gaseous soil fumigants and releasing the chemical through a plastic tube to an evaporation pan placed under the sealed plastic. Always use the proper container-opening procedure.

Large cylinders of gaseous fumigants require valves and pressure regulators to control the delivery of the gas to the evaporation pan. Use a separate pressurized cylinder of nitrogen to maintain a constant pressure in the fumigant cylinder and insure a uniform application rate.

To broadcast or strip apply gaseous formulations, add a manifold to evenly distribute the gas to the chisel or shank injectors. Mount the injectors 12 inches apart on a tool bar connected directly to a tarping machine. A common tarping machine has two discs that open small furrows immediately outside the area being treated. Rolled polyethylene is unrolled over the treated area and inserted into the open furrows. The tarp is sealed with soil thrown back into the furrow by closing discs. This fumigant applicator is suitable for strip application.

The rate of application depends on the speed the rig is driven and the flow rate of the chemical. To treat a field on a broadcast basis with a gaseous formulation, apply one strip, then replace one set of discs with an adhesive dispenser. One side of the second tarp is sealed with the adhesive to the first tarp, and the other side of the second tarp is sealed in the furrow made by the remaining discs. Repeat until the entire field is fumigated and covered with polyethylene.

Augers for site injection of gaseous formulations are used with either the 1- or 2-pound seamless cans or with large cylinders of gaseous fumigants. Attach augers to a large electrically operated drill or a hydraulic system.

Liquid Formulations. Chisel applicators inject volatile liquid fumigants to a soil depth of 6 to 8 inches. The chisels are mounted 10 to 12 inches apart on a tool bar. The fumigant is injected to a soil depth of 6 to 8 inches. This equipment can be used for broadcast and strip applications. The applicator may be either pump or gravity-flow driven. The fumigant passes through a manifold where its rate of flow is regulated. Filter screens and metering orifices are usually used in the manifold.

Bottom plows are also used for broadcast applications. These applicators usually work on the gravity flow principle.

Applicators for strip fumigation are similar to broadcast treatment, but fewer chisels are used. The fumigant is applied only where the crop is to be planted. This area must be marked, usually with a small disc or lister hiller. Subsoil-bedders are also excellent for row application of liquid fumigants.

Drenchers. Drenchers consist of an appropriate container for the emulsifiable concentrate and a metering device for depositing the fumigant on the soil. They are not used very often in Michigan, and pest control may not be adequate unless the fumigant is worked into the soil.

Irrigation. Applying soil fumigants via irrigation water is rarely used in Michigan. Because of how fumigants react to irrigation equipment, a professional fumigation consultant should help design any system for applying soil fumigants in irrigation water.

Fumigant Applicator Calibration

All fumigant applicators must be calibrated to deliver the desired rate of pesticide. Applicator calibration is usually done by applying the fumigant over a small area (or for a short time), measuring or weighing the amount of fumigant used, computing the amount per acre equivalent to the amount measured or weighed, and adjusting the equipment to more closely approach the desired amount.

A useful equation for determining the amount of fumigant that should be delivered in a specified area in order to obtain a desired amount per acre is:

$$A = \frac{W \times D \times R}{43{,}560}$$

where A is the amount that should be delivered, W is the width (in feet) of the test swath, D is the length (in feet) of the test swath, and R is the desired amount (in pounds or gallons) per acre.

For example, if you wished to apply 50 gallons of fumigant per acre (R = 50) and are trying the equipment in an area 8 feet wide (W = 8) and 100 feet long (D = 100):

$$A = \frac{W \times D \times R}{43{,}560} = 0.918 \text{ gal.}$$

Gaseous Formulations. The number of 1- or 2-pound seamless cans of gaseous fumigant necessary for good pest control depends on the volume of soil being treated and environmental parameters. When pressurized cylinders are used, weigh the cylinder, release a small amount of fumigant for a known period of time, and then reweigh the cylinder. The rate is calculated after determining the area covered during the period of time. Adjust the rate of flow with the pressure regulator valve. Repeat.

Volatile Liquids. Both ground-driven and tractor-speed-dependent fumigation equipment can apply volatile liquid and emulsified concentrate soil fumigants. Tractor speed does not have to be considered in the calibration of most ground-driven equipment; however, it must be used to calibrate gravity flow and tractor-speed-dependent equipment.

Safety

Fumigants are toxic gases, especially hazardous because they are also penetrating gases. To insure safety, **READ THE LABEL** before buying the fumigant.

Be sure that you read and understand all the instructions, particularly those dealing with the safe storage, handling, and application of the fumigant. Always use all of the required safety equipment. Equipment is usually available where you buy the fumigant.

Most fumigants are hazardous if inhaled or contacted by the skin. An emergency water supply should be available at all times. Some fumigants irritate skin or eyes, and a few of them will burn or blister the skin.

A single large exposure to any fumigant is poisonous. Repeated small exposures are also poisonous. The label will specify hazards, symptoms of poisoning, and first aid in case of poisoning. In case of poisoning, be sure to take the container along with the victim to the doctor.

Storage of fumigants is a hazard. They should be purchased just before use whenever possible to shorten the storage period. Store them on sturdy shelving in an area apart from feed or seed. They are best stored in a separate building that can be well ventilated and securely locked. The storage area should be posted to warn others of the presence of the fumigants. Fumes can escape from faulty valves or from damaged or corroded cans and can build up to dangerous concentrations in closed storerooms. Valves and containers should be checked frequently for possible leaks. The ventilator should be run to clear the air before entering the storage area.

All equipment, including safety equipment, should be thoroughly checked and adjusted before use. Check that pressure-approved components are used and tightly sealed when compressed gases are used. Make sure, too, that all components used will withstand the corrosiveness of the fumigants.

Your exposure time to the fumigant is reduced by getting everything set before opening the fumigant container. Be especially sure that there is adequate ventilation if you are using fumigants indoors. Apply the fumigants as rapidly as possible — following the application instructions exactly. Clothing retains fumigants; therefore, immediately remove any clothing, including shoes, that is accidentally wetted by the fumigant.

The treated area should be sealed off as tightly as possible from access by people, livestock, or pets. In-

form everyone with access to the area of the danger. Post the area to warn off people, and keep an eye on it for stray children and pets. Do not allow anyone to re-enter the area for the period specified by the manufacturer.

Nonfumigant Nematicides

Nematodes can also be controlled by nonfumigant nematicides, such as organophosphates, or organocarbamates, which are relatively non-phytotoxic but have high mammalian toxicities (Table 6). Nonfumigant nematicides are dispersed through the soil by incorporation and soil moisture. Some non-fumigant nematicides are systemics. In addition to direct toxicity, nonfumigant nematicides may inhibit nematode behavor. Application equipment is usually available to rent or loan from the supplier. Environmental constraints may be somewhat less than for fumigants.

Proper application equipment and use is important for successful nematode control. Both low and high pressure sprayers can be used to apply Nemacur 3S, Vydate 2L, or Furadan 3F to soil. Air blast equipment is appropriate for foliar applications of Vydate 2L. Only commercially purchased applicators should be used to apply Nemacur or Oxamyl granules. Proper calibration is essential. New Nemacur registrations are available for 1984 for bearing tree fruit.

TREE FRUIT NURSERYSTOCK NEMATODE CONTROL RECOMMENDATIONS
(Preplant Application)

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons)	Broadcast: 11.25 gal.	Apply as a pre-plant treatment at least 21 days prior to planting when soil temperature is between 50° and 80° F. Inject at an 8-inch soil depth. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F. or if soil has become very wet.
Telone II	Broadcast: 30 gal.	
1,3-D and Chloropicrin Telone C-17	Broadcast: 32 to 40 gal.	Same as 1,3-D
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-gas	Broadcast: 250-450 lb.	Apply as a pre-plant treatment in plant beds for production of transplants only. Prepare plant bed as if for planting. Seal with airtight cover. Inject material, treating when soil temperature is above 50° F. Expose to fumigation for 48 hours. Aerate treated area for 2 days before planting.
Methyl Bromide and Chloropicrin (67% and 33%, respectively) Terr-o-gas 67	Broadcast: 250-350 lb.	Apply as pre-plant treatment. Inject material at 6- to 8-inch depth. Seal treated soil with airtight cover. Expose to fumigation for 48 hours. Aerate for 2 days before planting in transplant bed. Allow at least two weeks soil aeration between field fumigation and planting when transplants are for fruit production. Do not treat soil if temperature is below 45° F. at 5-inch level.
MIC (Methyl Isothiocyanate and 1,3-D) Vorlex	Broadcast: 15-30 gal.	Apply as pre-plant treatment. For broadcast application, use shanks spaced 8 inches apart injecting at a depth of 8 inches. For row application, use two chisels spaced 8 inches apart per row. Seal soil immediately after application. If soil is 70° F. or more at 6-inch depth, seal soil surface with plastic tarp. Keep soil moist and undisturbed for 4 to 7 days. Colder soils require longer fumigation periods. Cultivate soil and allow to aerate one week for each 10 gal./acre of material.
Phenamiphos		For root-lesion and dagger nematode control for apple, peach and cherry nurseries. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Apply uniformly and incorporate into the soil.
Nemacur 3	Broadcast: 4-6 gal.	
Nemacur 15G	Broadcast: 75-125 lb.	
Oxamyl		Apply in a minimum of 20 gal. of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4 to 8 inches immediately after application. READ LABEL WARNINGS CAREFULLY!
Vydate L	Broadcast: 3 to 10 gal.	
Oxamyl 10G	Broadcast: 60-80 lb.	Pre-plant soil incorporation to a depth of 4-6 inches.

Continued

Nematicide	Application rate/acre	Limitations and/or Directions
Carbofuran		Incorporate granules into top 3 inches of soil. Use lower rates in light soils.
Furadan 10G	Row: 60-100 lb.	
Furadan 4F	Row: 1.5-2.5 gal.	Incorporate into top 1-2 inches of soil. Use lower rate in light soils.
Aldicarb		See Michigan label for specific application directions and safety cautions.
Temik 10G	Broadcast: 75-100 lb.	

TREE FRUIT NURSERYSTOCK NEMATODE CONTROL

(Post-Plant Treatment)

Nematicide	Application rate/acre	Limitations and/or Directions
Phenamiphos	Strip: 6 gal.	For root-lesion and dagger nematode control for apple, peach and cherry nurseries. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Incorporate to 2-4 inch depth. Do not use more than 3 applications, 6 gal. or 120 lb./acre/site/year. Do not use site for grazing or for feed.
Nemacur 3	Strip: 120 lb.	
Nemacur 15G	Broadcast: 120 lb.	
Oxamyl	Foliar Spray: 2 qt./gal.	Mix 2 qt. of Vydate L with 100 gal. of water and add 4 oz. of a recommended surfactant. Apply to run-off as a foliar spray. Make 4 applications on a 14 to 21 day schedule. READ LABEL WARNINGS CAREFULLY!
Vydate L		
Carbofuran		Incorporate granules into top 3 inches of soil. Use lower rates in light soils.
Furadan 10G	Row: 60-100 lb.	
Furadan 4F	Row: 1.5-2.5 gal.	Incorporate into top 1-2 inches of soil. Use lower rate in light soils.
Aldicarb	Rows: (100 oz/1,000 ft.)	Side dress granular 3-4 inches deep 10-12 inches to both sides of the row. See label for safety cautions.
Temik 10G		

TREE FRUIT ORCHARD ESTABLISHMENT

(Preplant Treatment)

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons)	Broadcast or row-strip: 40 gal. Broadcast or row-strip: 30 gal.	Apply as pre-plant fall treatment when the soil temperature is between 50° to 80° F. Space chisels 12 inches apart. Inject at 8-inch depth. Seal soil immediately. Treat a 7- to 10-foot wide strip in which new trees are to be planted.
Telone II	Individual tree site: 30 ml.	Individual trees can be treated by injecting with a handgun in a 10-foot area. Inject 10 feet, 12 inches deep, with spacing 12 inches apart. Seal soil. Allow 3 to 6 months to lapse between treating and planting or longer if the odor remains in the soil. See MSU Nematology Note (9/3/74) for more specific directions for the individual tree site application technique.
1,3-D and Chloropicrin Telone C-17	Broadcast or strip: 32-40 gal.	Same as 1,3-D
MIC (Methyl isothiocyanate and chlorinated C_3 hydrocarbons) Vorlex	Broadcast or strip: 15-30 gal.	Apply as a pre-plant fall broadcast treatment. Space chisels 8 inches apart and inject at 8-inch depth. Seal with drag and smooth roller immediately after application. If soil is 70° F. or higher at 6-inch depth, special attention must be given to sealing soil surface: tarping gives best seal. All 3 to 6 months to lapse between treatment and planting.

Nematicide	Application rate/acre	Limitations and/or Directions
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-gas	Individual tree site: 1.0 lb.	Deep inject with methyl bromide soil auger. Apply during fall before planting.
Phenamiphos Nemacur 3	Row-strip: 4-6 gal.	For root-lesion and dagger nematode control in apple, peach and cherry orchard sites. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area.
Oxamyl Vydate L	Broadcast: 3-4 gal. Strip: 3-4 gal.	Apply in a minimum of 20 gal. of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4 to 8 inches immediately after application. READ LABEL WARNINGS CAREFULLY!
	(At-Planting Treatment)	
Oxamyl Vydate L	Root Dip: 1 pt./50 gal.	Mix 1 pt. of Vydate L in 50 gal. of water and soak roots in solution for 15 minutes. READ LABEL WARNINGS CAREFULLY!
	(Post-Plant Treatment)	
Oxamyl Vydate L	Foliar Spray: 2 qt./100 gal.	Use only on trees and strawberry plants that will not bear fruit within one year after application. Mix 2 qt. of Vydate L with 100 gal. of water and add 4 oz. of a recommended surfactant. Apply to run-off as a foliar spray. Make 4 applications on a 14 to 21 day schedule. READ LABEL WARNINGS CAREFULLY!
Oxamyl 10G	Broadcast: 60-80 lb.	Pre-plant soil incorporation to a depth of 4-6 inches. Incorporate granules into top 3 inches of soil. Use lower rates in light soils. Non-bearing trees only. Incorporate into top 1-2 inches of soil. Use lower rate in light soils. Non-bearing trees only. For root-lesion and dagger nematode control for apple, peach and cherry orchards. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Incorporate to 2-4 inch depth.
Carbofuran Furadan 10G Furadan 4F	 Strip: 60-100 lb. Strip: 1.5-2.5 gal.	Incorporate granules into top 3 inches of soil. Use lower rates in light soils. Non-bearing trees only. Incorporate into top 1-2 inches of soil. Use lower rate in light soils. Non-bearing trees only.
Phenamiphos Nemacur 3 Nemacur 15G	 Strip: 4-6 gal. Strip: 70-130 lb.	For root-lesion and dagger nematode control for apple, peach and cherry orchards. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Incorporate to 2-4 inch depth. Do not apply within 72 days of apple harvest or 45 days of peach or cherry harvest. Do not use more than 6⅔ gal. or 133.3 lb./acre/site/year. Do not use as feed or grazing land.

Small Fruit

Plant-parasitic nematodes can cause extensive injury to small fruit crops. Research has shown that many fruit crops respond to nematicides. As a first step, however, it is important to purchase high quality propagative stock produced on nematode-free, fumigated or nematicide-treated soil. Populations of plant-parasitic nematodes can be reduced below fruit-crop injury levels through fallowing, use of cover crops and applications of fumigant or nonfumigant nematicides. Soil fumigation or use of a nonfumigant nematicide prior to planting vines on old fruit sites is often essential for development of healthy and productive vineyards. Likewise, strawberries and brambles to be planted in soil infested with root-knot or root-lesion dagger, needle, stubby-root or lance nematodes will respond to soil fumigation practices. Dagger nema-

todes are capable of transmitting viruses to several fruit crops including blueberry, grape and raspberry.

Proper soil preparation prior to soil fumigation is essential for maximum effectiveness. The soil should be cultivated to promote thorough decomposition of previous crop debris. Undecayed roots harbor nematodes, protect them from nematicide contact and interfere with fumigant application. The soil should be in excellent tilth and soil moisture should approach that desirable for seeding. Dry soil allows too rapid escape of fumigants. Dispersion of fumigants in excessively wet soil is poor. At soil temperatures below 50°F, soil fumigants do not volatilize and spread properly. Above 80°F, the materials escape too rapidly from the soil. Later summer or early autumn is usually best for the application of soil fumigants in Michigan.

While all aspects of the soil preparation procedures are not necessary for use of nonfumigant nematicides, proper soil cultivation and moisture conditions are important. In general, soil temperature has less influence on nonfumigant than on fumigant nematicides, and one rate of a nonfumigant nematicide is recommended for both mineral and organic soils.

Soil and root sampling is required for establishing the need for nematode control in Michigan small fruit production (see MSU Extension Bulletins E-800 and E-806). The most important nematode problems are listed in Table 7, and approximate action thresholds outlined in Table 8.

Table 7. Plant parasitic nematodes associated with economic losses in Michigan small fruit production.

Crop	Nematode	Parasitism	Mechanism
Strawberry	Northern Root-knot *(Meloidogyne hapla)*	Sedentary endoparasite	Pathogen and Predisposition agent
	Root-lesion *(Pratylenchus penetrans)*	Migratory endoparasite	Pathogen and Predisposition agent
Grapes	Dagger *(Xiphinema americanum)*	Ectoparasite	Virus vector
	Northern Root-knot *(Meloidogyne hapla)*	Sedentary endoparasite	Pathogen
	Michigan Grape Root-knot *(Meloidogyne nataliei)*	Sedentary endoparasite	Pathogen
	Lance *(Hopolaimus galeatus)*	Ectoparasite	Pathogen
	Ring *(Criconemella xenoplax)*	Ectoparasite	Pathogen
Brambles	Dagger *(Xiphinema americanum)*	Ectoparasite	Virus vector
	Root-lesion *(Pratylenchus penetrans)*	Migratory endoparasite	Pathogen
Blueberry	Dagger *(Xiphinema americanum)*	Ectoparasite	Virus vector
	Ring *(Criconemella spp.)*	Ectoparasite	Pathogen
	Ring *(Criconematinus spp.)*	Ectoparasite	Pathogen
	Needle *(Longidorus sp.)*	Ectoparasite	Pathogen
	Root-lesion *(Pratylenchus sp.)*	Migratory endoparasite	Pathogen

Table 8. Nematode population management action thresholds for Michigan small fruit production systems.

Crop	Nematode	Action Threshold per 100 cm^3 soil plus 1.0 g root	Crop	Nematode	Action Threshold per 100 cm^3 soil plus 1.0 g root
Strawberry	Root-lesion	1	Brambles	Dagger	1
	Northern Root-knot	1		Root-lesion	30
Grapes	Dagger	1	Blueberry	Dagger	1
	Northern Root-knot	10		Stubby-root	15
	Michigan Grape Root-knot	1		Ring	100
	Lance	15		Needle	1
	Ring	100		Root-lesion	30

SMALL FRUIT PRODUCTION

(Preplant Application)

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons) Telone II	Broadcast: 40 gal. Broadcast: 30 gal.	Apply as a pre-plant treatment at least 21 days prior to planting when soil temperature is between 50° and 80° F. Inject at an 8-inch soil depth. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F. or if soil has become very wet.
1,3-D and Chloropicrin Telone C	Broadcast: 32-40 gal.	Same as 1,3-D
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-gas	Broadcast: 450 lb.	Apply as a pre-plant treatment in plant beds for production of transplants only. Prepare plant bed as if for planting. Seal with airtight cover. Inject material, treating when soil temperature is above 50° F. Expose to fumigation for 48 hours. Aerate treated area for 2 days before planting.
Methyl Bromide and Chloropicrin (67% and 33%, respectively) Terr-o-gas 67	Broadcast: 250-350 lb.	Apply as pre-plant treatment. Inject material at 6- to 8-inch depth. Seal treated soil with airtight cover. Expose to fumigation for 48 hours. Aerate for 2 days before planting in transplant bed. Allow at least two weeks soil aeration between field fumigation and planting when transplants are for fruit production. Do not treat soil if temperature is below 45° F. at 5-inch level
MIC (Methyl Isothiocyanate and 1,3-D) Vorlex	Broadcast: 15-30 gal.	Apply as pre-plant treatment. For broadcast application, use shanks spaced 8 inches apart injecting at a depth of 8 inches. For row application, use two chisels spaced 8 inches apart per row. Seal soil immediately after application. If soil is 70° F. or more at 6-inch depth, seal soil surface with plastic tarp. Keep soil moist and undisturbed for 4 to 7 days. Colder soils require longer fumigation periods. Cultivate soil and allow to aerate one week for each 10 gal./acre of material.
Strip: 6 gal. Strip: 120 lb. Broadcast: 120 lb.	Phenamiphos Nemacur 3 Nemacur 15G	For root-lesion and dagger nematode control for apple, peach and cherry nurseries. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Incorporate to 2-4 inch depth. Do not use more than 3 applications, 6 gal. or 120 lb./acre/site/year. Do not use site for grazing or for feed.
Oxamyl Vydate L	Broadcast: 3-10 gal. Strip: 3-10 gal.	Apply in a minimum of 20 gal. of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4 to 8 inches immediately after application. READ LABEL WARNINGS CAREFULLY! NOT REGISTERED FOR USE ON GRAPES OR BRAMBLES.
Oxamyl Vydate L	Foliar Spray: 2 qts/100 gal.	NOT REGISTERED FOR USE ON BRAMBLES OR GRAPES! Use only on strawberry plants that will not bear fruit within one year after application. Mix 2 qt. of Vydate L with 100 gal. of water and add 4 oz. of a recommended surfactant. Apply to run-off as a foliar spray. Make 4 applications on a 14 to 21 day schedule. READ LABEL WARNINGS CAREFULLY!
Phenamiphos Nemacur 3 Nemacur 15G	Strip: 6 gal. Strip: 120 lb. Broadcast: 120 lb.	For root-lesion, root-knot and dagger nematode control for vineyard only. Apply in 20-40 gal. of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft. and rate is for treated area. Incorporate to 2-4 inch depth. Do not use more than 3 applications, 6 gal. or 120 lb./acre/site/year. Do not use as site for feed or grazing.

FUNGICIDES

Tree Fruit Crops

Benomyl *(methyl 1-(butylcarbamoyl)-2-benzimidazol carbonate)* is used primarily for the control of postharvest fruit rots caused by Botrytis (gray mold), *Penicillium* (blue mold or soft rot), and *Gloesporium* (Bull's-eye rot) on apples and pears. It is formulated as a 50% wettable powder under the trade name Benlate. For control of postharvest fruit rots on apples and pears, it may be used (without oil) as a preharvest spray at 6 oz. or as a postharvest dip or spray at 8 oz.

On stone fruits benomyl is also used as a postharvest dip or spray for the control of brown rot. It will not control fruit rots caused by *Rhizopus* sp. or *Alternaria* sp.

The widespread development of benomyl resistant pathogens on tree fruits has made this fungicide ineffective in many orchards. **If used, always combine it with Captan.** The combination will give at least some degree of control should benomyl-resistant strains be present. (See resistance to fruit fungicides, page 21).

Bordeaux mixture is a combination of soluble copper sulfate (bluestone), hydrated lime, and water. It is used for the control of fire blight on apples and pears, for peach leaf curl on peaches, and for brown rot blossom blight on sweet cherries. In a 2-6-100 Bordeaux, for example, the first figure of the formula is copper sulfate in pounds, the second figure is spray lime in pounds, and the third figure is water in gallons. Homemade Bordeaux is superior to prepared dry mixes.

Bordeaux has many compatibility problems. Before combining with other pesticides, check the compatibility chart and read the label on the can carefully.

Bravo *(chlorothalonil)* is registered on cherries for the control of brown rot blossom blight and cherry leaf spot through shuck-split. In 1983, leaf yellowing and defoliation were noted on sweet cherries sprayed with Bravo after shuck-split. It is a protective fungicide. Although registered on peach, it is not being included in the recommendations at this time because leaf and fruit injury were noted in a Michigan experimental field trial. Further research is needed to verify whether Bravo can be used safely on peach.

Captan *(N-trichloromethylthio-4-cyclohexene-1, 2-dicarboximide)* is used for control of apple scab, brown rot, and cherry leaf spot. It is also fairly effective against several minor diseases including: black rot, Botrytis blossom-end rot, Brooks fruit rot, Botryosphaeria rot, bitter rot, sooty blotch, and fly speck. It will not control apple rust, powdery mildew or fire blight. Recommendations are based on a 50% wettable powder formulation. Several dust formulations and an 80% wettable powder formulation are available and should be used at equivalent rates.

For early season scab control, Captan is used at 2 lb./100 gal. of dilute spray. Though primarily a protectant fungicide, it will eradicate scab if used within 18 hours after the beginning of an infection period at average temperatures above 50° Apply it at relatively short intervals during critical scab periods, when growth is rapid, or when rains are frequent.

Captan is associated with good finish on russet-susceptible apple varieties like Golden Delicious. On Red Delicious, it has caused a leaf spotting when used at full strength early in the season, especially when used in combination with sulfur. On other varieties, it may be combined with sulfur or with dinocap for powdery mildew control. It is incompatible with oil and should not be used in combination with oil or near oil applications.

On stone fruit crops, Captan is used for early season control of brown rot on apricots and for combined control of brown rot and cherry leaf spot on sweet cherries starting at petal fall. On prunes, plums, and peaches, it is used for control of brown rot on the maturing fruit.

Dichlone and **Quintar** (2,3-dichloro-1,4-naphthoquinone); Dichlone is sold as a 50% active wettable powder under the trade name Dichlone 50WP or as a flowable formulation under the trade name Quintar 5F. For scab control, use ¼ lb. or 3.2 fl. oz. per 100 gallon of water on a protective schedule. For eradication of scab, apply ½ lb. or 6.4 fl. oz. in applications up to 36 to 48 hr. after the start of the rain or ¼ lb. with a protective fungicide in applications up to 30 to 36 hr. after the start of the rain. Use Dichlone 50WP and Quintar 5F only from bud-break through pink to avoid the risk of fruit injury and the reduction of fruit bud formation for the following year.

Dichlone 50WP and Quintar 5F are used for the control of brown rot blossom blight on peaches, plums, prunes, tart cherries and sweet cherries. For this purpose, use the ½ lb. or 6.4 fl. oz. rates during the bloom period.

Difolatan *(cis-n-[(1, 1, 2, 2-tetrachloroethyl)thio]-4-cyclohexene-1, 2-dicarboximide)* is cleared for use on machine harvested tart cherries only to control brown rot and cherry leaf spot. It is formulated as an 80% active water dispersible granular and sold under the trade name SPRILLS. On apples, Difolatan is registered as a single application at green tip for apple scab as described in the section on apple scab controls (page 48).

Difolatan has consistently provided good leaf spot control in seasonal schedules when used at 6 pt./acre. Control with 3 pt./acre has been good in light to moderate leaf spot years where proper timing and thorough spray coverage were practiced.

Human skin sensitization has occurred in some

instances where Difolatan was used. Only a small percentage of the population is sensitive. A few farm workers have developed a reaction to the product after exposure to residues of Difolatan on the twigs, leaves and fruit. People who may come in contact with it must be warned of the possibility of this allergic reaction.

Dikar is a coordinated product of zinc ion and manganese ethylene bisdithiocarbamate, dinitro(1-methyl heptyl)phenylcrotonate and certain other dinitro phenols and derivatives. These are the active ingredients of Dithane M-45 and Karathane. Dikar has provided combined control of powdery mildew and apple scab on mildew susceptible varieties when used routinely. For best mildew control, the addition of a spreader-sticker is suggested.

European red mite suppression has been obtained when applied on a seasonal schedule and where superior oil was used before bloom. Best results have been obtained when used at the 2-lb. rate. Dikar is incompatible with oil. Good fruit finish has been obtained with Dikar. However, workers in other states have reported moderate fruit russet on McIntosh and Cortland where used at high spray concentrations.

Dinocap *(Karathane) (dinitro capryl phenyl crotonate)* is a 25% active wettable powder sold under the trade name *Karathane*. It is used primarily at the ½ lb. rate for the control of powdery mildew on susceptible apple varieties. A liquid formulation is also available. It is often used in the summer when high temperatures make the use of sulfur questionable on some varieties. This material may be combined with other fungicides used for scab control but should not be used with oil or liquid insecticides having an organic solvent (kerosene or xylene) base.

Dodine *(n-dodeclyguanidine acetate)* is an excellent fungicide for apple scab and cherry leaf spot control. It is sold under the trade name Cyprex and is formulated as a 65% active wettable powder. Dust formulations are also available. Dodine is primarily used as a protectant against apple scab, but also has eradicant properties. During critical periods for spore discharge and for longer back action, it is used at ½ lb. per 100 gal. of water.

As a protectant, it is used at ¼ to ⅜ lb. and has given good scab control at these rates with proper timing and coverage. The lower rate is used primarily during the cover sprays. This material is particularly effective in reducing secondary spread of scab where it has been applied at regular intervals. It will reduce the production of spores in established lesions and also reduce spore germination.

Dodine is commonly used with oil, but a physical incompatibility may occur when a hard water source is used. Furthermore, lime should not be used with Dodine since it reduces its effectiveness.

Dodine has given good cherry leaf spot control on tart cherries at ¼ to ⅜ lb. under light to moderate conditions. Under severe conditions ½ lb. will be necessary. A post-harvest spray is a must for late season control. It is also used on sweet cherries where brown rot is not a problem.

Ferbam *(ferric dimethyl dithiocarbamate)* is formulated as a 76% wettable powder. It is used as a protectant for control of apple scab, pear scab, cedar-apple rust, peach leaf curl, and brown rot. Rates of use vary from 1½ to 2 lb. It is used in combination with wettable sulfur on plums, prunes, and sweet cherries for control of leaf spot. In some cases, yellow apple varieties have produced inferior finish when this material was used.

Fixed Coppers are neutral, insoluble forms of copper compounds which usually require the addition of spray lime as a safener. Fixed coppers are sold under many trade names and differ in their metallic copper content. Recommendations of fixed coppers therefore are given in amount of actual copper to be used.

The main use for these compounds is on tart cherries for the control of leaf spot. For this purpose, they are used at the rate of 0.75 lb. of actual copper plus 3 lb. of hydrated lime starting at second cover.

Funginex *(triforine)* has Federal Registration for use on apples for apple scab, powdery mildew, and rust disease control. Applications are limited to the period from ½-inch green tip to petal fall with a limit of 5 applications per season. Funginex is primarily an after-infection or eradicant fungicide for use in after-infection type scab control programs. Treatments should be made within 72 hr. from the beginning of a wet period suitable for scab infection. It is used at 10 fl. oz. per 100 gallons dilute spray or 36-40 fl. oz. per acre.

Funginex is also registered for use on peaches, nectarines, apricots, cherries, plums, and prunes for brown rot blossom blight control and for season-long control of brown rot on peach, nectarine, and apricot fruit. It is used at 10 to 16 fl. oz. per 100 gallons of dilute spray or at 36 to 48 fl. oz. per acre in low volume sprays.

The use of funginex on cherries after the bloom period is no longer suggested because of widespread russetting problems experienced in 1982. Injury was more severe on sweet cherry than sour cherry but occurred on both crops. The injury problem occurred in experimental and commercial orchards.

Funginex is an emulsifiable concentrate formulation containing 18.2% triforine, the common name for the active ingredient. In experimental trials, triforine applied in orchard spray programs has given control of brown rot on stone fruits comparable to Benlate

Sulfur is available as a wettable powder and as a paste. Because of their convenience, the wettable sulfur formulations are generally used. Recommendations are based on a 95% wettable sulfur formulation. (before Benlate-resistance became a problem). In post-harvest trials, triforine has given somewhat better brown rot control than Benlate.

In after-infection studies, triforine has exceeded the after-infection activity of dichlone for brown rot blossom blight. Against cherry leaf spot, triforine applied within 1 to 3 days after infection will prevent typical lesion development, leaf yellowing, or leaf abscission. Although triforine has considerable after-infection activity, it is a weak protectant and will require frequent applications when rainy periods are extended.

Lime-Sulfur is used primarily as an eradicant in the silver tip to pre-pink period of bud development for the control of scab. It is available as a liquid and is used at the 2 gal. rate. Dry forms are also available. Lime-Sulfur is also used to some extent as a dormant spray on peach for peach leaf curl, on prunes and plums for black knot, and as a bloom spray on each of these crops for brown rot blossom blight. Although the use of lime sulfur was once quite prevalent, it has generally been replaced by less phytotoxic or milder fungicides.

Rovral *(iprodione)* is registered for the control of blossom and fruit brown rot on cherries, peaches, apricots, plums, prunes, and nectarines with a limit of five applications per season. Rovral is specifically effective for brown rot and will not control other tree-fruit diseases. It has given more consistent brown rot control at the 2 lb. of product per acre rate than at lower rates.

Streptomycin is a bactericide for use against fire blight on apples and pears. It is very effective against the blossom blight phase of this disease if sprays are well timed and thorough. Best results are obtained if sprays are applied when maximum temperatures above 65° F. exist or are likely, and are accompanied by precipitation or following rainy days. Apply the first spray before or within 24 hours after favorable conditions. Apply a second spray if favorable conditions reappear, or if blossoms are opening rapidly and favorable conditions persist, 1 to 2 days after previous spray. Repeat applications if warm, wet conditions prevail.

Recently, post-bloom sprays of Streptomycin have been approved on pears up to 30 days before harvest, on apples up to 50 days before harvest. Although sprays for the control of shoot blight need further study, the following is suggested for those who may wish to try this new procedure. In orchards with a history of severe fire blight, but where overwintering cankers have been removed and a well timed blossom blight program has been followed—use Streptomycin at 100 ppm. Follow a 7-day protective schedule starting at petal fall or 5 to 7 days after the last in-bloom spray. During periods of wet, humid weather, shorten intervals to 5 to 7 days. Continue program until terminal growth stops.

Formulations containing less sulfur should be used at higher rates. Once used extensively as a protectant for scab, it has generally been replaced by organic materials of the protective-eradicant type.

Sulfur is effective against powdery mildew and is used at the 2 lb. rate with scab fungicides for the control of this disease on susceptible apple varieties. When sulfur is used at reduced rates in a mildew suppression program, applications should be initiated at silver-tip and continued until cessation of terminal growth. Omit sulfur in applications where superior oil is used.

Sulfur is used on all stone fruits, except apricots, to control brown rot. It is especially important in the bloom and early cover sprays on peaches to control not only brown rot, but also peach scab and powdery mildew.

Triforine *(see Funginex)*

Small Fruit Crops

Bayleton A fungicide that has systemic activity with some "kick-back" action. It is registered for use in grapes. It controls black rot and powdery mildew. Bayleton is available as a 50% wettable powder. It is used at 3 to 6 oz./acre in a dilute or concentrate spray. Although Bayleton is outstanding for the control of powdery mildew, it will not control downy mildew. *Note:* Manufacturer states that for tank mixing, Bayleton should be added and completely dispersed before adding other chemicals. Also, caution should be exercised when adding emulsifiable concentrates.

Benomyl (Benlate) is registered for use in blueberries, grapes, strawberries, and raspberries. In blueberries, it is registered for control of mummy berry disease. It gives excellent control of blossom infection (which causes the berries to mummify). However, Benlate will not control the shoot blight phase of the disease. In grapes, Benlate gives good control of black rot and fair control of powdery mildew. It gives fair control of dead arm disease, but is totally ineffective on downy mildew. In strawberries, Benlate gives excellent control of grey mold, stem-end rot, leaf blight and leaf spot. It will not control leather rot, however. The addition of captan will control leather rot. In raspberries, Benlate is registered for control of *Botrytis* sp. and *Penicillium* sp. fruit rots and powdery mildew. Field research data indicate that Benlate will also give very good control of spur blight and anthracnose.

Bordeaux is used for control of spur blight in red raspberries. Bordeaux is an effective fungicide, but is somewhat injurious to tender foliage.

Captan is used in blueberries in combination with Ferbam for effective control of the blossom infection stage of mummy berry disease. It gives only fair to poor control of the shoot blight phase of the disease. In grapes, captan gives excellent control of dead arm disease and downy mildew. It also gives fair control of black rot disease, but gives no control of powdery mildew. In strawberries, it gives fair control of fruit rots and leaf diseases. In raspberries, captan gives good control of anthracnose.

Difolatan *(captafol)* is a broad spectrum, long-lasting fungicide with unique plant surface redistribution qualities when rain occurs. Difolatan is available as a 4 lb. per gallon flowable (4F) and now in 80% water dispersable granules ("Sprills"). It is registered in blueberries for control of Fusicoccum and Phomopsis cankers, and Alternaria and Anthracnose fruit rots.

Ferbam, used in combination with captan in blueberries, gives fair to poor control of the shoot blight phase of mummy berry disease and good control of the blossom infection phase (which gives rise to mummified fruit). In grapes, ferbam is one of the best fungicides for black rot control. However, it gives very little control of downy mildew or dead arm disease and no control of powdery mildew. In raspberries, ferbam gives fair control of anthracnose.

Folpet *(Phaltan) (n-trichloromethylthiophthalimide)* is formulated as a 50% WP. It is closely related to captan and is used effectively against black rot and dead-arm in grapes. It is also effective against grape powdery mildew and downy mildew.

Funginex *(Triforine, Saprol — N, N'-[1,4-piperazine-diyl-bis-(2,2,2-trichloroethylidene)]-bis-[formamide]).*

Funginex is a new systemic fungicide for the control of mummyberry disease. This fungicide comes as a 20% emulsifiable concentrate (E.C.).

Funginex should be applied by conventional ground equipment when possible. However, it does give excellent control of mummyberry disease of blueberry when applied by airplane in 5 to 10 gallons of water per acre.

For fruit in Michigan, the only full use label currently available is for control of mummyberry disease of blueberries.

Karathane gives good control of powdery mildew on grapes, especially in Concord, Niagara and other American varieties.

Mancozeb *(Dithane M-45 and Manzate 200)* is maneb *(manganese ethylenebisdithiocarbamate)* in combination with a zinc ion coordination product as a safener. It is an 80% wettable powder. In grapes, mancozeb gives excellent control of dead arm disease and downy mildew and good control of black rot. This product does not control powdery mildew.

Topsin M *(Thiophanate-methyl)* is a 70% wettable powder fungicide. It is registered for use in strawberries. It is used for the control of leaf blight, leaf scorch, leaf spot and Botrytis fruit rot (grey mold). Always use Topsin M in combination with Captan as a tank mix. It is very similar in activity to Benlate (Benomyl).

Vinclozolin *(ronilan)* is registered for use on strawberries for the control of Botrytis grey mold. Ronilan acts as a protectant fungicide. It has a fairly short life in the field (7 to 10 days active residue). While it is paricularly effective against Botrytis grey mold, it has a somewhat narrow range of anti-fungal activity. It is important that it be combined with Captan 50W as a tank mix to broaden the spectrum of activity.

Wettable sulfur gives fair to good control of powdery mildew in French hybrid and *vinifera* (European) varieties. Sulfur injures many American varieties and some French hybrid varieties. Consult the table (p. 91) for varietal susceptibility to sulfur injury in the grape spraying section. Sulfur can cause injury to tolerant varieties if the temperature is 85° F., or above, during spraying or shortly after spraying is finished.

Zinc-Maneb *(Dithane FZ).* This is a flowable formulation of Maneb plus zinc as a safener. It is used for the control of the same diseases in grapes as listed under Mancozeb.

RESISTANCE TO FRUIT FUNGICIDES

In the past, fungi resistant to fungicides were rare under field conditions. However, recent experience with some of the new organic fungicides with selective action on fungi indicates resistant strains of the target organisms will develop quickly where these are the predominant fungicides in the spray schedule.

Benomyl-resistance

When benomyl (Benlate) was introduced for the control of tree-fruit diseases, it gave outstanding control of several pathogens. In 1975, benomyl-resistant apple scab, benomyl-resistant brown rot, and benomyl-resistant leaf spot were found in a number of commercial orchards in Michigan.

Benomyl resistance has also developed in the fungi that cause blue mold and gray mold, two common storage diseases of apple and pear in Michigan.

Pathogens resistant to benomyl are also resistant to other fungicides in the benzimidazole group, such as thiophanate-methyl (Topsin M), thiabendazole (Mertect) and carbendazim, or MBC. Thus, these fungicides are of limited value because they cannot be used where resistant strains exist.

Another characteristic of benomyl-resistant strains is that they are fairly stable once they have arisen. Even if non-benzimidazole type fungicides are used in orchards where benomyl-resistance now exists, it is likely resistant strains will build up rapidly when a benzimidazole is re-introduced into the orchard.

Although it is seldom entirely possible to determine the source of resistant strains, it seems probable that benomyl-resistant strains were already present in nature when benomyl was introduced. Thus, by the continued use of benomyl, selection pressure was exerted on the population and the resistant strains were intensified. After benomyl was introduced, control failure occurred in about three years. Today, failures come much faster because of the history of benomyl usage in Michigan and because resistant strains, particularly to apple scab, are distributed throughout the fruit-producing areas.

Two methods or procedures have been suggested for preventing the buildup of resistance where benomyl is retained in the spray program. These are 1) use benomyl in combination with an unrelated fungicide, or 2) alternate benomyl with other non-related fungicides. In practice, alternation of fungicides is more risky than combinations because, if resistant strains are present, there is a lack of protection when the benomyl is applied alone.

Resistance to benomyl is widespread in Michigan, limiting the usefulness of this material in disease control programs. If adequate control was achieved in the past with benomyl, it may or may not prove effective in the current growing season. For the above reasons, benomyl alone, or combined with superior oil, and in some cases benomyl combinations have been withdrawn from the recommendations.

Suggestions for Resistant Apple Scab

Because benomyl-resistant strains of the apple scab fungus are present in a large number of commercial orchards, benomyl (Benlate) has been withdrawn from the list of fungicides recommended for apples.

Using Benomyl on Stone Fruits

Resistant strains of brown rot and leaf spot are present in Michigan, and the population size and distribution of benomyl-resistant strains have increased since 1975 when they were initially detected.

Present knowledge from limited field experience with benomyl resistance indicates benomyl-resistant brown rot or leaf spot can be delayed by restricting the use of benomyl as follows:

1. Use benomyl (Benlate) in the spray program only at the "key" brown rot infection periods and only in combination with captan. The combination with benomyl would be used:
   a) From "popcorn" to petal fall.
   b) From 21 days of harvest through the harvest period.
2. Between the two "key" brown rot periods, use a non-benzimidazole fungicide to prevent such problems as cherry leaf spot, peach scab, black knot, powdery mildew, etc.
3. Where suspected or proven cases of resistance exist, use only non-benzimidazole fungicides.
4. Never use benomyl fungicide on its own. Always combine it with another fungicide.

Dodine Tolerance

Dodine-tolerant apple scab has been found where dodine was used more or less exclusively for about 10 years. In laboratory studies, dodine-tolerant strains of apple scab tolerated 3 to 4X the dosage of dodine that kills sensitive strains while benomyl-resistant strains often grow at 1000X the dosage of benomyl required to kill sensitive strains.

Where dodine (Cyprex) has been used for some time without problem, use a second fungicide for part of the season.

Switch to a non-related fruit fungicide if dodine (Cyprex) has been used regularly for about 10 years and scab control is a problem.

On cherries which have received a Cyprex schedule for several years, a wise precaution is to integrate other fungicides in the program to reduce the risk of developing dodine-tolerant cherry leaf spot.

POST-HARVEST DISORDER CONTROL

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Fruit treated post-harvest must be properly labeled when marketed. The shipping container or master carton containing the treated fruit, but not the consumer package, must be marked "Treated with (name of the material) to retard spoilage." The lettering of this statement must be as large as the other lettering on the container.

Scald on Apples

Scald is a physiological (non-parasitic) disorder that develops on susceptible varieties of apples during storage and marketing. The most common symptom is a brown discoloration of the skin. Treat susceptible varieties of McIntosh, Cortland, Delicious, Greening,

Stayman, Turley and Roman Beauty (Red Rome) with a scald inhibitor whenever storage of several months or longer is anticipated. The occasional development of scald on Jonathan, Idared and Golden Delicious is not always severe enough to justify fruit treatment for its control, yet these varieties are treated sometimes.

CONTROL: Dip or drench the fruit shortly (within 2 weeks) after harvest with a scald inhibitor.

Diphenylamine (DPA), wettable powder or liquid at 1,000 or 2,000 ppm for warm fruit (50°F or higher) or 2,000 ppm for cold fruit. Apply at least 1,000 ppm to control scald on susceptible varieties including Cortland, Delicious, McIntosh, Mutsu, Rome Beauty, Stayman Winesap and Turley Winesap. An exception is that 2,000 ppm is required for control on early-picked Delicious. Frequent renewal of DPA and good agitation are essential to offset the DPA removed by the fruit and debris or settled out of the suspension. Treatment with 2,000 ppm is frequently employed to assure an effective concentration of DPA. Test kits for quickly measuring the DPA solution concentration are available from several suppliers, and are useful in efficiently maintaining an adequate level of the scald inhibitor. Avoid levels above 2,000 ppm because of injury and residue hazards. Rome Beauty and Golden Delicious may be damaged at lower levels, i.e. 1,500 ppm. If scald control seems necessary for Jonathan, Idared or Golden Delicious, use 1,000 ppm.

Ethoxyquin, liquid, at 2,700 ppm. Follow label recommendations as provided by the several suppliers. Although the mixture can be reused until dirty, frequent changing is recommended. It requires good agitation and should include a fungicide (see below), however, do not use Mertect Flowable® with Deccoquin® because of possible fruit injury.

Internal Breakdown and Bitter Pit of Apples

Internal breakdown is an "old-age" disorder which is retarded in development by good fruit handling and storage practices and by post-harvest treatment of the fruit with calcium chloride. The disorder is characterized by browning of the flesh followed by excessive softening and finally skin discoloration.

Bitter pit appears as dry, brown spots of tissue before and after harvest. Its development can be retarded during storage by treatment with calcium chloride. It may be used on Delicious and Northern Spy.

Dip or drench the harvested apples in a 4% solution of calcium chloride containing 33 pounds of actual calcium chloride per 100 gallons of water. The calcium chloride should be either Food Grade or Technical Grade that meets Food Chemical Codex specifications. It may be combined with DPA applied for scald control (see above). The treated fruit should be stored immediately or put under cover to avoid loss of the material (i.e., by rainfall) which must remain on the fruit during the storage period to be effective. The apples must be washed when prepared for use or marketing. Apples with enlarged, poorly corked lenticels, poor finish due to russeting, or mite injury in the calyx cavity may be damaged by calcium chloride. Include fungicide in the treatment solution to minimize the occurrence of fruit rots (see below).

Fruit Rots of Apples and Pears

Blue mold or soft rot and gray mold are the most common storage diseases of apple and pear in Michigan. They are caused by the fungi *Penicillium* and *Botrytis*, respectively. Spores of these fungi build up in solutions used to treat apples for scald or internal breakdown, and in water used in dumping bulk boxes. Decay from blue mold and gray mold can be prevented by adding one of the following fungicides to solutions that are used repeatedly for treating or handling fruit. Good agitation of the treatment solution is essential to keep sufficient fungicide in suspension. When drenching, be sure uniform coverage is obtained throughout the pallet box.

SUGGESTED CHEMICALS

Fungicides	Rate/100 gal. dilute
Thiabendazole (Mertect) 42.28% F.	16 fluid oz.
or	
Benomyl (Benlate) 50% WP	8 oz.

NOTE: Benomyl resistant strains of *Penicillium* and *Botrytis* now exist in Michigan and have resulted in poor control of blue and gray molds in several cases. Thiabendazole should not be substituted for benomyl because strains resistant to one fungicide are resistant to the other one as well. No other fungicide is available that can be substituted or combined with these fungicides. Losses from resistant strains can be minimized by changing treatment solutions frequently and by thoroughly rinsing the equipment between changes. (See Resistance to Fruit Fungicides, page 21).

Fruit Rots of Stone Fruits

Stone fruits that are not consumed within a day or so after picking should receive a post-harvest spray, drench, or dip treatment to decrease decay from brown rot and *Rhizopus* rot. A good pre-harvest spray or dust program is essential for rot control whether or not a post-harvest treatment is applied. Additionally, refrigerate to reduce the rates of fruit ripening and decay development.

The following fungicides are suggested for the combined control of brown rot and *Rhizopus* rot:

Fungicides	Rate/100 gal. dilute
Benomyl (Benlate) 50% WP plus	½ lb.
Botran 75% WP*	½ lb.

NOTE: Good agitation of the treatment solution is a must to maintain an effective fungicide suspension. Containers must be uniformly treated with sufficient volume of solution to achieve thorough wetting in the container. Botran is added for *Rhizopus* control.

*Omit Botran from this mixture when treating apricots, nectarines, and prunes. Botran has not been cleared for this use on these fruits as a drench or dip, although attempts are being made to obtain label clearance. Check with local authorities for changes in registration status. Botran has been cleared for post-harvest treatment of sweet cherries and peaches.

INSECTICIDES

Ambush (see permethrin).

BAAM is a formamidine insecticide-acaricide. It effectively controls pear psylla, pear rust mite and pear blister mites on pears and European red mite, two spotted mite and rust mites on most other fruit crops. It has proven to be excellent in controlling summer populations of pear psylla. It has demonstrated activity on both egg and mobile forms of mites and has a good vapor and systemic activity.

Carzol is a non-phosphate miticide-insecticide registered for use either pre-bloom or post-bloom on apples and pears to control the European red or two-spotted mite, the white apple leafhopper, tentiform leafminer and pear rust mite. On peaches it is registered to control lygus bugs and stink bugs. It is most effective for controlling immature and adult forms of European red and two-spotted mites. It is efficient against organophosphate resistant mites and also controls those resistant to other types of pesticides.

Formulated as a completely water-soluble powder, containing 92% formetanate hydrochloride, it dissolves rapidly in water to leave an invisible crop residue. Correct dosage rates and thorough tree coverage are important, since Carzol primarily kills the active stages of mites. Repeat applications should be made as needed or whenever mite infestations appear. No more than 4 lb. per acre can be applied in any one crop season and no closer than 7 days before harvest. If practicing integrated mite control, do not use after June 1 as Carzol is highly toxic to predatory mites.

The product is not stable in alkaline water. Its spray mixture must be freshly prepared just before application. It is compatible with many orchard spray materials, moderately toxic to honeybees and comparatively non-toxic to fish, birds, man and animals.

Chloropropylate, trade-named *Acaralate,* is a miticide for control of European red mite and two-spotted mite on apples and pears. As an emulsifiable concentrate, it kills young and adult forms of these mites. It is useful in pre-bloom preventive sprays or whenever mite infestations first appear. Pre-bloom applications are made as close to egg hatch as possible for best results. Correctly applied, they give residual control until mid-summer. It is highly toxic to predatory mites, and if attempting integrated mite control it should not be used post-bloom.

Post-bloom spraying must be repeated as often as necessary to control mite populations. Two applications spaced 7 to 10 days apart are required for maximum performance. Since only the active stages of mites are killed, it is essential that correct dosage is used and thorough coverage of trees obtained. Dilute or concentrate sprays must reach all parts of the tree, especially the underside of leaves. **Do not mix Acaralate with spray oils due to possible plant injury.** Virtually non-toxic to warm blooded animals, it is also safe to bees and other beneficial insects.

Cythion ULV is a formulation of 95% technical material of malathion. Its only uses are for Ultra Low Volume applications by air to control cherry fruit fly and blueberry maggot.

Demeton, better known as *Systox,* is formulated as a 6 lb./gal. E.C. and a 2 lb./gal. E.C. The Systox 6 E.C. mixes with Cyprex. Systox 2 E.C. does not mix with Cyprex. It is a contact and systemic phosphate formulated as an emulsifiable concentrate. It is generally utilized for systemic control of sucking insects such as aphids, leafhoppers and mites. Its major use in Michigan has been on apples and pears, either pre-bloom or early post-bloom, for clean-up of aphids. As a systemic, Systox quickly penetrates plant tissues and is translocated throughout the plant. This distinctive feature makes it less harmful to beneficial insects. Like parathion or certain other phosphates, this chemical is highly toxic to man and safety precautions must be given due attention.

Diazinon ranks intermediate between parathion and malathion in toxicity to humans. It is active against a variety of fruit pests, offering residual activity of 11 to 14 days and has clearance for use on apples, pears, cherries, peaches, plums, prunes, strawberries, grapes and brambles. The principal uses of diazinon in Michigan involve a 50% wettable powder formulation for control of cherry fruit fly on sweet and tart cherries, summer insect complex on apples after First Cover and insects troublesome to strawberries in mid-season. Drenching crown treatments of emulsi-

fiable concentrate will kill the overwintering stage of raspberry crown borers when they are a problem. Diazinon is proving to be a selectively useful insecticide in integrated control programs, since it is relatively non-toxic to important predatory mites.

Dimethoate is marketed as *Cygon* and *De-Fend* for control of a wide range of insects on bearing apples and pears. Sold as a 2.67 lb./gal. emulsifiable concentrate or 25% wettable powder, its systemic properties have specific value in aphid control. It is effective for white apple leafhopper at twice the rate of application required for aphids and when applied for aphids provides excellent control of tarnished plant bug. Compared to many insecticides, it is practically without compatibility problems. While toxic to bees, the product is one of the least poisonous of the organic phosphates to humans and animals.

Ethion has use on apples in combination with oils to control overwintering stages of mites, aphids and scale. Several formulations of Ethion-oil are available or the Ethion can be purchased separately and added to the oil prior to application. Ethion should not be sprayed after bloom on apple varieties maturing before McIntosh, since severe leaf injury and subsequent fruit drop are likely to occur.

Fenvalerate (Pydrin 2.4 E.C.) is a member of the new class of insecticides known as synthetic pyrethroids. Fenvalerate is a stomach and contact poison with low mammalian toxicity and very high insecticidal activity. It exhibits a long residual activity of about 21 days. It is also more effective in cool temperatures that are prevalent during its recommended use period. It is registered as a seasonal spray on pears but should not be used after petal fall because of resistance problems. When applied at white bud or petal fall stage, it gives outstanding control of green fruitworm and pear psylla. To avoid potential resistance, growers should limit its use to the pre-bloom period or petal fall. It is registered for seasonal applications on apples. It is an outstanding broad spectrum for most apple pests. It is an adulticide and ovicide for spotted tentiform leafminer.

Guthion is the most widely used insecticide in Michigan orchards. Available as a 50% wettable powder or 2 lb./gal. spray concentrate, it has provided good broad spectrum control of many primary fruit pests with a residual action of 10 to 14 days. The spray concentrate is not cleared for apples and pears. There have been no phytotoxicity or residue problems when the compound is used properly and in accordance with label directions.

To avoid prohibitive residues, no more than 8 applications of Guthion on deciduous fruit, nor 3 to 4 applications on grapes, strawberries and blueberries are permissible in a season. While Guthion is similar to parathion in toxicity to humans, it is of low toxicity to predaceous orchard mites. Make use of the safety measures reserved for organophosphate insecticides when handling this material.

Imidan is a phosphate chemical with a low toxicity to mammals comparable to Sevin. It is formulated as a 50% wettable powder for pre-bloom and post-bloom application on apples, pears, peaches, cherries, plums, prunes, grapes and apricots. It provides good broad-spectrum control of many fruit pests in Michigan.

In Michigan trials, Imidan has been outstanding in performance on apple maggot. The material can be a boon in attacking maggot outbreaks close to harvest. Imidan represents a biodegradable pesticide which in a short time interval dissipates into non-toxic residues harmless to man, wildlife and other living forms.

Kelthane, used as a specific miticide, has performed well in Michigan against the nymphs and adults of red mite, two-spotted mite and rust mites during the past several years. For best results, apply Kelthane when the average temperature is predicted to be above 70° F. for 5 to 7 days. Repeat applications 7 to 10 days apart are often necessary and advisable. Its toxicity ranks comparatively high in safeness to man and wildlife. It is highly toxic to predatory mites and should be used prior to June 1 if practicing integrated mite control.

Lannate (see Methomyl).

Lorsban is an organophosphorous insecticide used on peaches. Applied as trunk sprays by handgun, it effectively controls peach tree borers. Applications before newly hatched borers enter the trees made in early June and aimed at the lower scaffolds will also control lesser peach borer. It may be applied pre-bloom for scale and rosy aphid control. It may be used alone or in combination with oil. For 1984 Lorsban is registered as a broad spectrum pesticide for seasonal use on apples. It gives excellent control of scale insects. Lorsban is registered for control of borers attacking cherries for 1984.

Malathion is a mild phosphate that controls an unusual variety of fruit insects and is especially useful against several species of aphids. However, its residual effectiveness seldom exceeds 2 to 3 days. Thus, it can often be employed to best advantage in late season sprays. Its use is particularly indicated where a high degree of safety to man and animals becomes desirable. Obtainable as emulsifiable concentrate, wettable powder or dust, Malathion is presently used in Michigan for certain insect pests attacking brambles, currants and blueberries. Unlike many chemicals, it is generally compatible with every insecticide and fungicide in common usage.

Mesurol is a broad spectrum carbamate insecticide that at high rates is an effective bird repellant. It repells grackles, robins, starlings, and cedar waxwings from the treated crop area, and minimizes fruit loss due to bird damage. It is registered on cherries and blueberries and effectively controls cherry fruit fly and blueberry maggot. It is highly toxic to bees and predators. Its use is limited to two applications of the high rate and three applications of the lower rate per season.

Methomyl (Lannate or Nudrin) is registered for use on apple only as a 90% soluble powder and 1.8 lb./gal. E.C. Methomyl is primarily effective as a contact insecticide, though some systemic activity is also evident. Methomyl residues remain effective for about 5 days. Correct timing is a must.

Methomyl is effective in controlling green fruitworm, certain leafroller and leafminer pests which are difficult to control with other broad spectrum compounds. At the same time, it provides control of indirect pests such as aphids. For these reasons, Methomyl may be important where its combination with other broad spectrum insecticides would provide optimum control of a pest complex neither alone would adequately control.

Toxicity of Methomyl, while less than parathion, still requires the safety precautions necessary for such highly toxic compounds. Methomyl is extremely toxic to fish and bees, so avoid use when bees are active and keep out of any body of water. CAUTION: Outbreaks of wooly apple aphid may result from a season-long (multiple applications) of Methomyl.

Morestan—This miticide is formulated as a 25% wettable powder. It is registered for pre-bloom use on apple and pear for control of mites and their eggs. It should not be applied after the first bloom. Its residual activity makes this miticide particularly useful in controlling mites during seasons when weather conditions prevent the application of oils. Morestan is not highly toxic to humans but is toxic to fish and should not be used in any manner where water would be contaminated. Morestan is only slightly toxic to predaceous mites but should not be used after bloom. WARNING: do not mix with or follow oil applications.

Nudrin (see Methomyl).

Omite is closely related to Aramite in chemical structure and gives good control of mites. It is effective against the mite strains resistant to phosphate and chlorinated hydrocarbon miticides, and is cleared for use on apples, peaches, pears, plums and prunes. Omite is not a systemic, therefore complete coverage of upper and lower leaf surfaces and fruit is important for maximum results. Likewise, it is not a pre-bloom miticide, since performance is best when temperatures are 70° F. or higher. Mites hit by the spray stop feeding and die within 48 to 72 hours. Initial kill is slow, often 3 to 5 days, but is compensated for by long residual action. This material is not an ovicide, and is mainly effective against young and adult mite stages. It has minimal effect on beneficial insects, is reportedly less harmful to predator mites and data indicate it to be relatively non-toxic to man and animals. For best performance in cleaning up summer mite populations, make two applications 7 to 10 days apart.

Parathion is extremely toxic to man and animals. Along with a complete understanding of the label, adequate safety precautions include rubber gloves, suitable protective clothing and an approved face mask. It has been widely used since 1949 for control of many fruit pests. No injury from this material has been observed on peaches, plums and cherries. Apples, and occasionally pears, have been injured when parathion was used in excess of suggested dosages.

Pay-off is a second generation pyrethroid. It exhibits low mammalian toxicity while being very toxic to a large number of insects. It is used at considerably lower rates than first generation pyrethroids.

Penncap-M is a newly formulated version of methyl parathion. The methyl parathion is encapsulated (packed in small microcapsules) which significantly reduces the toxicity hazard to humans and other non-target organisms while extending the residual activity of the material. Formulated as a flowable containing 22% methyl parathion, the microcapsules are suspended in water. The methyl parathion slowly diffuses from the capsules over time providing residual control.

Penncap-M is registered for use on cherry, nectarine, plum, prune, peach, pear, apple and grape for control of key pests such as codling moth, oriental fruit moth, plum curculio, leafrollers and grape leafhopper.

Penncap-M is toxic to certain species of birds, wildlife and fish. Use with care around bodies of water. WARNING: Penncap-M has been implicated in a number of bee poisonings. This material and others may be collected from flowers by adult bees when foraging for pollen. It is then taken back to the hive where it is fed to the brood resulting in hive mortality. Penncap-M should not be used in orchards with bloom present, where cover crops are in bloom or where adjacent orchards or foliage are in bloom. These precautions will reduce the potential for bee poisoning and permit use of this effective insecticide.

Permethrin (Ambush or Pounce) is a member of the class of insecticides known as the synthetic pyre-

throids. These compounds exhibit low mammalian toxicity while having very high insecticidal activity. They act as stomach and contact poisons. A section 18 is pending for its use to control climbing cutworms on grapes. Check with the extension agent in your area to see if this emergency exemption has been approved for grapes. Permethrin is cleared for seasonal use on pears and up to and including petal fall on apples.

Phosphamidon offers limited usefulness in the battle between man and insects for the fruit crops. Its chief asset lies in its ability to control aphids and mites as both a contact and systemic poison. Therefore, as an 8 lb./gal. emulsifiable concentrate, it favorably joins Systox and Dimethoate as an optional choice on apples pre-bloom and early post-bloom for disposal of aphid populations. Phosphamidon warrants the same precautions granted any cholinesterase-inhibiting chemical and it is highly toxic to mite predators.

Plictran, formulated as a 50% wettable powder, is a non-phosphate miticide with outstanding activity on destructive plant-feeding mites—those both susceptible and resistant to other miticides. It is registered for post-bloom use on apples, plums, peaches, nectarines and pears to control the motile forms of European red, two-spotted and rust mites.

No more than 4 sprays can be applied between petal fall and harvest to apples nor more than 3 on pears. Since Plictran kills the active stages of mites, coverage of foliage must be thorough and complete to include uniform wetting of upper and lower leaf surfaces. The product mixes readily in water to form a suspension that can be applied with any conventional spray equipment. It is usable alone or compatible in tank-mix combinations with those insecticides and fungicides generally employed in orchard spray schedules. No phytotoxicity or adverse effects on fruit finish have been reported. Plictran is a preference miticide for "integrated-control" programs since it is not harmful to beneficial insects or predatory mites. Used as recommended, it presents no unusual health, contamination or environmental problems. It is non-toxic to honey bees, only somewhat hazardous to birds and fish, moderately toxic to wildlife and of low toxicity to man.

Pounce (see Permethrin).

Pydrin (see Fenvalerate).

Sevin is formulated as a 50 WP and 80 WP. Carbaryl by common name, it finds its place somewhere in the spray program for every fruit crop grown in Michigan. Its residual effectiveness varies from 10 to 14 days, depending on the insects to control. In most cases, it can be applied within a day or closer to harvest without fear of excessive residues. Sevin is not a miticide, may encourage aphid buildups and is inclined to be seriously toxic to bees. It is compatible with most pesticides and gives good control of certain pests resistant to other frequently used insecticides. Sevin offers a high degree of safety to animals and plants. There is the added advantage of its low toxicity to man and fish, lessening the hazards from spray drift that are associated with many pesticide chemicals. In as much as Sevin is a recognized fruit thinning agent, its use is avoided until at least 30 days after full bloom on McIntosh, Jonathan, Northern Spy and Delicious apple varieties.

Superior Oil—"Superior oil" has been recommended as one of the preventive European red mite control programs. The 70-sec. oil will give better European red mite control than some of the lighter viscosity oils.

The 70-sec. viscosity oil is not a dormant-type oil. It is lighter and more volatile than the original "superior oil" which was used as a dormant spray. The principal advantage of the lighter 70-sec. oil is the reduced possibility of plant injury. It is safer because it is more volatile, resulting in less persistence on the tree. It remains on the tree long enough to kill the mites but not so long as to interfere with vital plant processes or oil-incompatible pesticides which may be applied later.

Because of this safety factor, the 70-sec. oil can be applied between Green-Tip and Pre-Pink stages of tree development. European red mite eggs are most susceptible to control by oil when they are about to hatch. Under Michigan conditions, the period of egg hatch starts about the time the trees are in the Pre-Pink to Pink stage. Thus, the closer the application to Pre-Pink, the greater the kill of mite eggs. Oil applied earlier than Green-Tip is not as effective as later applications. The addition of a phosphate insecticide does not increase the miticidal value of oil.

Preventive European red mite control programs are designed to control the mites at an early stage in their development to prevent any build-up through the season. Supplemental measures are usually required in mid- to late-season. Eradicative mite control programs, on the other hand, attempt to control mites after they have increased sufficiently in numbers to damage the crop. During the past few seasons the eradicative programs have been expensive but not very successful in controlling established mite populations. Oil applications have no value in controlling the two-spotted mite.

The *minimum* specifications for the 70-sec. viscosity "superior oil" are as follows:

Properties[a]	Orchard Spray Oil
Viscosity at 100° F.[1]	
Saybolt Universal Seconds	66-90
Gravity[2] API (minimum)	33
Unsulfonated Residue[3] (%)	92
Pour Point[4], °F. (maximum)	20
Distillation, °F.	
10 mm Hg at 50% point[5]	438 ± 25
10% - 90% (maximum)	150
or	
760 mm Hg at 50% point[6]	675 ± 25
10% - 90% range (maximum)	120

[a]The following ASTM methods are to be used:
[1]D445-61 and D446-53; [2]D287-55; [3]D483-61T;
[4]D97-57; [5]D1160-61; [6]D447-59T.

Supracide 2E, common name methidathion, is an organophosphate insecticide. This compound has shown very good activity in controlling scale insects alone or in combination with oil. It is effective against rosy apple aphid. It is moderately toxic with an acute dermal LD-50 of 640 mg./kg. against rabbits and an acute oral LD 50 of 65 mg./kg. against rats. Apply prebloom only.

Thiodan, a distant relative to most conventional chlorinated hydrocarbons, has been an effective insecticide available for peach tree borers. Both the lesser borer and true peach tree borer are controlled by this product. Thiodan is suggested for growers who have severe borer problems on peaches, plums and cherries. A period of 21 to 30 days between last application and harvest, depending on the crop treated, must elapse if the fruit is to be within safe residue tolerances. Post-harvest sprays of Thiodan reduce late season infestations and there are no restrictions for post-harvest use of the product.

A 50% wettable powder and 3 lb./gal. emulsifiable concentrate are available for any of the described uses, with no more than two applications after petal fall and during the fruiting season. Of moderate toxicity, Thiodan requires the same caution granted any chlorinated product similar to it.

Trithion is an effective multipurpose organophosphate insecticide-acaricide registered on many fruit crops. It effectively controls pests on apples, apricots, tart and sweet cherries, grapes, nectarines, peaches, pears, plums, prunes and strawberries. It controls aphids, mites, scales and overwintering aphid and mite eggs.

Vendex is formulated as a 50% wettable powder, nonphosphate miticide with very good activity against a wide range of plant-feeding mites. It is registered for use on apples and pears to control European red, two-spotted, and rust mites. Apply no more than 4 times/season, and no more than 3 times between petal fall and harvest. Do not apply within 14 days of harvest. This product mixes readily with water to form a suspension that can be applied with any conventional spray equipment. It is usable alone or in tank-mix combinations with those insecticides and fungicides generally employed in orchard sprays. No phytotoxicity or adverse effects on fruit finish have been reported. Apply when mites appear. Vendex is a preferred miticide for integrated mite control and has the same good attributes as Plictran. It is of low toxicity to predaceous mites and can be utilized to adjust predator-prey ratios. Used as recommended it presents no unusual health, contamination or environmental problems. It is toxic to fish and should be kept out of ponds and streams. It is non-toxic to honeybees and of low toxicity to humans.

Vydate L is a systemic and contact carbamate insecticide-acaricide-nematicide. It is currently labeled as a nematicide and miticide on non-bearing trees, and as an insecticide-miticide on bearing apple trees. It gives excellent control of aphids, leafhoppers, mites and leafminer larvae; however, it is highly toxic to bees and predators. WARNING: Do not apply within 30 days after bloom at a rate greater than ½ pt./100 gal. or fruit thinning may occur. Outbreaks of wooly apple aphid may occur from season-long program of vydate.

Zolone is a non-systemic phosphate insecticide-miticide. Presently registered for use on apples, pears, grapes and the stone fruits, it controls most major fruit pests and suppresses or controls minor pests. Marketed as an emulsifiable concentrate containing 3 lb. of active ingredient per gallon and a 25% wettable powder, it can be applied to within 14 days of harvest on apples, pears, grapes; and within 7 days of harvest on stone fruits.

Formulation changes include the removal of xylene from the emulsifiable concentrate formulation and a change in the formulation process of the wettable powder.

Due to the elimination of xylene from the E.C. formulation, Zolone no longer carries a flammable label; it also should be less injurious to fruit finish.

Zolone is recommended in cover spray applications following First Cover if not practicing integrated mite control since it is highly toxic to mite predators.

Zolone is compatible with most fruit fungicides, some insecticides, offers residual properties averaging 7 to 14 days and has crop residue tolerances of 10 ppm.

MONITORING OF INSECTS

The tree fruit section of the 1984 Pesticide Handbook stresses the importance of biological monitoring of insect (mite) pests. Biological monitoring refers to checking orchards for the presence of pest species and following their development through time so that control decisions can be made.

Use biological monitoring to identify the pests present and design control programs specifically for them. By following the development of a pest through the season, the most vulnerable stage can be attacked very precisely. Biological monitoring of insects doesn't always mean reduced control costs, but this is certainly one of its goals. You may need as many, or more, sprays as in the past—but you spray only if the pest is present in numbers thought a threat to the crop.

All insects are "cold blooded" organisms and their seasonal development is tied primarily to the fluctuations of temperature. Likewise, temperature patterns vary from year-to-year, making it impossible to associate the presence of a pest with a particular date or even a stage in the development of the fruit tree. By following the development of a pest through the season, the vulnerable stage may be precisely determined and appropriate controls applied. This requires extra effort on the part of the grower, scout, or professional fieldman. Following are the techniques and tools used for biological monitoring of tree fruit insect pests.

Regular Inspections

Inspection of overwintering sites or sites where a pest is likely to be found during the growing season is perhaps an underrated monitoring method. This may require more effort and may not be as specialized or sensitive as other monitoring techniques, but is especially useful in detecting the presence of small, relatively immobile pests such as aphids, scales, mites, pear psylla nymphs, etc. Inspections are the only practical means of detecting the presence of some pests, such as climbing cutworms, before they cause damage. By simply marking sites where pests are located and returning at regular intervals, stage changes can be observed to aid in the timing of control applications.

Leaf Sampling-Brushing

Another monitoring technique used specifically to detect the presence and relative numbers of mite pests is leaf sampling and brushing. A sample of leaves, usually 50 or 100, are picked from trees throughout an orchard. The leaves are then passed through a mite-brushing machine where mites on the surface of the leaf are brushed onto a sticky plate. The mites on a predetermined area of the plate are counted and the average number of mites per leaf calculated. This technique is not only useful in detecting pest mites but also reveals the presence of predator mites and is an important tool in integrated mite control.

Bait-Lure Trap

Two trapping techniques are used to monitor the presence and seasonal activity of fruit insect pests. The bait-lure trap is designed to monitor fruit flies, pheromone traps are designed to attract moth species which are fruit pests. The bait-lure trap attracts adult fruit flies (cherry fruit flies, apple maggot, or blueberry maggot) through a combination of their attractive color and the odor given off by the bait (usually a mixture of protein hydrolasate and ammonium acetate). The flies are trapped in a sticky substance coating the trap. By inspecting them at regular intervals, their presence and relative activity, or abundance, can be judged. The attractive powers of these traps are not known, and if fly populations are low (as in most commercial orchards) the ability of the trap to attract and therefore detect individuals, is questionable. However, traps placed in abandoned orchards, or commercial orchards with annual problems are useful for this purpose.

Pheromone Trap

The other type of monitoring trap is the pheromone trap (sex-lure). Pheromones are synthetic, chemical substances, which imitate the natural hormones for sex attraction in the female of an insect species. Plastic wicks or capsules with minute quantities of these attractants lure the males of the insect involved. The interior of these specially-designed traps is pre-coated with adhesive. Since each insect species generally has its own sex hormone, only a pure culture of the specific insect monitored is collected. This feature makes insect detection and identification easier.

Pheromone traps offer new dimensions in near-perfect orchard detection, emergence timing and monitoring of red-banded leafroller, codling moth, fruit tree leafroller, tufted apple bud moth, and Oriental fruit moth. These traps may be used to determine insect presence or absence in an orchard to assess insect populations, emergence trends, and economic damage thresholds. They eliminate much of the guesswork in spray timing for many of the more troublesome fruit insects. These traps are supplemental reinforcements and not replacements for other commonly used insect monitoring procedures.

PLANT GROWTH REGULATORS

Department of Horticulture

Plant growth regulators are organic compounds, other than nutrients, which influence growth, development, and maturation of vegetative and reproductive plant structures. The degree and type of response varies with the type and concentration of chemical, the crop, and the stage of plant development when applied. Before applying a growth regulating compound, know how it will affect the tree and crop, and any important side effects which might occur.

Plant growth regulators must be absorbed into the plant to be effective. The leaf and fruit are the primary absorbing organs. Therefore, any factor which influences the initial contact of the chemical with the plant, or its absorption, may have a marked effect on its response. The environment before, after, and during application, may have a profound influence on performance. Factors which increase absorption (high temperature, slow drying, healthy foliage) will increase the response, and those factors which decrease absorption (fast drying, cool temperatures, damaged foliage) will decrease the response. Use caution when considering growth regulators for plants low in vigor, or those under stress since they often over respond.

A major problem in growth regulator application is the variation in response that occurs between years, and at different locations during the same year, even when conditions are seemingly the same. To minimize variation and improve consistency, consider these factors:

1. **Dosage:** Growth regulators must be applied within a narrow dose range (concentration in relation to the volume of water per tree) to produce a desired response. If the amount of chemical applied to the tree is too high, an injury may result, or if too low, it may result in an inadequate response.

2. **Time of Application:** To be effective, most growth regulators must be applied within a narrow time interval, often within a few days. Also a specific growth regulator may induce different responses, which depend upon the stage of plant development at the time of application.

3. **Variety:** Varieties often differ in degree of response. Read the product label for specific instructions concerning timing and concentration.

4. **Coverage:** Responses are generally localized. All plant growth substances must be applied with precision. Insure that the proper amount is applied in a correct manner. Uniform, thorough coverage is essential. Calibrate your sprayer accurately, for large trees direct ⅔ of the spray volume into the upper ⅓ of the tree. Whenever possible, apply growth substances as a dilute spray.

5. **Environment:** The weather conditions before, after, and during application may affect performance by influencing dose and absorption of growth regulators. Whenever weather conditions approach extremes, avoid the application of plant growth substances.

6. **Tree Vigor and Stress:** Trees low in vigor, or under stress, often respond excessively so that special adjustments in dose, or elimination of the growth regulator application may be necessary.

7. **Evaluation:** Always leave several non-treated trees so that you can evaluate the effectiveness of your treatment [application]. Keep good records so that future adjustments can be based on your past experiences.

Chemical Thinning

Apples

High labor costs, the demand for large-sized fruits, and the need for thinning during the period of Petal Fall to 14 days after Petal Fall to induce annual bearing have stimulated the practice of thinning with the naphthaleneacetic acid compounds, referred to as NAA, and naphthaleneacetamide (NAD). NAA is available in acid form and as a sodium salt.

Thinning With NAA

Varieties differ greatly in their response to NAA thinning sprays. On this basis, they are divided into three groups: (1) easy to thin; (2) intermediate, and (3) hard to thin.

Listed below are the varieties and the suggested concentrations of NAA to use 5 to 7 days after Petal Fall as a guide when first starting a thinning program:

1. **Varieties Easy to Thin:** McIntosh, Delicious, Empire, Idared, Paulared, Jerseymac, Jonathan, Northern Spy, and Rhode Island Greening: 4 grams of *actual* NAA per 100 gallons (10 parts per million). Spur type Delicious are harder to thin than regular Delicious.

2. **Intermediate Group:** Grimes Golden, Oldenburg (Duchess), Fameuse (Snow), Hubbardston, and Wagener: 6 grams of *actual* NAA per 100 gallons (15 parts per million).

3. **Varieties Hard to Thin:** Yellow Transparent, Wealthy, Golden Delicious, Rome Beauty, and Baldwin: 8 grams of *actual* NAA per 100 gallons (20 parts per million).

If the first application of NAA (made 5 to 7 days after Petal Fall) does not give enough thinning, increase the concentration 2 to 5 parts per million and follow with a second application 7 to 10 days later. Very late applications can cause very small sized fruit.

Thinning With NAD

Amid-Thin is suggested for use on apples in Michigan at 50 parts per million at Petal Fall applying 350 gallons per acre. Concentrations lower than this have not given adequate thinning. Applying Amid-Thin *after* Petal Fall has resulted in *no* thinning; *and* it has caused the fruit to stick fast to the tree so that no "June drop" occurred giving a large crop of valueless, small apples.

NAD is suggested especially for early varieties which ripen before McIntosh, and for varieties likely to be injured by NAA applications. These include Yellow Transparent, Oldenburg (Duchess), Early McIntosh, Wealthy and Northern Spy. Amid-Thin can also be used on most other varieties. However, there are cases where the material did not thin Delicious, but instead, led to a large crop of undersized, distorted apples. **Do not apply** Amid-Thin *after* Petal Fall on the Delicious variety.

Sevin as a Thinning Agent

Sevin can cause unfavorable crop reduction when used throughout the season, beginning at *Petal Fall.* Studies have revealed that it was only the use of Sevin during the period of Petal Fall through Second Cover which caused the reduced yield. Applications at other times in the growing season had no adverse effect.

Sevin may be useful for fruit thinning but it has not produced consistent and adequate results in research trials. Thinning with Sevin does not appear to be concentration-dependent. If not used as an insecticide, rates of ½ to 2 lb./100 gal. will result in similar thinning responses. Apply Sevin at First Cover for fruit thinning. Sevin used at Second Cover following thinning applications of NAA can cause overthinning.

Guide for Chemical Thinning of Apples in Michigan.[1]

Variety	Chemical Method	
	NAA 5-15 days after petal fall (ppm)	NAD at petal fall (ppm)
Delicious[2]	10	—
Jonathan	10	50
McIntosh	10	50
Empire	10	50
Northern Spy	10	50
R. I. Greening	10	50
IdaRed	10	50
Winesap	10	50
Grimes Golden	15	50
Fameuse (Snow)	15	50
Cortland	15	50
Rome Beauty	20	—
Yellow Transparent[3]	20	50
Wealthy	20	50
Baldwin	20	—
Golden Delicious[4]	20	—
Dutchess	—	50
Early McIntosh	—	50
Paulared, Jerseymac	10-15	50
Other summer varieties[5]	—	50

[1]*This table should be used as a guide only. Specific chemical methods, and chemical concentrations may vary depending upon tree vigor, fruit set, environmental conditions, and application techniques.*
[2]*Some spur type Delicious may require higher concentrations.*
[3]*NAA may cause pre-mature ripening and fruit cracking.*
[4]*Sevin may cause fruit russetting of Golden Delicious.*
[5]*Varieties which mature before McIntosh.*

Evaluating Results

The results of the thinning spray (NAA or Amid-Thin) may be determined 7 to 10 days after application, as the affected fruits do not grow but remain the same size as when the spray was applied. Fruits *not affected* will continue to grow and become larger. This makes it possible for you to follow with an added application of NAA, if you desire.

Cautions

- As a general rule, apply NAA under fast-drying conditions, when the temperature is between 70° and 75° F. On the other hand, Amid-Thin gives best results when applied under slow-drying conditions. Amid-Thin is often applied in the evening.
- Weak trees are thinned more easily than vigorous ones. Weak wood in lower portion of tree thins easier than vigorous wood in the top.
- Thinning with NAA and Amid-Thin is greater when weather conditions during Bloom do not favor good pollination and fruit set. However, when fruit set is questionable, but chemical thinning is a "must," use Amid-Thin at 50 parts per million at Petal Fall.
- If the weather during the week preceding Bloom or the week after Bloom is cloudy, wet, and humid, thinning is accomplished more easily than if the weather during these periods has been fair and sunny.
- When freezing temperatures (32° F. and lower) occur after Pink and before applying the thinning sprays, NAA may cause excessive thinning. Reduce the concentration by 2 or 3 parts per million if frost, wind, chemical or insect damage to foliage has occurred.
- Each grower must work out the concentrations of NAA best suited for his orchard conditions. Sprays of NAA will remove all the fruit and severely damage the leaves if too high concentrations are used. When conditions exist which might result in injury, or loss of crop from overthinning with NAA, Amid-Thin applied at Petal Fall using 50 parts per million is safer for widespread use. However, these decisions must be made by the grower.
- Uniform coverage is important to avoid overthinning or under-thinning different parts of the tree.
- Thinning is most effectively accomplished with NAA applied 5 to 15 days after petal fall. The earlier applications permit evaluation and a second application, if necessary.

Thinning With Concentrated Mixtures

Fruit-thinning sprays can be applied in concentrate form with airblast equipment. A 2x concentration is suggested in the beginning whereby you use one-half the amount of spray per tree that would be used in conventional spraying.

If higher concentrations are tried, a good starting point is a 3x concentration but applying only one-fourth the number of gallons of spray per tree or per acre that you would use in conventional spraying.

Here, also, to obtain the amount of thinning desired, you must work out the concentration and gallonage per tree or per acre best suited to your orchard conditions.

Defruiting Young Apple Trees

Removing fruit on small trees before they are large enough to produce a profitable crop is often desirable. On some varieties, these fruit reduce tree growth and may contribute to a buildup of insects and diseases if the orchard is not on a full spray schedule. NAA at 15 ppm *plus* Sevin at 2 lb./100 gal., applied at petal fall has proven effective on Jonathan, Red Delicious and McIntosh. The use of this combination results in much more thinning than generally would be expected, but may not completely defruit the tree. For other varieties, try the recommended rate of NAA *plus* 2.0 lb. of Sevin per 100 gal. Higher concentrations may cause some leaf damage, and should not be used.

Pears

Michigan growers continue to use NAD for thinning Bartlett pears with the suggested time of application Petal Fall.

The following rates are given as guides: (a) trees of low vigor 25 parts per million (ppm); (b) trees of medium vigor 35 ppm, and (c) trees of high vigor 45 ppm. When the thinning spray is applied after Petal Fall, leaves are more subject to epinasty or twisting.

Bosc pears may be completely defruited with NAD at 25 ppm. No suggestions are available for using NAD for pear thinning purposes other than Bartlett.

Peaches

At the present time, no reliable chemicals are available for thinning peaches.

Pre-Harvest Drop Control of Apples

NAA (naphthaleneacetic acid), 2,4,5-TP (2,4,5-trichlorophenoxypropionic acid), and Alar may be used to control pre-harvest drop.

Apply NAA at first sign of fruit drop. It becomes effective in about 2 days and controls drop for 6 to 10 days. A repeat application may be necessary if harvest is delayed. Apply NAA at 10 parts per million (ppm) on McIntosh and earlier ripening varieties and at 20 ppm on varieties maturing after McIntosh.

Do not use 2,4,5-TP on varieties maturing before McIntosh. It becomes effective 6 to 10 days after application and provides drop control for 2 to 4 weeks. Apply at 10 to 20 ppm 2 weeks before anticipated harvest and before foliage begins to deteriorate or is frosted.

NAA and 2,4,5-TP may stimulate ripening and treated fruit should be harvested before it becomes overmature.

Alar is effective for pre-harvest drop control when applied at 750 to 1,000 ppm, 70 days before anticipated harvest. **Do not apply Alar within 60 days of harvest.** In contrast to the hormone type chemicals (NAA, 2,4,5-TP), which tend to hasten ripening of the fruit, Alar tends to retard maturation and treated fruit are generally more firm than non-treated apples at the time of normal harvest. For greater pre-harvest drop control, NAA or 2,4,5-TP may be applied in addition to a previous application of Alar.

NOTE: The use of 2,4,5-TP to control pre-harvest drop of apples is currently being reviewed by the EPA, and may not be available for use during the 1984 growing season.

Alar on Apples

Alar-85 *[butanedioic acid mono (2-2-dimethylhydrazide)]* will induce various fruit and vegetative-modifying responses depending on the time of application, degree of tree vigor and rate used. Desirable effects from Alar application include an intensification of color in red cultivars, increased fruit firmness, a reduction in: pre-harvest drop, water core, and vegetative growth, and promotion of flower bud formation.

Alar can be used any time after petal fall to 60 days before harvest in apple orchards. Early season applications 10 to 21 days after petal fall at the rate of 2,000 ppm (2 lb./100 gal.), tend to promote flower bud formation and to reduce the amount of vegetative growth. If applied to fruiting trees, particularly weak trees, reduction of fruit size is likely to occur that same season. Jonathan fruit size is markedly reduced by high concentrations applied shortly after petal fall. Early season applications may also produce similar results to those made 60 to 70 days prior to harvest, but the response may not be as pronounced nor as consistent. In general, the earlier the application, or the higher the concentration, the greater the reduction of fruit size during the current growing season.

Mid-summer applications of 500 to 1,000 ppm (½ to 1 lb./100 gal.) up to 60 days prior to harvest provide pre-harvest drop control, extend the harvest period, delay maturity, delay fruit softening and delay water core development.

The rate of application depends upon tree vigor, variety, and crop load. Do not apply Alar to trees low in vigor. If fruit size is a problem, eliminate Alar from your program the year following such a response. Do not apply Alar more than once during the growing season. Uniform, thorough tree coverage is essential for good response. For specific information concerning concentration and timing, consult your current product label.

Ethephon on Apples

Pre-harvest applications of ethephon favor red color development, hasten fruit maturity and ripening, and promote abscission of apples. The type and degree of response depends on the concentration, time of application, and the variety of apple. Ethephon will not completely overcome conditions unfavorable for development of red color. Conditions that are normally associated with poor fruit color, such as high temperatures, excessive vigor, or dense trees, may limit red color development to the point that adding ethephon still will not bring color up to a satisfactory level. Use ethephon only on apples intended for early sale since its ripening effect may shorten the storage life of the fruit. Apply ethephon at 150 to 300 ppm (½ to 1 pt. of ethephon per 100 gal. of water) 7 to 21 days before normal anticipated harvest. Responses are usually noticeable within 7 days. The time and rate of application depend upon the apple variety and your market objectives.

For early season varieties that mature before McIntosh, use 75 to 150 ppm (¼ to ½ pt./100 gal.) applied 7 to 10 days prior to normal harvest. On McIntosh and later season varieties use 200 to 300 ppm (⅔ to 1 pt./100 gal.) 14 to 21 days before normal harvest. Tree response is influenced by temperature at time of, and the interval immediately after, application. Cool weather delays response, and warm weather accelerates it.

Ethephon promotes fruit abscission. NAA or 2,4,5-TP must be used to counteract the abscission effect or excessive fruit drop will occur. A single application of 2,4,5-TP (10 to 20 ppm) may cause more ripening, and should not be used on varieties maturing before McIntosh. However, it will provide effective drop control for 2-4 weeks. A previous Alar application (1,000 ppm) is recommended to increase firmness of ethephon-treated fruit, but will not likely control fruit drop without the addition of NAA or 2,4,5-TP.

Ethephon on Cherries

Ethephon may be used to promote fruit loosening to facilitate mechanical harvesting of sweet and tart cherries. Response will depend upon the variety, concentration and time of application, and the environmental conditions during and after harvest.

Concentrations of 250 to 400 ppm, applied as dilute sprays 7 to 14 days before anticipated normal harvest date, effectively loosen sweet cherry for mechanical harvest. Generally, the lower rates (250 to 300 ppm) were more effective on Napoleon and Emperor Francis and the higher rates (350 to 400 ppm) on the dark varieties.

Time of application is an important factor from two aspects. First, a low concentration (250 to 300 ppm) will provide adequate loosening if given adequate time for action (10 to 14 days) while higher concentrations (up to 400 ppm) will loosen fruit to the same degree more quickly. Therefore, it is possible to substitute time for concentration and obtain the same effect. Second, it is important that the chemical not be applied too early in the season. The fruit should be in Stage III of growth, that is enlarging rapidly and the grass-green color should begin to yellow or take on a tinge of red. If ethephon is applied earlier than this, the fruit may fail to enlarge further and drop from the tree with the stems attached.

On tart cherries, ethephon at 200 ppm, applied 7 to 10 days before normal harvest, provides an adequate response to enhance fruit loosening to facilitate mechanical harvesting.

Temperature and tree vigor are associated with the degree of response achieved. At higher temperatures (greater than 85° F.) the magnitude of response is increased, and at lower temperatures (below 60° F.) it is decreased. It is apparent that trees low in vigor or under stress respond to a greater extent, and gumming and leaf abscission may result. Do not treat such trees with ethephon.

Consider the following points before applying ethephon to cherries:

1. Concentration: For light sweet cherries, 300 ppm (1 pt./100 gal.); for dark sweet varieties, 400 ppm (1⅓ pt./100 gal.); for tart cherries, 200 ppm (⅔ pt./100 gal.).

2. Time of Application: Apply approximately 7 to 10 days before anticipated harvest.

3. Temperature: Do not spray when the temperature is below 60° F., or greater than 85° F. Remember that hot weather will shorten the time, and cool weather will lengthen the time needed for response.

4. Vigor: Do not spray trees that are low in vigor, or under stress conditions.

5. Do not spray trees that had serious gumming the previous year.

6. For specific application instructions, consult your current product label.

Alar on Cherries

Alar may be used on cherry to advance and concentrate maturity, promote fruit loosening, increase fruit firmness, and increase fruit color. The type and degree of response will depend upon the tree vigor and the variety or species.

For *tart* cherry, research suggests that Alar-85 applied at the rate of 2 to 4 lb./100 gal., two weeks after full bloom, will likely result in improved red color, increased fruit firmness, advanced maturity, and promotion of fruit loosening. Vigorous trees exhibit little or no response to Alar applications.

On *sweet* cherry, Alar applied at the rate of 1 to 2 lb./100 gal., two weeks after full bloom, will likely result in a 5 to 7 day advancement in maturity, an increase in color development, and some reduction in fruit removal force. Alar is suggested for use on dark sweet varieties for canning or fresh market, but not for use on sweet cherries used for brining. Alar should not be used on trees of low vigor or plantings where fruit size tends to be small. Although Alar may advance maturity 5 to 7 days, cherry quality will remain good even if harvest is delayed.

Alar on Concord Grapes

Alar, when properly applied to Concord grapes, may increase fruit set, increase yield, and reduce vegetative growth. The magnitude of the effect will depend upon the time and amount of the material applied as well as the condition of the vineyard at the time of application. The following instructions should be used as a guide to proper application.

To increase yield, apply Alar-85 between first bloom and full bloom at the rates in table below.

Response to Alar is greatest when vine vigor is moderate to high, on vines which have not set adequate crops. Alar, when applied between first and full bloom, will reduce vegetative growth. The degree of reduction in growth depends upon the amount applied. In Michigan, growth reduction is generally not necessary, unless vines are extremely vigorous. For maximum reduction in vegetative growth, use the maximum allowable application rate of 1¼ lb./100 gal. or 2½ lb. per acre.

Recommended Rate of Alar-85 on Concord Grapes

Vine Vigor	Pruning wt. per vine (8′ x 9′ spacing)	lb. of Alar per 100 gal.	lb. of Alar per acre
Low	Do not use	—	—
Medium	2-3 lb.	½-1	1-2
High	3 lb.	1	2-2½

Gibberellic Acid on Cherry

Gibberellic acid may be used to reduce flowering and fruiting of young tart and sweet cherry trees to promote vegetative growth. Do not treat trees the first year they are planted in the orchard. Treatment should be made the second year to prevent flowering the third season and can be repeated the third year to prevent flowering the fourth year.

Apply at rate of 50 to 100 ppm two to four weeks after normal bloom time. If tree vigor is very low, a second application about three weeks later may be helpful. Do not treat more than twice in one year.

Water Sprout and Sucker Control
(Apple and Pear)

Application of 1% NAA paint or spray can aid in water sprout control around large pruning cuts and help control suckers at base of tree. Follow label directions in preparation of 1% NAA solution (Tre-Hold Sprout Inhibitor A112).

To control water sprouts in vicinity of large pruning cuts, apply 1% NAA mixture on bark in immediate vicinity of the cut and 2 to 3 inches below the cut. To control existing sprouts, remove undesired sprouts and treat the area where existing sprouts were removed.

To control root suckers, remove existing suckers during dormant season and spray new suckers when 6 to 10 inches high with 1% NAA solution. To avoid potential for excessive thinning, do not treat suckers on bearing trees until one month after bloom. Repeat spray treatments may be required in successive seasons, particularly if root suckering has been excessive or a problem for many years.

Ammate X at 60 lb./100 gal. sprayed onto root suckers in midseason will kill this growth. Do not allow spray to drift into the tree canopy.

WILDLIFE DAMAGE CONTROL IN ORCHARDS

By Glenn Dudderar
Dept. of Fisheries and Wildlife

Mouse Damage Control

Habitat Reduction

Mouse habitat in orchards can be reduced by regular mowing and by the use of herbicides. Eliminate brush and brush piles within the orchard and where possible, in areas surrounding the orchard. Pick up trash, particularly pieces of old packing crates. Pick up drops as soon as possible, especially before snow cover.

Mouse Guards

A wide variety of mouse guards are commercially available to protect young trees from mice. The guards can also be home-made from quarter inch wire mesh. These guards are placed around the young trees and should extend an inch or two below the ground and at least 18 inches above the ground. Where snow is likely to accumulate to a depth greater than 18 inches, higher guards are advisable. Such guards will also protect the stems of trees from rabbit, woodchuck and porcupine damage.

Repellent Chemicals

Both Capsicum (Miller's Hot Sauce) and thiram (Selco, Science, Pratt's) are registered to repel mice from fruit trees. Apply .006 percent capsicum mixed with the proper antidesiccant or a 10 to 20 percent solution of thiram mixed with a resin sticker until run-off to the base of all trees to a height of 24 inches. Application should be made in late fall just prior to snow fall. Where mouse populations are large, these repellent chemicals may not provide adequate protection unless also accompanied by mouse guards and/or poison baiting. Both chemicals also repel rabbits. Thiram seems to be the most effective.

Poison Baits

Three chemicals in various bait forms are available for mouse control in orchards: zinc phosphide (Orchard Bait, ZP), diphacinone (Ramik), and chlorophacinone (Rosol). All are available in pelleted form and zinc phosphide is available in a treated grain bait or can be purchased in concentrated form for home-made baits. All baits are equally effective if applied directly to vegetation where mouse runways and mouse burrows are evident. When baits are broadcast either by ground or by aircraft the chlorophacinone baits seem to be most effective while the zinc phosphide baits seem to be least effective.

Apply zinc phosphide baits at the rate of 6 to 8 pounds per acre treated and chlorophacinone and diphacinone baits at the rate of 10 pounds per acre treated. If satisfactory control is not achieved by the chlorophacinone or diphacinone treated baits on the first treatment, a subsequent treatment is advisable two or more weeks after the first treatment. Re-treatment wih zinc phosphide treated baits is usually less successful unless the baits are applied directly to mouse burrows and runways or are home-made using apple cubes.

Applications of poison baits should be made in late fall, after the harvest and just prior to the first snowfall. Where mouse populations are large, treatments earlier in the fall may be necessary. The weather should be dry and sunny during application and for at least 3 subsequent days. Weather is less of a problem with Ramik because of its superior durability. Where possible, treatment of border areas will reduce the rate of reinfestation by mice into the orchard. In no case should any poison bait be applied to bare soil or be placed in piles. Such application increases the hazard to non-target animals. Zinc phosphide poses more hazard to non-target birds than mammals and chlorophacinone and diphacinone pose more hazard to non-target mammals.

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Rabbit Damage Control

Habitat Reduction

Regular mowing and herbicide application to eliminate tall grass, dense vegetation, brush, and brush piles will reduce rabbit habitat. Where possible, such habitat should be eliminated in border areas around the orchards.

Repellent Chemicals

Capsicum and thiram reduce rabbit damage to trees. Application rates are the same as for mice. A special formulation of ammonium hydroxide (Hinder) is also commercially available and is applied in a 5 percent solution. All chemicals should be applied to the point of runoff and to a height of 18 inches above the highest probable depth of snow accumulation. Hinder must be re-applied every 2 weeks or after every rain. Of the three chemical repellents, tests at MSU have shown thiram to give the most reliable protection for up to 90 days. Since rabbit damage may begin to occur as early as late summer, begin application as soon as damage is first noticed. Re-treat prior to first snowfall. A third treatment is advisable in late winter where possible.

Population Reduction

Persistent hunting throughout the legal rabbit hunting season or trapping can sufficiently reduce the rabbit population to virtually eliminate rabbit damage, especially where rabbit habitat has been greatly reduced. If trapping is preferred, use wooden box traps baited initially with whole kernel corn. Once these traps have caught a rabbit, they do not need to be rebaited to catch additional rabbits, especially when there is snow on the ground.

Ground Squirrel Damage Control

Population Reduction

Ground squirrels can be eliminated from orchards by trapping and gasing or poison baiting. In small orchards where ground squirrels are burrowing between and under only a few trees, the most economical method to eliminate them is to trap them with rat-sized wooden based snap traps baited with a mixture of peanut butter and oatmeal. Check the traps

daily. Trapping can eliminate a few ground squirrels quickly.

In larger orchards or where ground squirrel populations are large, burrow gasing or poison baiting is necessary. Zinc phosphide treated bait is commercially available for ground squirrel control. Tablespoon quantities of baits should be placed in or immediately around all burrows. Diphacinone and chlorophacinone baits may be registered for ground squirrel control in Michigan in the very near future.

Ground squirrels may be gased in their dens by gas cartridges or aluminum diphosphide tablets (Phostoxin). When using gas cartridges, ignite and insert one gas cartridge per burrow. Immediately seal the entrance of that burrow and wait to see if any smoke escapes from an undetected burrow entrance. Treat those burrow entrances in the same way. When using aluminum phosphide tablets place two tablets down the entrance of each burrow and seal the entrance.

Porcupine Damage Control

Porcupine damage is best controlled by trapping and persistent shooting. Bait large wire box traps with corn cobs or similar material soaked in brine. Porcupines are most easily shot at dusk on warm spring evenings.

Woodchuck Damage Control

Habitat Alteration

Because woodchucks dig burrows, mowing, herbicides and brush removal does not greatly reduce their habitat. It does, however, make the burrows much easier to find. Burrow detection is an essential part of woodchuck control.

Population Reduction — Trapping, Gasing, Others

Woodchucks can be trapped by one of three methods. During the months of March and April woodchucks are easy to catch in the familiar wire box traps baited with whole kernel corn, carrots, celery or pieces of apples or potatoes. Once spring green-up occurs, however, woodchucks become more and more difficult to catch in box traps. Woodchucks can also be caught in a number 1 leg hold trap placed directly in front of the burrow entrance, staked down away from the entrance to prevent the woodchuck from gaining leverage on the edge of the burrow walls and pulling itself free. Old woodchucks may weigh twenty pounds or more and will require a larger trap. Woodchucks may also be trapped by placing a body gripping killer trap (Conibear 220) directly over the burrow entrance. Unfortunately, any animal attempting to go into the burrow will also be killed by this process.

Woodchucks may be gased in their burrows by the following materials: (a) U.S. Fish and Wildlife gas cartridges; (b) carbon bisulfide; (c) calcium cyanide; and (d) aluminum phosphide (Phostoxin). With all of these materials, it is vital that the woodchuck burrows be located early in the spring; and prior to placement of any of the materials, preparations be made to seal the burrow entrances with a piece of inverted sod or other appropriate device. Specific directions for the use of these materials in woodchuck control are found on the labels but the following information is essential. When using the gas cartridge, wait for approximately 15 minutes after sealing the burrow entrance and look for a plume of smoke emerging from a second burrow entrance. Seal the second entrance as well. Regardless of which material is used, check all burrow entrances within a week of treatment and re-treat any burrow that has been reopened. Young woodchucks usually leave their mother's den in late June or July thus making springtime den gasing far more effective than summer treatment.

Finally, woodchucks can be eliminated by persistent shooting, especially if the orchardist enjoys shooting or who knows a responsible person who does. Large dogs will also eliminate woodchucks if they have the right temperament and are encouraged to do so.

Deer Damage Control

Exclusion

Deer can be excluded from orchards by upright fencing 8 feet in height. A specially designed slanted fence is equally effective but costs two-thirds as much as the upright fence. Both types of fences are 100% effective and may be the least costly method where deer numbers are large, damage is great and trees are highly vulnerable, such as dwarf trees.

Specially designed electric fences can be used to repel deer efficiently, but must be erected exactly as specified. Vegetation control along the fences to prevent shorting is also essential. Where deer are numerous, it is usually necessary to obtain a kill permit from the DNR in order to eliminate any deer which get inside the fence. Sources of designs for deer fences can be obtained from county extension offices.

Repellent Chemicals

The following six materials are at least partially effective in repelling deer:

a. Feather meal
b. Tankage or meat meal
c. Putrescent whole egg solids (Deer-Away)
d. Ammonium hydroxide (Hinder)
e. Capsicum (Miller's Hot Sauce)
f. Thiram (Selco, Pratt's, Science)

Feather meal, meat meal and putrescent whole egg solids are the most effective repellents in fruit areas

but each has certain limitations that must be accounted for if they are to be effective. Use feather meal or tankage *only* during the warm months of the year. They provide protection for at least thirty days, but usually no more than 60 to 90 days. Place two to three teaspoonfuls of these materials in small cloth bags and hang one bag in each tree in the orchard. Inspect the orchard every 30 days for damage and if damage resumes, reapply fresh materials.

An application of putrescent whole egg solids provides close to 100% protection for a minimum of at least 3 weeks under the worst possible conditions. Under less severe conditions, protection may last 2 to 3 months. Where winter browsing occurs, apply in late fall. Where spring and summer browsing occurs, apply in early spring before buds begin to swell. Do not apply to fruit trees between bud swell and leaf hardening. A second application may be necessary in mid-summer. Treat all tree surfaces within the reach of deer to the point of runoff.

Ammonium hydroxide as formulated in Hinder effectively repels deer but only for short periods in dry weather. The effectiveness of Hinder can be extended by putting the liquid in dispensing devices in each tree. The dispensing device either slowly releases the concentrate or releases a new amount with each rain. Some examples are sponges covered with metal or plastic lids and plastic narrow necked bottles with open tops and holes in sides near the top.

Fruit growers have reported that small bars of hand soap hung in trees will repel deer. Whether this technique will continue to be effective, especially in cold weather, remains to be seen.

Population Reduction

The more numerous and hungry the deer are, the less effective the above methods will be. Therefore it is extremely important that orchardists work closely with local DNR wildlife biologists in helping them create the kind of hunting season that will maintain the deer population at a level that keeps damages within acceptable limits but still provides ample hunting opportunity. Even so, it will be necessary from time to time in special situations to shoot deer out of season when they are causing damage. Special permits may be obtained from the local conservation officer to do so. When applied judiciously, this kind of shooting can be an excellent method of damage control but is definitely not a substitute for legal hunting to maintain or reduce deer herds to the proper levels. Orchardists who attempt to reduce deer numbers by out of season shooting as a substitute for appropriate legal hunting and other damage control usually find that it is an inefficient, if not ineffective, substitute. When combined with other damage control methods and the appropriate legal hunting, out of season shooting can be an excellent and effective supplement.

Bird Damage Control

Starlings, robins and blackbirds cause the greatest amount of damage to fruit in Michigan. Cedar waxwings can occasionally cause minor losses to cherries.

Repellent Devices and Chemicals

Propane exploding cannons, broadcast recordings of alarm and distress cries and electronic broadcasting devices (Av-Alarm), and two-stage exploding 12 gauge shotgun cartridges can be used effectively to repell birds from fruit. To be effective, however, all these devices must be varied frequently in both location and rate of operation. Maximum effectiveness will be achieved by using two or more of these devices in combination. Birds will become accustom to and ignore a routine, unvaried application of any or all of these devices.

Methiocarb (Mesurol) is an excellent taste repellent and can be applied to cherries, grapes and blueberries in Michigan. Apply at the rate of 200-400 gal/acre of 1.33 lbs. in 100 gal. water as soon as the first blush of color appears on the fruit. If short term protection (2 weeks or less) is desired, one heavy application (400 gal/acre) may provide more efficient control than 2 light treatments. Application may be made within 7 days of harvest. Mesurol is extremely distasteful and should be used with caution in pick-your-own operations.

Population Reduction

Large decoy traps baited with a variety of moist foods such as apples, cherries, blueberries, lettuce and potatoes can be used to catch large numbers of birds efficiently. Starlings, which are unprotected, can be quickly and easily destroyed. Decoy traps appear to be most effective if operated in the spring when birds first appear in the orchard. If operation is begun during the ripening process the trap may not trap birds as efficiently as it attracts them and may result in increased damage, especially where birds are extremely numerous. When protected species are trapped they can be released unharmed. If the protected species causing damage are released north of the orchard in early spring and south of the orchard in mid-summer, they usually do not return to cause damage. Where possible traps should be made portable so that they can be moved to the places where they are most needed and will be most effective.

Further information, specific plans or recommendations may be obtained from the following sources.

MSU Cooperative Extension Service Offices

MSU Extension Wildlife Specialist
Dept. Fisheries & Wildlife
East Lansing, MI 48824 (517) 355-7493

U.S. Fish & Wildlife Service
Manly Miles Building
East Lansing, MI 48823
(517) 337-6652

The U.S. Fish and Wildlife Service will, in addition, provide technical assistance.

WEED CONTROL IN FRUIT CROPS

By J. Hull and E. Hanson
Department of Horticulture

Weeds compete directly with trees and vines for soil moisture and nutrients and often serve as hosts for insects, nematodes, and diseases. Weeds may also provide cover for rodents which attack tree trunks during the winter months. Certain noxious weeds, such as poison ivy or Canada thistle may make harvesting of fruit an unpleasant task.

To produce a healthy tree with a strong trunk and scaffold branches, it is necessary to provide optimum growing conditions the first few seasons. Perennial weeds, such as quackgrass, nutsedge, or Canada thistle can seriously reduce the growth of newly planted trees and should be controlled with repeated tillage or herbicides prior to planting a new orchard. Annual weeds may also inhibit the growth of young trees, particularly stone fruits, and should be controlled when trees are actively growing. Control of weeds in an area 2 to 3 feet from the trunk is adequate in the first 2 years. As the tree becomes bigger and the roots spread over large areas, weeds should be controlled on an area about equal to the drip-line of the trees.

Herbicides for Orchards and Vineyards

Several herbicides are utilized effectively by commercial fruit growers and they provide economic advantages over other cultural weed control methods. Fruit trees are not completely immune to herbicide injury, but will often tolerate dosages much higher than that required to kill weeds. Generally, trees gain herbicide tolerance with age. Newly planted trees may be susceptible to herbicide injury, gain some tolerance when 2 or 3 years old, and become very tolerant when older. Trees growing on sandy soils which are low in organic matter are more susceptible to soil-applied herbicides than trees growing on heavier, loam soils. Because a margin of tolerance is involved, herbicides must be applied as accurately as possible.

AMS (Ammate-x). Ammate is a herbicide which is effective on woody perennials such as poison ivy. It kills both by contact and translocation. It may be utilized safely in apple orchards if care is taken not to allow the chemical to contact the foliage or newly formed bark. Ammate should be used when poison ivy or other perennials are leafed-out in late spring. The foliage should be thoroughly soaked using 60 pounds of chemical per 100 gallons of water. The residual life of this chemical in the soil is very short during the summer months. Ammate is extremely poisonous, may be corrosive to sprayers and should be handled carefully. It is usually used as a spot spray with a small hand sprayer.

2,4-D (Weedone 638, Dacamine 4D). These nonvolatile forms of 2,4-D may be utilized safely on the orchard floor if care is taken to avoid drift onto the foliage of trees. The primary use is to control perennial broadleaved weeds such as dandelions, field bindweed and common milkweed. 2,4-D is absorbed through the foliage of these weeds and translocated to the root system. Apply the chemical at low pressure using 1 pound of active chemical per acre on perennials which are growing actively. At this rate of application, the chemical disappears from the soil in 2 to 3 weeks. Several spot applications are often needed to completely eradicate these deep-rooted perennials. 2,4-D is only registered for use under apple and pear trees. Never use in sprayers that will later be used for foliar applications on fruit and vegetable crops.

Dalapon (Dowpon). Dalapon is utilized primarily for quackgrass control under apple and pear trees which are well established. Apply at 10 pounds per acre when quackgrass is 4 to 6 inches high in the spring. Dalapon is absorbed both by the foliage and root system. It is usually combined with simazine (Princep) or diuron (Karmex) to obtain season-long control of the entire weed spectrum. Do not use Dalapon under stone fruits or garpes in Michigan because of toxicity that has occurred particularly on sandy soils.

Dichlobenil (Casoron). This chemical is effective for controlling quackgrass in established tree fruits and bush fruits. It has broad clearance on all tree fruit, brambles, grapes, and blueberries. The granular formulation is superior to the wettable powder for controlling quackgrass. Proper timing of application is critical for obtaining optimum results. The most consistent results have been obtained by applying the chemical in November prior to snowfall. Six pounds of chemical (150 lb. of 4% granules) per acre will normally provide good control of quackgrass and annual weeds until late summer of the following year. Some other perennial weeds such as field bindweed and Canada thistle are also suppressed by this chemical. Casoron has been the most effective chemical that is currently registered for quackgrass control in blueberries and brambles. It has also been used effectively

on established nursery trees but may cause injury on extremely sandy soils low in organic matter.

Tractor mounted granular spreaders are available which will apply Casoron accurately in bands along the rows. Application with hand spreaders has been less satisfactory. Do not apply granules when it is windy.

Diuron (Karmex). Diuron is particularly effective on annual grasses and broadleaved weeds. At higher rates of application, it may also suppress quackgrass. Diuron has been used in Michigan for several years to control annual weeds in apples, blueberries, brambles, grapes, and pear plantings. When applied at 2 to 3 lb./acre prior to the emergence of weeds, it will provide acceptable weed control for the growing season. There is no buildup of chemical in the soil from annual applications of this rate. Diuron is utilized successfully with paraquat to obtain season-long control of most weeds.

Fluazifop-butyl (Fusilade) is a systemic herbicide only effective on grasses. It is formulated as a 4 lb. per gallon liquid and is labeled only for nonbearing trees. Add one quart of crop oil for every pint of fusilade. Apply to actively growing grasses before they exceed growth stage specified on product label (annual grasses less than 8 inches tall and actively growing perennial grasses with 4 to 6 inches new growth).

Glyphosate (Roundup). Glyphosate has excellent activity on both annual and perennial weeds. It is translocated in perennial plants and kills the underground parts. This characteristic makes it an excellent herbicide for control of quackgrass, Canada thistle, field bindweed, common milkweed, and many other perennial weeds. Since glyphosate is absorbed by the foliage, wait until perennial weeds have a large amount of foliage for best results. For example, quackgrass should be at least 8 inches tall and field bindweed should be in the bud or flower stage. Glyphosate becomes rapidly inactivated by soil and will not prevent annual weeds from emerging. This herbicide can seriously damage fruit trees if contact occurs on green tissues (leaves or shoots), but contact on occasional suckers has not caused problems. The sprays should be carefully directed toward the base of the tree.

Hexazinone (Velpar). This chemical is labeled only for blueberry to control many herbaceous and woody plants. The primary advantage of using Velpar is for woody perennials, as it controls or suppresses briars, brambles and wild cherry. Apply 1 to 2 pounds in the spring before blueberry plants begin active bud development. Do not apply on soils that are 85 percent or more sand. Do not apply to blueberry plants less than 5 years old and do not repeat applications in successive years.

Napropamide (Devrinol). Napropamide can be applied at 4 lb/A in newly planted or established orchards, blueberry, grape and bramble plantings. Apply to weed-free ground. This chemical is readily inactivated by light and is most effective if incorporated into soil by tillage, irrigation or rainfall following application. Does not control established weeds. Most effective for control of annual grasses but has exhibited poor performance in established Michigan orchards for the usual spectrum of weeds present.

Norflurazon (Solicam). This chemical is labeled for apple, pear, peach and plum and can be applied to newly planted apple and peach trees after the soil has settled. Apply before weeds emerge or combine with paraquat or glyphosate for control of existing vegetation. Apply 2.5 to 5 pounds per acre, using the lower rate on coarse soils (sandy loam). Rainfall is necessary to move Solicam into the weed root zone for the chemical to be effective. Solicam is more effective on grasses than broadleaf weeds and does not control established weeds. Apply in fall or early spring.

Oryzalin (Surflan) can be safely used on newly planted fruit trees and vines after the soil has settled and no cracks are present. Areas to be treated should be free of established weeds. Surflan is also registered for bearing trees and vines. It is a preemergence herbicide, effective in controlling annual grasses and many annual broadleafed weeds. It has little effect on established weeds and grasses but may be combined with Paraquat or Roundup to kill established weeds and prevent regrowth. It may also be combined with Princep, Karmex, or Goal for broad spectrum, season-long control. Observe restrictions for these herbicides when applying in combination with Surflan. One-half inch of rain or sprinkler irrigation, to move Surflan into the weed seed germination zone, is required to activate the herbicide.

Oxyfluorfen (Goal) can be applied to dormant, nonbearing or bearing peach and plum plantings and to established grapes at least 3-years old that are trellised. It can be applied for preemergence and postemergence control of susceptible weed species at 0.5 to 2.0 lb./A as a direct spray to the base of the trees. It can be applied in combination with paraquat, glyphosate and oryzalin.

Paraquat (Paraquat CL). Paraquat provides very rapid knockdown of annual and perennial weeds. It may be utilized under all fruit trees and in vineyards. Paraquat has no action through the soil to prevent further weed growth and usually new weeds will be evident 30 to 40 days after application. Since this herbicide has no activity in the soil, it may be used on first year plantings. Bands 4 to 6 feet wide may be sprayed over sod prior to planting trees or the spray

may be directed under the tree after planting. Care must be taken not to allow this chemical to touch the foliage or areas of the trunk where bark has not formed. If weed growth is severe, apply at a rate of 1 pound of active ingredient per acre. On lighter infestations, ½ lb./acre is adequate. The addition of a wetting agent at 1 qt./100 gal. of spray usually increases the effectiveness of the material. To eliminate weed competition for the entire growing season, two to three applications are necessary. Paraquat is extremely toxic and should never be allowed to touch skin or eyes. Avoid inhaling mist of this chemical.

When trees have been established one growing season, paraquat may be combined with simazine or diuron in the spring to provide seasonlong weed control.

Pendimethalin (Prowl) is labeled for use on nonbearing fruit trees and grapes for preemergence weed control. Adequate rainfall (at least ½ inch) within 7 days after application is important for adequate weed control. Controls seeds as they germinate but not established weeds. Formulated as a 4 lb. per gallon liquid. Can be utilized in same manner as oryzalin but has been less effective in MSU trials.

Pronamide (Kerb). Like dichlobenil, pronamide acts through the soil to kill quackgrass rhizomes and germinating annual weeds. It is most effective on grasses and will miss several weeds in the compositae family. Our research has shown pronamide to be useful on sandy loam soils at rates of 1 to 2 lb./A of active ingredient. It is not effective on soils with a high organic matter content.

Simazine (Princep). Simazine is a very effective herbicide that has been utilized by Michigan fruit growers for many years. It is primarily effective on germinating, annual weeds but does provide some quackgrass suppression when applied in the fall as a granule or when applied in the spring in combination with paraquat. The use rate (2 to 4 lb./acre) varies with soil type. Injury may occur on stone fruit on extremely sandy soils when the rate of application exceeds 2 lb./acre. Simazine does not build up in the soil from annual applications of the above rates.

Terbacil (Sinbar). This chemical is currently registered for use only on peaches and apples which have been established at least three years, blueberries established at least one year, and strawberries. It controls most annual weeds and also will suppress the growth of some other perennial weeds.

In tree fruits, spring applications (April 15-May 1) of Sinbar at one pound of active ingredient per acre have been sufficient to control annual weeds. Two or three pounds per acre are needed to control quackgrass, the lower rate being adequate on lighter soils. Sinbar may move quite readily in very sandy soils and tree injury manifested as veinal chlorosis of leaves has been observed from applying too much chemical on these soils. Do not apply Sinbar on sandy or gravelly knobs or bulldozed areas where there is essentially no organic matter in the soil.

Herbicides for Strawberries

The herbicides now registered for strawberries are quite specific in the weed spectrum that they control. Rarely will one chemical handle all of the weed problems in a single planting. Research has revealed the following information about each chemical.

Chloroxuron (Norex, Tenoran). This herbicide is most effective when applied to broadleaved weeds in the seedling stage. It will knock down common weed species such as common chickweed, lambsquarter, pigweed, purslane, and wild mustard and prevent germination of these weeds for 40 to 60 days. Use 4 pounds of active ingredient per acre applied 7 to 10 days after transplanting or in fall or spring on established fields for good results on the above weeds. Chloroxuron has not provided adequate control of grasses in our tests. However, a combination of 4 lb./acre with diphenamid (Enide) at 4 lb./acre or DCPA (Dacthal) at 6 lb./acre has allowed control of both broadleaves and grasses when applied pre-emergence. Chloroxuron may not be used within 60 days of harvesting the crop.

DCPA (Dacthal). Dacthal provides good control of annual grasses such as crabgrass and foxtail when used at 8 lb./acre on sandy soils. It has been much less effective on heavier soils and has not consistently controlled broadleaved weeds. Dacthal should be used for grass control in new and established plantings before emergence of the weeds. It is more effectively used in combination with Chloroxuron to obtain control of broadleaved weeds also.

Diphenamid (Enide). Diphenamid is also more effective on annual grasses than on broadleaved weeds, but will provide acceptable control of several common broadleaves if irrigation is utilized soon after application. Diphenamid has inhibited rooting of runner plants on light sandy soils. Consequently, we do not recommend its use on new plantings located on these soils. It may be used safely on established plantings at 4 lb./acre on light soils and 6 lb./acre on heavier soils. One application will control weeds for 6 to 10 weeks. It controls germinating grain in mulched plantings. Do not apply within 60 days of harvest. Combinations of diphenamid with chloroxuron also look very promising.

2,4-D Amine (Formula 40). 2,4-D (alkanol amine form only) has been effectively used in the renovation program for established strawberry plantings. When utilized immediately after harvesting, at 1 lb./acre, it provides good control of annual broadleaved weeds. It also provides control of some fleshy-rooted perennials not controlled with other chemical treatments. Do not

apply 2,4-D at other times during the growth of the strawberry plant or injury and yield reduction may occur.

Fluazifop-butyl (Fusilade). This chemical is for control of grasses only and is applied over the top of the plants when grasses are actively growing but less than 6 inches of new growth. The rate applied varies with stage of grass growth but should include 1 quart of crop oil concentrate per acre.

Napropamide (Devrinol). Napropamide is extremely effective on annual grasses and some broadleaved weeds when applied preemergence in strawberries at 1 to 2 lb./A. It is sensitive to soil moisture and should be either incorporated into the soil about 2 inches deep prior to establishing new plantings, or irrigated in on established plantings. It may be applied in spring or fall or at other times of the year after cultivation. It is an amide herbicide like diphenamid and there is a potential for inhibition of runner rooting on extremely light sandy soils, although we have not encountered crop injury with this material when used at recommended rates.

Sethoxydim (Poast) is applied post emergence for grass control when grasses are actively growing. Rate applied varies with grass species and stage of growth. Applications should include 1 quart of nonphytotoxic crop oil concentrate per acre.

Terbacil (Sinbar). Terbacil has been recently labeled for pre- and post-emergence weed control in established strawberries. Although it controls some problem weeds that are not killed by the above herbicides, the safety margin on strawberries is extremely narrow. Do not apply terbacil on newly planted berries, and avoid application during periods of the year when the plants are making active growth. The safest times to apply terbacil are after mowing the plants at renovation time or late fall after growth stops. Research in Michigan indicates that rates should not exceed ⅜ lb./acre active ingredient on sandy loams and ⅝ lb./acre on loam soils.

Weed Sprayers

Many types of sprayers are suitable for chemical weed control. You do not need to buy expensive, high-gallonage, high-pressure spray equipment. A complete weed-control sprayer should have the following features:

1. A low pressure pump. It should be easily replaced, not subject to damage by wettable powders, and have minimum capacity of 9 gallons per minute.

2. Solution agitation (stirring). It can be either mechanical or a bypass from the pump. If a power takeoff sprayer does not provide agitation, add a bypass to a galvanized tee between the pump and pressure gauge. To increase agitation in the tank, place an agitator nozzle on the end of the overflow hose. In this case, a separate valve on the bypass line will regulate pressure. If the pump does not have enough capacity for agitation under specific spraying conditions, provide it by using both the next lower tractor gear and nozzle tips with a smaller orifice.

3. 50-mesh screens for suction line and nozzles. Wettable powders will not go through the 100-mesh screens which are sometimes provided.

4. A spray boom. It should have nozzles adjustable for distance between nozzles on the boom and for height above the ground. This is especially important for band spraying.

5. A gauge to measure pressure accurately up to 100 lb./square inch.

6. Flat fan nozzles. The best nozzle size for general use is equivalent to an 8004 Teejet. For most work, a wide-angle nozzle—73 to 80 degrees—is best because the boom can be held close to the ground to reduce drift. This is most important when it is windy.

7. For tree fruit and nurseries, 110-degree angle nozzles. A rigid boom with three 110-degree angle nozzles located 2 feet apart and 14 inches above the ground will spray a strip 6 feet wide. The sprayed area can be reduced to 4 feet by plugging the inside nozzle or extended to 8 or more feet by making the boom proportionately longer and adding more nozzles. Although these booms are useful on level terrain, they cannot be used on steep slopes unless a wheel or other device is placed at the end of the boom to keep it parallel with the ground.

For vineyards and nurseries, a TOC nozzle placed on a gun or on the end of a boom may be used, if it can be held at a rigid 45-degree angle.

Sprayer Calibration

One of the most important factors in effective weed spraying is accurate calibration—determining the amount of spray material applied per acre. A range of 20 to 60 gallons per acre, at a pressure of 20 to 60 pounds per square inch, is satisfactory.

Adjust the boom height so that the spray overlaps about a third at ground level. For overall spraying, using 80-degree nozzles, this places the nozzles about 18 to 20 inches apart on the boom and 18 to 20 inches from the sprayed surface.

A good way to calibrate a sprayer is to:

1. Fill the spray tank with water only.

2. Spray a measured area, in a field if possible, at a fixed tractor speed and pressure gauge setting. Be sure to allow for partial coverage if bands are used.

3. Measure the amount of water needed to refill the tank.

4. Divide this amount by the fraction of an acre sprayed to get the gallons applied per acre.

5. Mix the amount of chemical desired per acre with water to give this much spray material.

For example, if 10 gallons were applied on one-fourth acre, the volume of spray material applied would be 40 gallons per acre. If you change the tractor speed or gear, pressure setting, nozzle size, or number of nozzles, the amount of liquid applied per acre will be different and recalibration will be necessary.

Band Application

Drive down the row in one direction; never go in a circle around the trees, since this concentrates the spray at the base of the tree.

Apply the spray as a complete row treatment or as squares under the orchard trees. It is usually best to spray a strip on one side of a row going in one direction and on the other side coming back. In vineyards, the entire band (under a row) may be sprayed with a 45-degree angle TOC nozzle on a gun or boom. The width of the band will be determined by the age of the plants and desires of the grower. Most orchard trees should have weeds controlled under the full spread of the branches. For young trees, vineyards and nurseries, a 3- to 4-foot band in the row may be sufficient.

1985 Suggestions for Chemical Weed Control in Fruit Crops.

NOTE: — *Rates Given Are for Pounds of Active Ingredients per Acre Actually Covered with Spray Material unless otherwise specified. These amounts should not be interpreted as the amounts required to treat an acre of orchard. Always read the label on the container.*

TREE FRUITS

Crop	Weed Problem	Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
APPLES, PEARS, (First year plantings)	Emerged annuals	paraquat (Paraquat CL)	½ to 1	Before or after planting trees and again during season as needed.	Spray in band about 4 feet wide to emerged weeds. Two to 3 applications are needed for season-long control. Do not allow spray to touch foliage of trees. Do not spray high on the trunks of newly planted trees.
	Annuals	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting.	Delay application until ground has settled following planting. Use lower rate on lighter soil.
		or Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
		pronamide (Kerb)	1 to 2	November	Apply after harvest and before soil freezes.
		or norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	Use only on apples; use lower rate on sandy soils.
	Grasses	fluazifop-butyl (Fusilade)	½ to 1	To actively growing grass.	Apply to grasses 4 to 8 inches tall.
APPLES, PEARS (Established one year or more)	**ALL OF THE ABOVE CHEMICALS MAY BE USED AS SPECIFIED.**				
	Germinating annuals	simazine (Princep)	2 to 4	Fall or spring before weeds emerge.	Simazine rate may be decreased if weed control was complete in the previous year.
		or diuron (Karmex)	2 to 3	In spring before weeds emerge.	
		or terbacil (Sinbar)	½ to 1	Late April or early May.	Use only on apples. Use lowest rate on sandy soils. Do not apply on sand pockets or knobs.
		or norflurazon (Solicam)	3 to 6	Fall or spring before weeds emerge.	Use lower rates on sandy soils.

(continued on page 43)

Crop	Weed Problem		Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
		or	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground.	Use lower rate on lighter soil. Apply early spring.
		or	Napropamide (Devrinol)	4	Apply to weed-free ground.	Incorporation protects from rapid photo inactivation.
	Quackgrass and emerged weeds		simazine (Princep) plus (Paraquat CL)	4 plus ½ to 1	Same as above.	Simazine rate may be decreased if weed control was complete in the previous year.
			dichlobenil (Casoron)	6	November.	Use granular formulation.
			pronamide (Kerb)	1 to 2	November	Apply after harvest and before soil freezes.
	Dandelions		2,4-D (Dacamine 4D)	1	After fruit harvest in fall and prior to bloom in spring.	Use these low volatile forms of 2,4-D only. Spray at low pressure when there is no danger of drift onto trees.
	Quackgrass		glyphosate (Roundup)	1½ to 2	Quackgrass should be 8-10 inches tall.	This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees.
		or	dalapon (Dowpon Basfapon)	10	When quackgrass has 4 to 6 inches of new growth.	Will suppress quackgrass for 1 to 2 months. May be used with simazine to control annual weeds.
		or	pronamide (Kerb)	1 to 2	November	Apply before soil freezes.
	Field-bindweed and other problem perennials		2,4-D (Dacamine 4D)	1	When weeds are growing rapidly.	Use these low volatile forms of 2,4-D only. Spray at low pressure when there is no danger of drift onto trees. Where growth is dense, use 80 to 100 gallons of water per acre.
		or	glyphosate (Roundup)	2 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees.
	Poison ivy and other woody perennials		AMS (Ammate-X)	60 lb./100 gal.	When poison ivy is growing rapidly.	Apply as a spot spray in infested areas, wetting the poison ivy foliage thoroughly. Do not allow spray drift to contact tree foliage and avoid wetting tree trunks.
CHERRIES (TART AND SWEET), PEACHES, PLUMS (First year plantings and established orchards)	Annuals		paraquat (Paraquat CL)	½ to 1	Before or after planting trees and again during season as needed.	Spray in band about 4 feet wide to weed foliage. Two to 3 applications are needed for season-long control. Do not allow spray to touch foliage of trees. Do not spray high on the trunks of newly planted trees.
		or	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting.	Delay application until ground has settled following planting. Use lower rate on lighter soil.
		or	Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
		or	norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	Use only on peach.

Crop	Weed Problem	Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
CHERRIES (TART AND SWEET), PEACHES, PLUMS (Established one year or more)	Annuals and quackgrass	simazine (Princep) plus paraquat (Paraquat CL)	2 to 4 plus ½ to 1	When weeds are 2 to 4 inches high.	Do not spray on sand pockets or knobs, use lowest rate of simazine on plums. Simazine rate may be decreased if weed control was complete in the previous year.
		simazine (Princep)	4	October or November.	Use granular formulation. More effective if followed by paraquat at ½ lb./acre in the spring.
		dichlobenil (Casoron)	6	November.	Use granular formulation.
		or norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	Use only on peach.
PEACHES (Established 3 years or more)	Annuals and quackgrass	terbacil (Sinbar)	½ to 2	Late April or early May.	Use lowest rate on sandy soils. On sand pockets or knobs, do not apply any chemical.
CHERRIES (non-bearing)	Emerged annuals and perennials	glyphosate (Roundup)	1 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees. Do not apply to cherry trees that will bear fruit within a year after application.
PEACHES, PLUMS	Annual broadleaf	oxyfluorfen (Goal)	½ to 2	Dormant	Do not apply after bud swell.
		SMALL FRUITS			
BLUEBERRIES, BRAMBLES (Established at least one year)	Annuals	diuron (Karmex)	2 to 4	In spring before weed growth starts.	Apply at least 60 days before harvest. Not effective on organic soils. Use low rate on young plantings.
		or simazine (Princep)	2 to 4	Late fall or in spring before growth starts.	Use low rate on young plantings.
		or Napropamide (Devrinol)	1 to 2	Apply before weeds emerge in spring.	
	Quackgrass and annuals	dichlobenil (Casoron)	4 to 6	November.	Granular formulation is most effective on quackgrass. Do not exceed 4 lb./acre on brambles.
		or pronamide (Kerb)	1 to 2	November.	Apply to dormant quackgrass or before emergence of annual weeds. Do not use on muck soils.
		or terbacil (Sinbar)	1.6 to 3.2	In spring before weed growth starts.	For use only in blueberry plantings that have been established at least a year. Apply the lower rate on sands and sandy loams and the higher rates on clay loams.
		or simazine (Princep)	4	October or November.	Granular formulation is most effective on quackgrass.
	Emerged weeds	paraquat (Paraquat CL)	½ to 1	Spring.	Apply as a directed spray to emerged weeds. On brambles, apply before growth starts in the spring. Avoid contact on new canes or shoots of brambles or blueberries or injury will occur.
BLUEBERRY	Woody perennials	hexazinone (Velpar)	1 to 2	Early spring before bud break.	Do not apply on light sandy soils or in sucessive years.
GRAPES	Annuals	Oryzalin (Surflan)	2 to 4	After planting.	Wait until soil has settled after planting. Apply to weed-free soil and avoid spray contact with leaves and trunks. Use the lower rate on sandy soils.

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Crop	Weed Problem	Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
		or diuron (Karmex)	2 to 5	In spring before weed growth starts.	Use lower rates on sandy soils. **Do not apply in vineyards less than 3 years old.**
		or simazine (Princep)	2 to 4	In spring before weed growth starts.	Same as above.
		or Napropamide (Devrinol)	4	Apply to weed-free ground.	Apply in early spring.
	Annuals and perennials	paraquat (Paraquat CL) plus simazine (Princep)	½ 4	Apply when weeds are 4 to 6 inches high.	For maximum knockdown, add a surfactant at 2 qt./100 gal. of spray. Do not allow spray to touch grape leaves.
		dichlobenil (Casoron)	6	November.	Granular formulation is most effective on quackgrass.
		glyphosate (Roundup)	1 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots. Unless all spray can be kept off green tissues, applications should not be made after the bloom stage.
	broadleaves	oxyfluorfen (Goal)	½-2	Dormant	Vines must be 3 years old and trellised.
STRAWBERRIES (New and established plantings)	Germinating grasses	diphenamid (Enide)	4 to 6	About 5 days after planting and before weeds emerge. In spring or fall on established fields.	Do not use on new plantings on sandy soils. Do not apply within 60 days of harvest. Controls seedling grains if applied prior to mulching.
		DCPA (Dacthal)	6 to 8	About 5 days after planting and before weeds emerge. In spring on established fields.	Particularly effective on sandy soils. Do not apply after first bloom.
	Germinating and emerged broadleaves	chloroxuron (Tenoran, Norex)	4	After transplanting and before weeds are 2 inches high. In fall or spring on established fields.	Do not apply within 60 days of harvest. Do not apply more than twice in a season.
		Select strawberry herbicides according to your weed problem. If both grasses and broadleaves are a problem, use a combination of chloroxuron + diphenamid or chloroxuron + DCPA.			
	Annuals	Napropamide (Devrinol)	1 to 2	Apply before weeds emerge in spring, fall or following cultivation.	May inhibit runner rooting on extremely light sandy soils. Must be irrigated in or incorporated into the soil at 2" deep prior to planting.
(Established plantings)	Emerged broadleaved weeds	2,4-D (Formula 40)	1	Apply after harvest at renovation time.	Do not apply after August 1 or misshapen fruit may be produced the next season.
		terbacil (Sinbar)	¼ to ⅝	Apply at renovation (after mowing) or in late fall.	Use the lowest rate on sandy soils. Do not use on new plantings. Do not use on the 'Guardian' and 'Earliglow' varieties. Check the label for crops that can be planted after strawberries.
	Emerged grasses	fluazifop-butyl (Fusilade)	.125 to 1	When grass is 4-6 in.	Use lower rate on annuals and higher rate on quackgrass. May need to repeat 2 weeks later on quackgrass. add 1 qt. crop oil. Do not apply when flowering or fruiting.

Tree-Row Volume

Angus J. Howitt

With the introduction of dwarf and semi-dwarf trees it is no longer feasible to spray all trees at the same gallonage and dosage. There is then a need for a method of determining rates per acre for different sized trees. As early as 1972 researchers Lyons and Byers of the Winchester Fruit Research Laboratory recognized the necessity of determining rates per acre for different sized trees. An average sized mature tree was considered to be 19.5 feet tall, 23.5 feet across and spaced 35 x 35 feet. Trees of this size were sprayed with 400 gpa. The amount of pesticide required to treat an acre of large trees is considerably greater than the amount required on an acre of trees planted at a higher density. Proper application required that adjustments be made to compensate for these differences. Concentrate spraying must be considered in terms of reducing the gallons of water per acre for the row — spacing and tree — size combination being sprayed. As the gallonage of water is reduced errors become more critical. Sprays applied 3x or higher concentrate levels result in a 20-25% increase in deposit, thus allowing a similar reduction in rate of pesticide application without a reduction in pesticide deposit. From a practical viewpoint the acceptable concentrate level depends on several factors including the pest being controlled, density of foliage, weather conditions, and material being applied. Dilute sprays are preferred for applying growth regulators and control of pests such as scale and wooly aphid. In most other cases concentrate sprays usually provide satisfactory results.

The key figure for midwestern and eastern orchards is that we apply one gallon of spray solution per 1450 cubic feet of orchard foliage. Hence for each orchard we must know the number of cubic feet. Cubic feet in an orchard is obtained by multiplying the tree ht x the tree width x lineal feet in an orchard.

EXAMPLE: Rows are 35 ft apart, with a tree width of 23.3 and a tree ht of 20. The lineal feet in this orchard is $43560 \div 35 = 1245$ lineal ft. The cubic feet $= 1245 \times 23.2 \times 20 = 580{,}180$ $580{,}180 \div 400 =$ 1450 cubic feet. As was stated previously it takes 1 gallon of spray material for every 1450 cubic feet. To simplify tree-row-volume, a graph is presented on Page 47 in which all factors in the formula are included. To use the graph a grower begins by drawing a line from 0 to the number on the chart that corresponds to the specific row width in his orchard. This gives the base line for all orchards of that row spacing. Once this is done, the height and width of the trees for each planting are multiplied together to get a number for use on the vertical axis of the graph. Follow this line horizontally across the graph from the calculated height x width figure to the intersection with the row spacing base line. Directly below this point on the horizontal axis is the required gallons per acre figure for dilute spraying. Two examples are shown on the graph. Example 1 illustrates 25 foot row spacing with trees that are 16 feet high and 16 feet wide. Draw a base line from 0 to 25, multiply 16 x 16 to get 256. Follow a horizontal line from 256 to the base line. Vertically below this a base gallonage of 313 gpa dilute can be found. Example 2 shows a need of 220 gpa dilute for 20 foot rows and trees that are 12 feet high and 12 feet wide.

Most growers are not using dilute sprays, therefore, the lower row of numbers on the horizontal axis has been added to allow those using concentrate sprayers to compute the needed rate per acre. The base figure to use in this case is the rate of material per concentrate given on a product label. As with dilute spraying, the basis is that smaller, easier to spray trees need less material per acre than standard sized trees. This second row of numbers is used to compute the percentage of the full rate per acre needed. Example 1 in this case becomes 78% and Example 2 55%. A product calling for 1 lb per acre would need 0.78 lb per acre in Example 1 and 0.55 lb per acre in Example 2. This can be expressed by the formula:

$$\frac{43560}{\text{Row width}} \times \frac{\text{Tree width}}{580000} \times 400 \text{ gal/acre} \times \text{Leaf density} \times \text{Pesticide rate/100 gal dilute (pts, lbs, oz)} = \text{lbs, pts, or oz per acre}$$

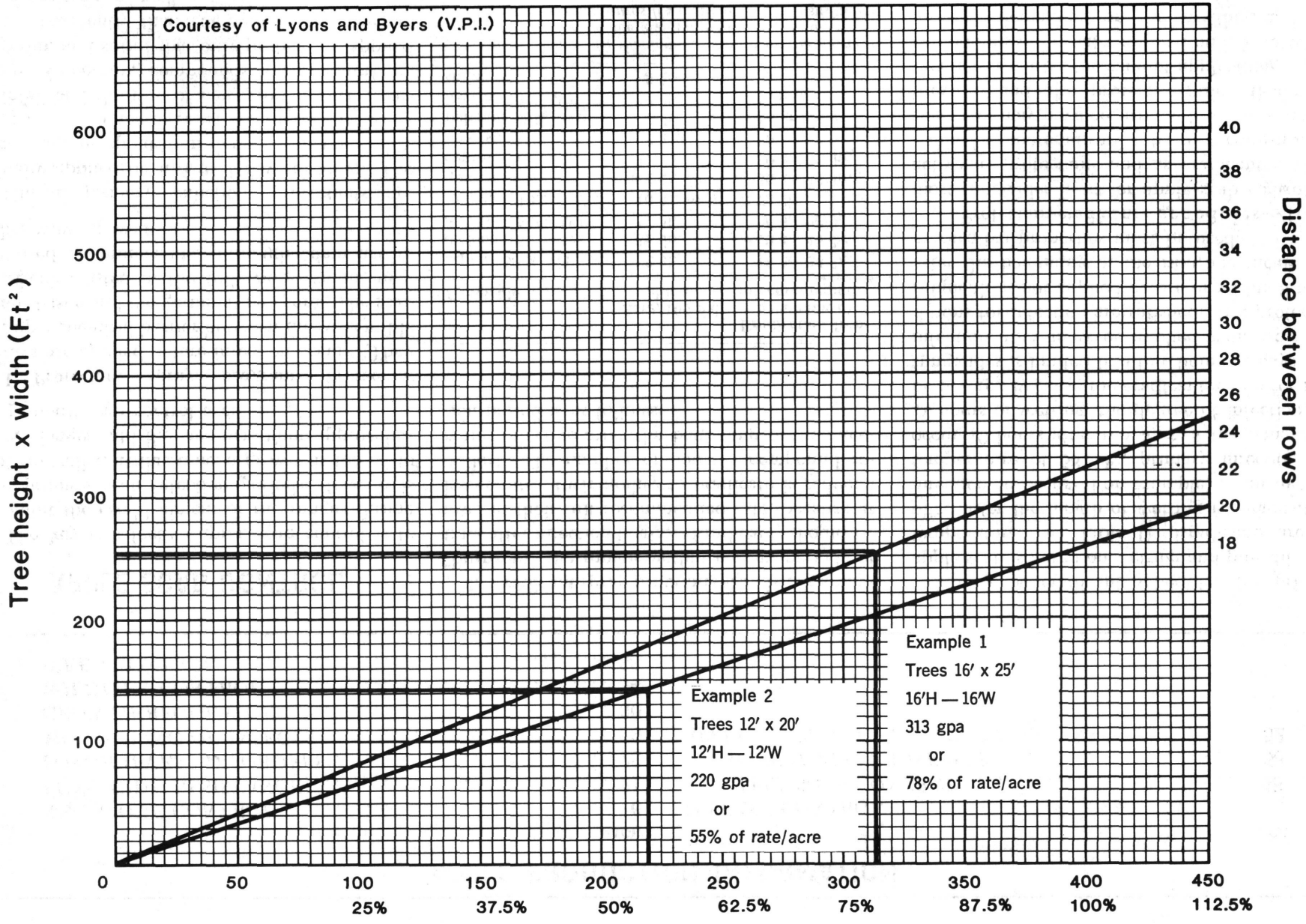
Leaf density depends on foliage. 0.7 represents early season before the foliage is fully expanded. 1.0 represents a typical well pruned Red Delicious in mid-season. 1.2 would represent a Red Delicious with heavy foliage in mid-season. As with any other production procedure, grower judgement must be used with this method. Where tree size is quite variable, calibration should be done for the average of the largest trees. Since two-thirds of the spray is directed to the top of the trees, excess material should be blown over the smaller trees. A well-pruned orchard may require only 85% of the base rate early in the season while a full foliaged processing orchard would need the full rate. There can be no substitute for grower experience and judgement in making additional adjustments related to leaf density, pest pressure, or desired results from thinners and growth regulators.

Failure to apply the proper rates per acre can lead to disasterous results when dealing with thinners, growth regulators and other rate sensitive materials. At the very least, overestimating causes excess materials to be applied and under estimating could lead to lack of control.

It is also important to note that tree-row-volume or any other concept for determining rate per acre will not make up for poor application techniques or improper timing. This method should allow growers to more precisely calibrate their equipment for the various blocks they must spray and thereby reduce problems that arise from too little or too much material per acre. But, it will only be effective if the necessary adjustments of equipment are made before spraying blocks of different sized trees.

Until a grower gains experience with this method it is suggested that a grower experiment with one or two blocks before committing his entire orchard to tree row volume.

TREE — ROW VOLUME GRAPH



Tree Fruit

APPLE PRODUCTION INFORMATION

APPLE SCAB CONTROL

The key to effective apple scab control is to prohibit the establishment of the fungus during the primary scab infection periods. If scab is not controlled at this time, a grower is forced to spray longer into the summer. Four approaches to primary scab control are:

1. Protectant spray program — Protectant sprays are applied before infection occurs. They set up a chemical barrier between the susceptible plant tissue and the germinating spore. The scab fungicides listed in the following sections may be used as protectants, although some act in other ways as well.

During primary infection, protectants are usually applied on a 5 to 7 day schedule. The frequency of application depends on the ability of the compounds to resist weathering action of rainfall and the rate of new growth during this time. Generally, compounds such as ferbam, glyodin, and sulfur that only protect are applied more frequently than compounds that can act in other ways as well.

2. Eradicant spray program—Eradicant sprays "burn out" the fungus within certain periods of time after infection begins. Eradicants should be used at their full recommended rate, because at lower rates, their ability to eradicate is reduced or lost. The number of hours a compound remains effective after the beginning of an infection period is as follows:

Fungicide	Rate/100 gal. dilute	Eradication from beginning of infection period.*
captan 50% WP	2 lb.	18 to 24 hr.
dichlone 50% WP	½ lb.	36 to 48 hr.
dichlone 50% WP	¼ lb.	30 to 36 hr.
funginex 18.2% EC	10 fl. oz.	72 hr.
quintar 5 F	6.4 fl. oz.	36 to 48 hr.
cyprex 65%	½ lb.	30 to 36 hr.
lime sulfur	2 gal.	60 to 72 hr.
polyram 80% WP	2 lb.	18 to 24 hr.
ferbam 76% WP	2 lb.	None
sulfur 95% WP	5 lb.	None

**Growers should use beginning of rain as the start of infection. Based on average temperature of 50 to 60° F. At average temperatures lower than 50° F., use higher eradicative time figures.*

Timing of eradicant schedules for primary apple scab is based on wetting and prevailing air temperatures (see table 1). Eradicants are applied after the length of wetting is sufficient for infection to occur. For example, at an average temperature of 58° F., primary infection will occur 10 hours after the start of the rain. After 22 hours of wetting, the degree of infection will be severe. Because the eradicant action for most fungicides is limited to a few hours or days after infection, they must be applied soon after conditions for infection are satisfied. If a protectant fungicide is not applied before or within 9 hours after the beginning of the rain, chemicals with eradicative properties must be used.

3. Protectant-eradicant schedules—Today, most fungicides used for apple scab control are active as protectants and as eradicants. When applied at the eradicant rate, they control infections that may have occurred a few hours or days previous and also protect exposed tissues for several days after the time of application. These compounds are usually applied on a 5- to 10-day interval, depending on the weather and tree growth.

Table 1. Approximate number of hours of wetting required for primary apple scab infection at different air temperatures*

Temperature Average	DEGREE OF INFECTION		
	Light	Moderate	Heavy
°F	hrs.[a]	hrs.	hrs.
78	13	17	26
77	11	14	21
76	9½	12	19
63 to 75	9	12	18
62	9	12	19
61	9	13	20
60	9½	13	20
59	10	13	21
58	10	14	21
57	10	14	22
56	11	15	22
55	11	16	24
54	11½	16	24
53	12	17	25
52	12	18	26
51	13	18	27
50	14	19	29
49	14½	20	30
48	15	20	30
47	17	23	35
46	19	25	38
45	20	27	41
44	22	30	45
43	25	34	51
42	30	40	60
33 to 41[b]	—	—	—

*From W. D. Mills, Cornell University.
[a]The infection period is considered to start at the beginning of the rain.
[b]Data incomplete at these temperatures.

4. Single application technique — A single spray is applied at the green tip stage of bud development and through retention and redistribution protects new growth for several weeks. The only fungicide registered for use in this manner is Difolatan. It is used on apples at 15 lb. or at 25 lb./acre as a single spray applied at the green tip stage of bud development. In this program, start using other suitable fungicides in a regular program at pink when the low rate is used or no later than early petal fall when the high rate is used. Apply Difolatan under good drying conditions to avoid excessive loss of deposit from rain on undried deposits. Thorough spray coverage, especially in the top half of the tree, is essential for uniform redistribution and control.

Difolatan is not effective against powdery mildew. On mildew-susceptible varieties, use the 15 lb./acre rate and initiate a strong powdery mildew control program in early pink. See powdery mildew control on page 58.

Scab Control Fungicides

The usual apple scab control fungicides are listed below. Timing and selection of a particular fungicide depends on the type of program the grower wishes to use in his orchard. Protectant fungicides should be applied more frequently than protectant-eradicant fungicides provided full rates are maintained for fungicides with eradicant properties. Timing of eradicants is based on rainfall and infection periods.

Primary scab usually starts at silver tip and is completed about 4 weeks after petal fall. However, maturation and discharge of ascospores may vary considerably from season to season and important deviations in timing will be announced by the District Horticultural Agents.

If primary scab is well controlled, the rates used during summer are reduced and the sprays are applied on a 10- to 14-day interval, or less frequently than during the primary period. If primary scab is not controlled, fungicide rates and intervals should not be reduced until scab lesions are inactivated.

Additional Comments on Scab Fungicides: Lime sulfur is used at the silver tip to pre-pink stage of bud development. Do not use sulfur compounds, dichlone, Quintar, captan, Dikar, or dinocap (Karathane) with oil, or near oil applications. Do not use dichlone or Quintar beyond full pink.

When primary infection is light, the standard program at high rates and with good timing is usually sufficient to prevent secondary spread. However, where infection is more severe, the following approaches are suggested for suppressing lesion development and sporulation and for protecting emerging tissues.

Use Cyprex 65% WP at 12 oz./100 gal. and apply 2 applications one week apart. The first application should be applied as soon as possible after infection occurred or, if necessary, as soon as possible after lesions appear. In orchards where both dodine and benomyl resistance are suspect, use captan 50% WP at 2 lb./100 gal.

APPLE SCAB FUNGICIDES

Fungicides	PRIMARY SCAB		SECONDARY SCAB		Comments
	Rate/100 gal. dilute	Rate/acre	Rate/100 gal. dilute	Rate/acre	
Lime sulfur	2 gal.	8 gal.			Do not use after pre-pink.
Dichlone 50% WP plus protectant	¼ lb. ½ strength	1 lb. ½ strength			Do not use beyond early pink.
Funginex 18.2% EC	10 fl. oz.	36-40 fl. oz.			For use from ½-inch green tip to petal fall in eradicant spray programs.
Quintar 5F (protectant)	3.2 fl. oz.	12.8 fl. oz.			Do not use beyond early pink.
Quintar 5F (eradicant)	6.4 fl. oz.	25.6 fl. oz.			Do not use beyond early pink.
Captan 50% WP	2 lb.	8 lb.	1 lb.	4 lb.	
Dikar 80% WP	2 lb.	8 lb.	1½ lb.	6 lb.	
Polyram 80% WP	2 lb.	8 lb.	1½ lb.	6 lb.	
Difolatan 80% DG	6¼ lb.	25 lb.			Single application only of Difolatan 80% DG — see item 4 on page 49.
Difolatan 80% DG	3¾ lb.	15 lb.			

How to Use The 1985 Fruit Pesticide Recommendations

The evaluation of how well certain insecticides control specific insects found in the 1985 Fruit Pesticide Manual was obtained from research data gathered during the past several years. The ratings can help growers determine which materials to use to control certain pests. The ratings may not be accurate in all orchards, as orchards differ due to past chemical application (which may lead to resistance), population levels at time of application and environmental conditions affecting insect susceptibility and pesticide activity or persistence.

To use the Recommendations, determine what stage of growth the fruit is in and look under that part of the schedule (example: petal fall of apples). Then determine which pests are present and if their populations are high enough to warrant a control measure (eg: you found green fruitworm larvae chewing leaves). Next, look under the columns titled "Efficiency" for that insect and read the numbers and letters there (eg: 11e, 26f, 29g). The number refers to the chemicals in the column headed "Suggested Chemicals," and the letter refers to a rating of e = excellent, g = good, f = fair and p = poor. In our example, Methomyl is excellent, Thiodan is fair and Zolone is good in controlling green fruitworm.

Continue this procedure for all the insects present at this time. After you have chosen the best insecticides to use for the complex of insects in your crop, refer to the rates provided and apply them in calm conditions to achieve the best coverage possible.

If you are trying to achieve "Integrated Mite Control" or are concerned about the beneficial insects present in the orchard, then look at the Table named "Effectiveness of Insecticides in Controlling Insect Pests Attacking Apples." On the bottom of this table, these insecticides are rated as HT = highly toxic, MT = moderately toxic and NT = relatively non-toxic to the beneficial insects. If one material is rated toxic and another rated moderately toxic, use the least toxic one to preserve the beneficials.

The schedule part of the Handbook only lists chemicals that rate excellent or good. Other insecticides may provide fair or poor control of the pests; these ratings can be found in the table. Under some circumstances it may become necessary to use one of the less effective compounds to control the pests.

EFFECTIVENESS OF INSECTICIDES IN CONTROLLING INSECT PESTS ATTACKING APPLES

Ratings of control are E = excellent, G = good, F = fair and P = poor. Ratings against beneficials are HT = highly toxic, MT = moderately toxic and NT = relatively non-toxic

	INSECT	STAGE	Acaralate 1	Carzol 3	Diazinon 5	Dimethoate 6	Ethion + Oil (2) 7	Guthion 8	Imidan 9	Kelthane 10	Methomyl 11	Malathion 13	Methoxychlor 14	Morestan 15	Omite 16	Parathion 17	Penncap M 18	Phosphamidon 20	Plictran 21	Sevin 23	Superior Oil (2) 24	Systox 25	Thiodan 26	Trithion 27	Vendex 28	Zolone 29	Vydate 30	Supracide	Lorsban	Pydrin	Pounce	Ambush	Pay-off
PESTS	Apple Maggot	Adult			G	E		E	E			P	P			F	E	P		G						G			F	E			E
	Codling Moth	Adult			E	G		E	E		E	P	P			G	E	P		E				F		E	P		E	E			E
	Cutworms	Larvae							F		F					F													E	E			E
	European Red Mite	Active	G	G		P	E			G				G	G	P			E		E			F	E	F	E						P
	Fruit Tree Leafroller	Larvae			G			E	E		E					G	E			F						E	P		E	E	E	E	E
	Green Apple Aphid	Active			F	E	E	P	F		G	P	P			P	P	E		P	E	E	E	F		G	P		G				G
	Green Fruitworm	Larvae			F			F	F		E					F	G	P					E			G	P		E	E	E	E	E
	Oblique Banded Leafroller	Larvae			G			E	E		E					G	E			F						E	P		E	E	E	E	E
	Plum Curculio	Adult				P		E	E		F	P	P			F	E			P						G	G		E	E	E	E	E
	Red Banded Leafroller	Larvae			G	P		E	E		E	P				G	E	P		F						E	P		E	E	E	E	E
	Rose Chafer	Adult															E			G									G				G
	Rosy Apple Aphid	Active			F	E	E	F	F		G	P	P			P	F	E		P	E	E	E	G		G	E	E	E	G			G
	Rust Mite	Active	G	E	F	P		P	P	G				G	G		P	P	G	G		F	E		G	G	E						P
	San Jose Scale	Adult					E										F				E			G				E	E	G			F
		Crawler			G												E							E				E	E	G			
	Spotted Tentiform Leafminer	Adult		G				F	F		G						P						E		G				E			E
		Larvae			F	F					E						P	P				G	P		G	P			P			P
	Tarnished Plantbug	Active			F	E		F	F		G					F	F						E		F			F	E	E	E	E
	Two Spotted Mite	Active	G	E		P				G				G	G		P		E					F	E		E					
	White Apple Leafhopper	Active		E	G	G					E					P		P		E1		G	E	G		G	E		F				G
	Wooly Apple Aphid	Active			F	G					P					G	E	G					E	G		G	P		E				F
BENEFICIALS	Bees		NT	MT	HT	HT	NT	HT	HT	NT	HT	HT	NT	NT	NT	HT	HT	HT	NT	HT	NT	MT	MT	MT	NT	NT	HT		HT	HT	HT	HT	HT
	Mite Predators		HT	HT	NT	MT	NT	NT	NT	HT	HT	MT	MT	MT	NT	MT	MT	HT	NT	HT	NT	HT	MT	HT	NT	NT	HT		NT	HT	HT	HT	HT
	Insect Predators		NT	MT	HT	HT	NT	MT	MT	MT	HT	MT	MT	NT	NT	HT	HT	HT	NT	HT	NT	MT	MT	MT	NT	NT	HT		NT	HT	HT	HT	HT

[1]Second generation only

[2]Use only before pre- pink stage

1985 Recommendations for Control of Apple Pests

The rate of material per 100 gallons is based on a standard dilute spray of 400 gallons per acre. If fewer gallons are used, refer to the rate-per-acre figure to insure the proper amount of pesticide is applied.

After each pest name appears a series of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number corresponds to the number of the pesticide in the column headed "Suggested Chemicals." The letter p = poor for the pesticide controlling the pest. Star (*) denotes preferred materials for use in integrated mite and aphid control program.

APPLE SCAB CONTROL (see Pages 48-50 for details)

Silver Tip to Eighth Cover

Fungicides	PRIMARY SCAB Rate/100 gal. dilute	PRIMARY SCAB Rate/acre	SECONDARY SCAB Rate/100 gal. dilute	SECONDARY SCAB Rate/acre	Comments
Lime sulfur	2 gal.	8 gal.			Do not use after pre-pink.
Dichlone 50% WP plus protectant	¼ lb. ½ strength	1 lb. ½ strength			Do not use beyond early pink.
Funginex 18.2% EC	10 fl oz	36-40 fl oz			For use from ½-inch green tip to petal fall in eradicant type programs.
Quintar 5 F (protectant)	3.2 fl. oz.	12.8 fl. oz.			Do not use beyond early pink.
Quintar 5 F (eradicant)	6.4 fl. oz.	25.6 fl. oz.			Do not use beyond early pink.
Captan 50% WP	2 lb.	8 lb.	1 lb.	4 lb.	Because dodine- and Benlate-resistant apple scab are widespread in Michigan, dodine (Cyprex), Benlate and Topsin M are not recommended for general use on apples.
Dikar 80% WP	2 lb.	8 lb.	1½ lb.	6 lb.	
Polyram 80% WP	2 lb.	8 lb.	1½ lb.	6 lb.	
Difolatan 80% DG	6¼ lb	25 lb			
Difolatan 80% DG	3¾ lb	15 lb			Single application only of Difolatan 80% DG — see item 4 on page 49.

Green Tip

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Spotted Tentiform Leaf Miner (adult and eggs)	3g, 26f, 31e, 34e, 35e, 37e	3. Carzol 92 SP	5 oz	1¼ lb	Tight cluster and pre-pink sprays are needed for control of Spotted Tentiform Leaf Miner adults and eggs. Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		26. Thiodan 50 WP*	1 lb	4 lb	
		26. Thiodan 3 EC	⅔ qt	2⅔ qt	
		31. Pydrin 2.4 EC	2.7 fl oz	10.7 fl oz	
		34. Ambush 2 EC	3.2 fl oz	12.8 fl oz	
		35. Pounce 3.2 EC	2 fl oz	8 fl oz	
		37. Pay-off 2.5 EC	1 fl oz	4 fl oz	

Pre-Pink

DISEASES

Apple Scab (Primary) — See Silver Tip and page 48.

Powdery Mildew — See "Special Apple Disease Controls," page 58.

INSECTS/MITES

European Red Mite	**24e**	3.	Carzol 92 SP	5 oz	1¼ lb
San Jose Scale	**24e, 32e, 33e**	24.	Superior Oil*	2 gal	8 gal
		26.	Thiodan, 50 WP*	1 lb	4 lb
Spotted Tentiform Leaf Miner (adult and eggs)	**3g, 26f, **31e, **34e, **35e, **37e**	26.	Thiodan 3 EC	⅔ qt	2⅔ qt
		31.	Pydrin 2.4 EC	2.7 fl oz	10.7 fl oz
		32.	Lorsban 4 EC	2 pt	4 pts
		33.	Supracide 2 E	1 qt	3-6 qts
		34.	Ambush 2 EC	3.2 fl oz	12.8 fl oz
		35.	Pounce 3.2 EC	2 fl oz	8 fl oz
		37.	Pay-off 2.5 EC	1 fl oz	4 fl oz

*Unless applied dilute (300-400 gal/A) the use of oil is questionable. Growers unable to spray dilute should consider using organic meticides applied at pink or petal fall against motile stages of mites.

Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.

**Pydrin, Pounce, Ambush and Pay-off are adulticides and ovicides and should be applied before the eggs hatch.

Pink

DISEASES

Apple Scab (Primary) — See Silver Tip and page 48.

Powdery Mildew — See "Special Apple Disease Controls," page 58.

Mildew control is critical at this time. If a severe problem exists, start at green tip.

INSECTS/MITES

European Red Mite	**3e, 15g, 30g**	3.	Carzol 92 SP*	5 oz	1¼ lb
Aphids	**5g, 6e, 11g, 20e, 25e, 26e, 27g, 29g, 30g**	5.	Diazinon 50 WP*	1 lb	4 lb
		6.	Dimethoate 2.67 EC*	1½ pt	6 pt
		6.	Dimethoate 25 WP	2 lb	8 lb
Tarnished Plantbug	**3g, 6e, 11g, 26g, 29g, 31e, 34e, 35e, 37e**	8.	Guthion 50 WP	½ lb	2 lb
		9.	Imidan 50 WP	1 lb	4 lb
Green Fruitworm	**11g, 26f, 29g, 31e, 34e, 35e**	11.	Methomyl 1.8 EC	2 pt	8 pt
		11.	Methomyl 90 SP	½ lb	2 lb
		15.	Morestan 25 WP	½ lb	2 lb
Spotted Tentiform Leaf Miner (larvae)	**11e**	20.	Phosphamidon	¼ pt	1 pt
		25.	Systox 6 EC	⅓ pt	1⅓ pt
Resistant Oblique Banded Leafroller	**11e, 31e, 34e, 35e, 37e**	26.	Thiodan 50WP*	1 lb	4 lb
		26.	Thiodan 3 EC	⅔ qt	2⅔ qt
		27.	Trithion 4 EC	½ pt	2 pt
Non-Resistant Oblique Banded Leafroller	**8e, 9e, 11e, 29e, 31e, 34e, 35e, 37e**	29.	Zolone 3 EC	1 pt	4 pt
		30.	Vydate 2 L	1 pt	4 pt
		31.	Pydrin 2.4 EC	2.7 fl oz	10.7 fl oz
		34.	Ambush 2 EC	6 fl oz	24 fl oz
		35.	Pounce 3.2 EC	2 fl oz	8 fl oz
		37.	Pay-off 2.5 EC	1 fl oz	4 fl oz

Mite control will not be necessary now if dormant oil was applied. Check with the Extension agent to see if the applied for State label was granted for use of permethrin or fenvalerate to control spotted tentiform leafminer.

Star (*) denotes preferred materials for use in integrated mite and aphid control program.

Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Apple Scab (Primary)	See Silver Tip and page 48.				
Powdery Mildew	See "Special Apple Disease Controls," page 58.				
Fire Blight	See "Special Apple Disease Controls," page 58.				

Petal Fall

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Apple Scab (Primary)	See Silver Tip and page 48.				
Powdery Mildew	See "Special Apple Disease Controls," page 58.				
Fire Blight	See "Special Apple Disease Controls," page 58.				
INSECTS/MITES					
White Apple Leafhopper	**3e, 5g, 6g, 11e, 25g, 27g, 37g, 31g, 34g, 35g**	3. Carzol 92 SP	5 oz	1¼ lb	Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		5. Diazinon 50 WP*	1 lb	4 lb	
		6. Dimethoate 2.67 EC*	1½ pt	6 pt	
		6. Dimethoate 25 WP	2 lb	8 lb	
		8. Guthion 50 WP*	½ lb	2 lb	
		9. Imidan 50 WP*	1 lb	4 lb	
		11. Methomyl 1.8 EC	2 pt	8 pt	
		11. Methomyl 90 SP	½ lb	2 lb	
		18. Penncap 2 FM**	1 pt	4 pt	
		25. Systox 6 EC	⅓ pt	1⅓ pt	
		26. Thiodan 50 WP*	1 lb	4 lb	
		27. Trithion 4 E	½ pt	2 pt	
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	
		31. Pydrin 3.2 EC	2.7 fl oz	10.7 fl oz	
		32. Lorsban 50 WP*	12 oz	3 lb	
		34. Ambush 2E	3.2 fl oz	12.8 fl oz	
		35. Pounce 3.2 EC	2 fl oz	8 fl oz	
		37. Pay-off 2.5 EC	1 fl oz	4 fl oz	
Tarnished Plantbug	**6e, 26g, 31e, 37e, 34e, 35e**				*WARNING:*** Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 26). Half rates of the combinations of Guthion plus methomyl or Imidan plus methomyl or Zolone plus methomyl or Penncap-M plus methomyl will also control all petal fall pests.
Green Fruitworm	**11g, 18g, 26g, 29g, 31e, 32g, 37e, 34e, 35e**				
Plum Curculio	**8e, 9e, 18e, 29g, 31e, 32g, 37e, 34e, 35e**				
Leafrollers	**8e, 9e, 11e, 18e, 29e, 31e, 32e, 37e, 34e, 35e**				Vydate 2 L should not be used within 30 days post bloom at rates greater than ½ pt./100 gal. or fruit thinning may occur.
Spotted Tentiform Leaf Miner (Larvae)	**11e**				
Oblique Banded Leafroller	See Pink				

First Cover

DISEASES

Apple Scab (Primary)	See Silver Tip and page 48.
Powdery Mildew	See "Special Apple Disease Controls," page 58.
Fire Blight	See "Special Apple Disease Controls," page 58.
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 58.

INSECTS/MITES

Plum Curculio	See Petal Fall
Leafrollers	See Petal Fall

If White Apple Leafhopper, Green Fruitworm, Tarnished Plantbug or Aphids were not controlled at petal fall, then these pests should be controlled now with the chemicals recommended at petal fall.

Second Cover

DISEASES

Apple Scab (Secondary)	See Silver Tip and page 48.
Powdery Mildew	See "Special Apple Disease Controls," page 58
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 58

INSECTS/MITES

Codling Moth	**5e, 8e, 9e, 11e, 17g, 18e, 23e, 29e, 31e, 37e**	5.	Diazinon 50 WP*	1 lb	4 lb
		8.	Guthion 50 WP*	½ lb	2 lb
		9.	Imidan 50 WP*	1 lb	4 lb
		11.	Methomyl 1.8 EC	2 pt	8 pt
		11.	Methomyl 90 SP	½ lb	2 lb
		17.	Parathion 15 WP*	1½ lb	6 lb
		17.	Parathion 8 F	¼ pt	1 pt
		18.	Penncap 2 FM	1 pt	4 pt
		23.	Sevin 50 WP	2 lb	8 lb
		23.	Sevin 80 S	1¼ lb	5 lb
		27.	Trithion 4 E	½ pt	2 pt
		29.	Zolone 3 EC	1 pt	4 pt
		29.	Zolone 25 WP	1½ lb	6 lb
		31.	Pydrin 3.2 EC	2.7 fl oz	10.7 fl oz
		32.	Lorsban 50 WP	12 oz	3 lb
		37.	Pay-off 2-5 EC	1 fl oz	4 fl oz
San Jose Scale (crawlers)	**5g, 18g, 32e**				
Tufted Apple Budmoth	**8g, 29g, 18g, 31e, 32e, 37e**				

If tufted apple bud moth is a problem, half rates of Zolone and Penncap M or half rates of methomyl and Guthion will control this pest.

In sandy soils, rose chaffer may become a pest, and if so, Sevin at 8 lb. per acre of 50 WP will control it.

If spotted tentiform leafminers are a problem, methomyl can be used to control them at rates recommended at petal fall. Call the local Pest Management code-a-phone or determine from the Extension Horticultural agent when sprays for codling moth should be applied.

Summer Mite Control

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
Mites			1 qt	4 qt	
adults:	**3e, 10g, 16g, 21e, 28g, 30e**	3. Carzol 92 SP	5 oz	1¼ lb	Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		10. Kelthane EC	1 qt	4 qt	
immatures:	**3e, 10g, 16g, 21e, 28g, 30g**	10. Kelthane 35 WP	1¼ lb	5 lb	
		10. Kelthane 4 F	1 pt	4 pt	
		16. Omite 6 F	8-10 fl oz	32-40 fl oz	
		16. Omite 30 WP*	1¼ lb	5 lb	
		21. Plictran 50 WP*	4-6 oz	1-1½ lb	
		28. Vendex 50 WP*	4-8 oz	1-2 lb	
		30. Vydate 2 L	1 pt	4 pt	

Third Cover

DISEASES					
Apple Scab (Secondary)	See Silver Tip and page 48.				
Powdery Mildew	See "Special Apple Disease Controls," page 58.				
INSECTS/MITES					
Codling Moth	See Second Cover	6. Dimethoate 2.67 EC*	1½ pt	6 pt	
Mites	See Summer Mite Control	25 WP	2 lb	8 lb	
		20. Phosphamidon 8 EC	¼ pt	1 pt	
Red-banded Leafroller	See Petal Fall	25. Systox 6 EC	⅓ pt	1⅓ pt	
Green Apple Aphid	**6e, 20e, 25e, 27g, 30g, 31g, 32e, 37g**	27. Trithion	½ pt	2 pt	
		30. Vydate 2 L	1 pt	4 pt	
Tufted Apple Budmoth	**8g, 29g, 18g, 32e, 31e, 37e**	31. Pydrin 2.4 EC	2.7 fl oz	10.7 fl oz	See note under 2nd cover on Tufted apple budmoth.
		32. Lorsban 50 WP	12 oz	3 lb	
		37. Pay-off 2-5 EC	1 fl oz	4 fl oz	

Fourth Cover

DISEASES	
Apple Scab (Secondary)	See Silver Tip and page 48.
Powdery Mildew	See "Special Apple Disease Controls," page 58.

APPLE MAGGOT

Apple maggot can be a problem from early July through the month of September. The pupae require moisture before the adults emerge. Often rains come late in August and September resulting in large numbers of flies emerging in late August and through September. Flies move into orchards from abandoned and unsprayed trees.

INSECTS/MITES

Apple Maggot	**5g, 8e, 9e, 18e, 23f 29g, 31g, 32f, 37e**	5. Diazinon 50 WP*	1 lb	4 lb	Call the local Pest Management code-a-phone or determine from the Extension agent when sprays for apple maggots should be applied.
		8. Guthion 50 WP*	½ lb	2 lb	
Codling Moth	See Second Cover	9. Imidan 50 WP*	1 lb	4 lb	
		18. Penncap-M*	1 pt	4 pt	
		23. Sevin 50 WP	2 lb	8 lb	
		23. Sevin 80 S	1¼ lb	5 lb	Combinations of half rate of Lorsban plus half rate of Guthion, Imidan, Zolone, or Penncap M will control apple maggot, San Jose scale and other pests with the exception of spotted tentiform leafminer and white apple leafhopper.
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	
		31. Pydrin 2.4 EC	4 fl oz	1 pt	
		32. Lorsban 50 WP	12 oz	3 lb	
		37. Pay-off 2-5 EC	1 fl oz	4 fl oz	

Fifth Cover

DISEASES

Apple Scab (Secondary)	See Silver Tip and page 48.
Powdery Mildew	See "Special Apple Disease Controls," page 58.

INSECTS/MITES

Apple Maggot	See Fourth Cover
Codling Moth	See Second Cover
Red-banded Leafroller	See Petal Fall
Resistant Oblique-Banded Leafroller	**11e, 31e, 37e**
Nonresistant Oblique-Banded Leafroller	**8e, 9e, 11e, 29e, 31e, 37e**

Sixth, Seventh and Eighth Covers (If Needed)

DISEASES

Apple Scab (Secondary)	See Silver Tip and page 48.

INSECTS/MITES

Aphids	See Third Cover				
Apple Maggot	See Fourth Cover	3. Carzol 92 SP	2 oz	½ lb	
Codling Moth	See Second Cover	5. Diazinon 50 WP*	1 lb	4 lb	Half rates of the combination of Guthion and Methomyl or Imidan and Methomyl or Zolone and Methomyl will control all these pests.
Red-banded Leafroller	See Petal Fall	8. Guthion 50 WP	½ lb	2 lb	
		11. Methomyl 1.8 EC	1 pt	4 pt	
Spotted Tentiform Leaf Miner (larvae)	**11e, 30e,**	11. Methomyl 90 SP	¼ lb	1 lb	
		18. Penncap 2 FM	1 pt	4 pt	
White Apple Leafhopper	**3e, 5g, 11e, 23g, 30e, 31g, 37g**	23. Sevin 50 WP	1 lb	4 lb	**See note above on combinations of half rate of Lorsban with other insecticides.
		80 S	10 oz	2½ lb	
Tufted Apple Budmoth	**8g, 29g, 18g, 31e, 32e, 37e**	27. Trithion 4 E	½ pt	2 pt	
		29. Zolone 3 EC	1 pt	4 pt	
San Jose Scale	**5g, 13g, 32e**	29. Zolone 25 WP	1½ lb	6 lb	
		30. Vydate 2 L	1 pt	4 pt	
Resistant Oblique Banded Leafroller	**11e, 31e, 37e**	31. Pydrin 2.4 EC	4 fl oz	1 pt	
		32. Lorsban 50 WP**	12 oz	3 lb	
Nonresistant Oblique Banded Leafroller	**8e, 9e, 11e, 29e, 31e, 37e**	37. Pay-off 2-5 EC	2 fl oz	8 fl oz	

SPECIAL APPLE DISEASE CONTROLS

(Controls are suggested where these diseases are economic problems)

Apple Powdery Mildew

Mildew is an economic problem on susceptible varieties including: Jonathan, Rome Beauty, Paulared, Cortland, Monroe, and Idared.

Powdery mildew control should start at green tip, although pink may be early enough if temperatures are generally below 50° F. Early sprays (pink to petal fall) are paramount to success in controlling powdery mildew. Applitions should be continued until terminal growth stops. Mildew sprays should be applied every 5 to 7 days, particularly from pink to first cover, even though scab sprays may not be necessary. Because powdery mildew is most active when mild weather exists, failure to maintain protection from mildew infection during this period may allow infection to become established. Where mildew is controlled through first cover, spray intervals may be increased to about 10 days.

If oil is used for mite control, there is a danger of phytotoxicity where sulfur, Karathane, or Dikar are applied too closely to the oil application.

TIMING: Green tip to petal fall, first cover to third cover (or cessation of terminal growth)

Fungicides	Rate/100 gal. dilute	Rate/acre
Scab fungicide plus Bayleton 50% WP†	½-1½ oz	2-6 oz
OR		
Dikar 80% WP**	2 lb	2 lb
OR		
Funginex 18.2% EC*	10 fl oz	36-40 fl oz
OR		
Scab fungicide plus Wettable Sulfur	2 lb	8 lb
OR		
Scab fungicide plus Dinocap (Karathane) 25% WP	½ lb	2 lb

†*Where mildew is a severe problem, use 4-6 oz/acre in two to three applications, then reduce to 2-3 oz/acre. Where mildew is a minor problem, use 2 oz/acre. Short spray intervals (5-7 days) are preferred to long (10-14 day) interval. Also controls rust.*

**For use from ½-inch green tip to petal fall. Also controls apple scab and rust.*

***Dikar will control apple scab.*

Sooty Blotch, Fly Speck, and Scab

TIMING: Cover sprays starting at third cover

Fungicides	Rate/100 gal. dilute	Rate/acre
Captan 50% WP plus Zineb 75% WP	1 lb 1 lb	4 lb 4 lb
OR		
Captan 50% WP	2 lb	8 lb

Cedar-Apple Rust

TIMING: Pink to third cover

Bayleton 50% WP plus Scab fungicide	½-1 oz	2-4 oz
OR		
Ferbam 76% WP plus Scab fungicide	¾ lb ½ strength	3 lb ½ strength
OR		
Funginex 18.2% EC*	10 fl oz	36-40 fl oz

*For use from ½-inch green tip to petal fall. Also controls apple scab and mildew.

Blister Spot

Blister spot is a bacterial disease of apple caused by a bacterium in the genus *Pseudomonas.* It is a widespread and serious problem on the variety Mutsu. The disease has also been observed as a minor problem on Jonathan, Red Delicious, Golden Delicious, Winesap, and Jerseymac. Additional information on this disease may be found in Bulletin NCR 45 "Diseases of Tree Fruits."

Research conducted by the New York State Agricultural Experiment Station indicates this disease can be controlled with a spray mixture of:

	Amount per 100 gallons
Streptomycin (Agristrep), plus	¼ lb.
Glyodin	1 pt.

If glyodin is not available, increase the rate of streptomycin to ½ lb. per 100 gallons. The first spray should be applied no later than 2 weeks after petal fall and should be followed weekly by two additional sprays. Sprays should be applied dilute or 2X concentration.

Fire Blight of Apple and Pear

Two bactericides, streptomycin and Bordeaux mixture, are effective against the blossom phase of fire blight. Streptomycin is usually preferred because it is more effective and less phytotoxic to fruit and foliage. Sprays are important, particularly during bloom, because they often prevent fire blight from getting started and spreading as a problem for the remainder of the season. Once the disease is established, control is difficult. These chemicals also give some control of

Continued

terminal blight if applied as a preventative. The rates are:

Bactericide	Rate/100 gal. dilute
Bordeaux mixture	
Copper sulfate	2 lb
Hydrated spray lime	6 lb
OR	
Streptomycin 17%	½ lb

Streptomycin sprays: Use streptomycin when maximum temperatures above 65° F. exist or are likely, and are accompanied by precipitation or follow rainy days. Apply ½ lb rate (100 ppm) when moderate to severe conditions occur. When temperatures slightly above 65° F. are anticipated with moisture, use ¼ to ⅜ lb. per 100 gallon dilute.

Apply the first spray before or within 24 hours after favorable conditions develop. Apply a second spray if favorable conditions reappear, or, if blossoms are opening rapidly and favorable conditions persist, 1 to 2 days after previous spray. Repeat applications if warm, wet conditions prevail.

Bordeaux 2-6-100 is suggested when the fire blight problem is slight and timed as outlined for the streptomycin sprays. Do not use streptomycin after a Bordeaux spray.

To avoid fruit russeting, apply Bordeaux during quick drying conditions and fog the spray into the trees. Bordeaux controls scab; **streptomycin does not.**

Bordeaux may also be used for late bloom, summer twig, leaf and fruit infection control.

NOTE: Dormant pruning of overwintering cankers on pears is a must. On apples, remove cankers ½ in. or larger first, and, if feasible, remove smaller ones as well.

Susceptible apple varieties include: Wagener, Monroe, Niagara, Wayne, Tompkins King, Twenty Ounce, Rhode Island Greening, Yellow Transparent, Jonathan, Idared, Fenton (Beacon), Rome Beauty, Paulared, Granny Smith and many crab apple varieties. In some years, Golden Delicious, Empire and Stayman will develop twig infections. All commercial pear varieties in Michigan are susceptible.

Post bloom sprays: Streptomycin can be used to within 30 days of harvest on pears, 50 days on apples. The following suggestions are provided for those wishing to attempt early and mid-summer control of shoot, leaf, and fruit blight. Apply the ½ lb. rate on a 7-day protective schedule starting at petal fall or 5 to 7 days after the last in-bloom spray. During periods of wet, humid weather, shorten interval to 5 to 7 days. Continue program until terminal growth stops. Spray during the evening or early morning hours to increase effectiveness.

PEAR PRODUCTION INFORMATION

1985 Recommendations for Control of Pear Pests

The rates of materials per 100 gallons for use on pear are based on a standard of 300 gallons per acre dilute spray for mature trees. If less gallonage is used, refer to the rate-per-acre figure to insure that the proper amount of pesticide is applied.

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

Late Dormant or Delayed Dormant

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Pear Psylla	**31e**	31. Pydrin 2.4 EC	3.6 fl oz	10.7 fl oz	
	34e	34. Ambush 2 EC	4.3 fl oz	12.8 fl oz	
	35e	35. Pounce 3.2 EC	2.7 fl oz	8 fl oz	
	37e	37. Pay-off 2.5 EC	1 fl oz	3 fl oz	

Green Tip to Pre-Pink

DISEASES					
Pear Scab		Ferbam 76 WP	1½ lb	4½ lb	Benlate at 6 oz./100 gal. dilute is preferred where pear scab is a problem. Limit sprays to 2 or 3 per season with Captan or Ferbam used at other times.
		Captan 50 WP	2 lb	6 lb	

INSECTS/MITES					
European Red Mite	24e	18. Penncap 2 FM	1 pt	4 pt	Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.
San Jose Scale	**18e, 24e, 27g**	24. Superior Oil	2 gal	6 gal	
		27. Trithion 4 E	1 pt	3 pt	

White Bud

DISEASES					
Pear Scab	Fungicides listed under Green Tip to Pre-Pink.				
INSECTS/MITES					
European Red Mite	**3g, 15g,**				
Leafrollers	**8e, 9e, 29e, 31e, 34e 35e, 37e**	2. Amitraz 1.5 EC	1-2 pts	2-4 qts	European Red Mite control is not necessary if dormant oil was applied. Pear Rust Mite control requires prebloom and petal fall applications and post bloom treatments as needed. Alternate row spraying and high concentrate sprays are ineffective.
		3. Carzol 92 SP	½ lb	1½ lb	
Green Fruitworm	**26g, 29g, 31e, 34e, 35e, 37e**	8. Guthion 50 WP	½ lb	1½ lb	
		9. Imidan 50 WP	1 lb	3 lb	
Tarnished Plantbug	**3g, 31e, 34e, 35e, 37e**	10. Kelthane 35 WP	1¼ lb	3¾ lb	
		10. Kelthane 18.5 EC	1 qt	3 qt	
Pear Psylla	**31e, 34e, 35e, 37e**	10. Kelthane 4 F	¾-1 pt	3-4 pt	
Pear Rust Mite	**2g, 3e, 10e, 21e, 30g**	15. Morestan 25 WP	½ lb	1½ lb	Spraying at flower bud separation (green cluster) is the most effective prebloom timing for rust mite control.
		21. Plictran 50 WP	6 oz	1⅛ lb	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		30. Vydate 2 E	2 pt	6 pt	
		31. Pydrin 2.4 E	3.6 fl oz	10.7 fl oz	
		34. Ambush 2 E	4.3 fl oz	12.8 fl oz	
		35. Pounce 3.2 EC	2.7 fl oz	8 fl oz	
		37. Pay-off 2.5 EC	1 fl oz	3 fl oz	

Bloom

DISEASES	
Fireblight	See Fire Blight of Apple and Pear, page 58.
Pear Scab	See Green Tip.

Petal Fall

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Fireblight	See Fire Blight of Apple and Pear, page 58.				
Pear Scab	See Green Tip.				
INSECTS/MITES					
Plum Curculio	**8e, 9e, 18e, 29g, 31e, 34e, 35e**	2. Amitraz 1.5 EC	2 pts	4 qts	
		3. Carzol 92 SP	½ lb	1½ lb	
Green Fruitworm	**18g, 26g, 29g, 31e, 34e, 35e**	8. Guthion 50 WP	½ lb	1½ lb	*WARNING:* Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 26).
		9. Imidan 50 WP	1 lb	3 lb	
Tarnished Plantbug	**26g, 31e, 34e, 35e**	18. Penncap-M	2 pt	6 pt	
Pear Rust Mite	**2g, 21e, 10e, 3e**	21. Plictran 50 WP	6 oz	1⅛ lb	
		26. Thiodan 50 WP	1 lb	3 lb	
		26. Thiodan 3 EC	1 qt	3 qt	
		29. Zolone 3 EC	1 pt	3 pt	
		31. Pydrin 2.4 E	3.6 fl oz	10.7 fl oz	
		34. Ambush 2 E	4.3 fl oz	12.8 fl oz	
		35. Pounce 3.2 EC	1 fl oz	3 fl oz	

First Cover

DISEASES					
Fireblight	See Fire Blight of Apple and Pear, page 58.				
Pear Scab	See Green Tip.				
INSECTS					
Plum Curculio	See Petal Fall				

Summer Mite Control

Mites					
adults:	**3g, 10g, 16g, 21e, 28g**	3. Carzol 92 SP	¼-½ lb	¾-1½ lb	
		10. Kelthane 35 WP	1¼ lb	3¾ lb	
immatures:	**3g, 10g, 16g, 21e, 28e**	10. Kelthane 18.5 EC	1 qt	3 qt	
		16. Omite 30 WP	1¼ lb	3¾ lb	
		21. Plictran 50 WP	6 oz	1⅛ lb	
		28. Vendex 50 WP	8 oz	1½ lb	

Summer Covers

DISEASES

Pear Scab — Fungicides listed under Green Tip to Pre-Pink.

INSECTS

Codling Moth	**2e, 5e, 8e, 9e, 17g, 18e, 23e, 29e**	2.	Baam 1.5 EC	2 pt	3 qt
		5.	Diazinon 50 WP	1 lb	3 lb
		8.	Guthion 50 WP	½ lb	1½ lb
San Jose Scale crawlers:	**5g, 17g, 18e**	9.	Imidan 50 WP	1 lb	3 lb
		17.	Parathion 15 WP	1 lb	3 lb
Pear Psylla	**2e**	17.	Parathion 8 F	⅓ pt	1 pt
		18.	Penncap 2 FM	2 pt	6 pt
Apple Maggot	**5g, 8e, 9e, 18e, 29g**	23.	Sevin 50 WP	2 lb	6 lb
		23.	Sevin 80 S	1¼ lb	4 lb
		29.	Zolone 3 EC	1 pt	3 pt

Codling Moth control is not necessary for first generation as the pear is too hard for the larvae to enter successfully. Hence no insect sprays, other than for Pear Rust Mite, are required from petal fall until second generation Codling Moth in August. Check with your local Extension agent for timing of this application.

PEACH AND NECTARINE PRODUCTION INFORMATION

1985 Recommendations for Control of Peach and Nectarine Pests

The rates of materials per 100 gallons suggested below are based on a standard of 300 gallons per acre dilute spray for mature trees. If less than 300 gallons are applied per acre, refer to the rate-per-acre column to insure proper amount of pesticide is applied.

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

Dormant

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Peach Leaf Curl	**4e, 6e, 12e**	4. Bravo 500F	1½-2 pt	4½-6 pt	Apply in autumn after leaf drop or spring before bud swell.
Bacterial Spot	**6f**	12. Ferbam	1½-2 lb	4½-6 lb	
Valsa Canker	See page 69	6. Bordeaux mixture			
Crown Gall	See page 70	Copper sulfate	6 lb		*PRE-PLANT TREATMENT TO CONTROL PEACH TREE BORER*
		Spray lime	6 lb		Check plants for Crown Gall. If plants are not infested, dip trees in bundles or individually in Thiodan (3 lb./gal. EC) used at the rate of 10 qt./100 gal. water. Dip trees several inches above the grafting bud scar and plant immediately or allow to dry before returning to storage. Do not plant if infected with Crown Gall.
INSECTS					
Peach Tree Borer	See note				

Pink

DISEASES					
Brown Rot	See Bloom.				
Valsa Canker	See page 69				
INSECTS/MITES					
Tarnished Plant Bug	**31e, 34e, 35e**	29. Zolone 3 EC	1 pt	3 pt	
Green Fruitworm	**29g, 31e, 34e, 35e**	31. Pydrin 2.4 EC	3.6 fl oz	12.8 fl oz	
		34. Ambush 2 EC	4.3 fl oz	12.9 fl oz	
		35. Pounce 3.2 EC	2.7 fl oz	8 fl oz	

Bloom

DISEASES					
Brown Rot	**1e, 2e, 3e, 4g, 14f**	1. Benlate 50 WP, plus	4 oz	12 oz	Where pink bud spray is omitted, or if weather is unusually favorable for disease, begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails. Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.
Valsa Canker	See page 69	Captan, 50 WP	1½ lb	4½ lb	
		2. Funginex 18.2 EC	¾-1 pt	1-1½ qt	
		3. Rovral 50 WP	½ lb	1½-2 lb	
		4. Bravo 500F	1½-2 pt	4½-8 pt	
		7. Dichlone 50 WP	½ lb	1.5 lb	
		7. Quintar 5 F	6.4 fl oz	19.2 fl oz	
		14. Wettable Sulfur 95 WP	5 lb	15 lb	
		14. Lime Sulfur (Balloon pink only)	2 gal	6 gal	

Petal Fall

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	**1e, 2e, 3e, 4g, 14f**	1. Benlate 50 WP, plus	4 oz	12 oz	Powdery mildew is sometimes an economic problem in S.W. Michigan, particularly on Reo-Oso-Gem and Redskin.
Powdery Mildew	**1g, 2g, 14g**	Captan 50 WP	1½ lb	4½ lb	
		2. Funginex 18.2 EC	¾-1 pt	1-1½ qt	
		3. Rovral 50 WP	½ lb	1½-2 lb	Rovral may be used from pink bud to petal fall and 5 weeks before harvest to day of harvest.
		4. Bravo 500F	1½-2 pt	4½-8 pt	
		14. Wettable sulfur 95 WP	5 lb	15 lb	
INSECTS					Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.
Plum Curculio	**8e, 9e, 18e, 29g, 31e, 34e, 35e**	5. Diazinon 50 WP	1 lb	3 lb	
		8. Guthion 50 WP	½ lb	1½ lb	
Oriental Fruit Moth	**5g, 8e, 9e, 17g, 18e, 23e, 29e, 31e, 34e, 35e**	8. Guthion 2 EC	1 pt	3 pt	
		9. Imidan 50 WP	1 lb	3 lb	
		17. Parathion 15 WP	1½ lb	4½ lb	
Rose Chafer	**18g, 23g**	17. Parathion 8 F	⅓ pt	1 pt	
Tarnished Plant Bug	**26f, 31e, 34e, 35e**	18. Penncap 2 FM	5 pt	5 pt	
Green Peach Aphid	**25e, 26e, 29g**	23. Sevin 50 WP	2 lb	6 lb	
		23. Sevin 80 S	1¼ lb	4 lb	
		25. Systox 6 EC	⅓ pt	1 pt	
		26. Thiodan 3 EC	1 qt	3 qt	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	
		31. Pydrin 2.4 EC	3.6 fl oz	10.8 fl oz	
		34. Ambush 2 EC	4.3 fl oz	12.9 fl oz	
		35. Pounce 3.2 EC	2.7 fl oz	8 fl oz	

Shuck Split

DISEASES					
Brown Rot	**5g, 14f**	14. Wettable sulfur 95 WP	5 lb	15 lb	Benlate is omitted at shuck split through fourth cover in order to delay resistance problems. Topsin M should not be used for the same reason.
Powdery Mildew	**14g**	5. Captan 50 WP	2 lb	6 lb	
Bacterial Spot	See page 69				

INSECTS					
Plum Curculio	See Petal Fall				
Oriental Fruit Moth	See Petal Fall				
Rose Chafer	See Petal Fall				
Lecanium Scale	**5g, 17g, 18e, 23g, 27e**				
Tarnished Plant Bug	**26g, 31e, 34e, 35e**				
		5.	Diazinon 50 WP	1 lb	3 lb
		17.	Parathion 8 F	⅓ pt	1 pt
		17.	Parathion 15 WP	1½ lb	4½ lb
		18.	Penncap 2 FM	1.5 pt	4.5 pt
		23.	Sevin 80 S	1¼ lb	4 lb
		23.	Sevin 50 WP	2 lb	6 lb
		26.	Thiodan 50 WP	1½ lb	4½ lb
		26.	Thiodan 3 EC	1½ qt	4½ qt
		27.	Trithion 4 E	½ pt	1½ pt
		31.	Pydrin 2.4 EC	3.6 fl oz	10.8 fl oz
		34.	Ambush 2 EC	4.3 fl oz	12.9 fl oz
		35.	Pounce 3.2 EC	2.7 fl oz	8 fl oz

First Cover

DISEASES						
Brown Rot	**5g, 14f**	5.	Captan 50 WP	2 lb	6 lb	Peach scab is sometimes an economic problem in southwest Michigan. It is usually more severe on late maturing varieties and fruits should be protected to at least 60 days of harvest.
Peach Scab	**5g, 14g**	14.	Wettable sulfur 95 WP	5 lb	15 lb	
Powdery Mildew	**14g**					
Bacterial Spot	See page 69					
X-Disease	See page 69					
INSECTS						
Oriental Fruit Moth	See Petal Fall					
Tarnished Plant Bug	See Shuck Split					

Second Cover

DISEASES					
Peach Scab	Fungicides listed under first cover.				
Powdery Mildew	Fungicides listed under first cover.				
Bacterial Spot	See page 69.				
INSECTS					For Lesser Peach Tree Borer control apply sprays between June 3 to 10 and another 3 weeks later. Apply with a hydraulic gun as a course dilute spray, with concentration on scaffold limbs, crotches and trunk.
Oriental Fruit Moth	See Petal Fall				
Lesser Peach Tree Borer	**26g, 32e**	26.	Thiodan 3 EC	4-5 qts	
		32.	Lorsban 4 E	3 qts	

Third Cover

DISEASES					
Peach Scab	Fungicides listed under first cover.				
Powdery Mildew	Fungicides listed under first cover.				
Bacterial Spot	See page 69.				
INSECTS					For Peach Borer control apply sprays the first week in July. Apply to the base of the tree as a coarse dilute spray. Use a hydraulic gun.
Oriental Fruit Moth	See Second Cover				
Lecanium Scale	See Shuck Split	26.	Thiodan 3 EC	4-5 qts	
Peach Tree Borer	**26g, 32e**	32.	Lorsban 4 E	3 qts	

Summer Mite Control

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Mites					
adults:	**10g, 16g, 21e, 27g**	10. Kelthane 4 F	1 pt	3 pt	
immatures:	**10g, 16g, 21e, 27g**	10. Kelthane 35 WP	1½ lb	4½ lb	
eggs:		10. Kelthane 18.5 EC	1 qt	3 qt	
		16. Omite 30 WP	1½ lb	4½ lb	
		21. Plictran 50 WP	6 oz	18 oz	
		27. Trithion 4 E	½ pt	1½ pt	

Fourth Cover

DISEASES					
Brown Rot	Fungicides listed under first cover.				
Bacterial Spot	See page 69.				
INSECTS					
Oriental Fruit Moth	See Petal Fall Cover				

Pre-Harvest

DISEASES					
Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.					
Brown Rot	**1e, 2e, 3e, 5g, 14f**	1. Benlate 50 WP, plus	4 oz	12 oz	Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.
		Captan 50 WP	1½ lb	4½ lb	
		2. Funginex 18.2 EC	¾-1 pt	1-1½ qt	
		3. Rovral 50 WP	½ lb	1½-2 lb	
		5. Captan 50 WP	2 lb	6 lb	
		14. Wettable sulfur 95 WP	5 lb	15 lb	
INSECTS					
Oriental Fruit Moth	See Petal Fall				

Post-Harvest

DISEASES	
X-Disease	See page 69

SPECIAL PEACH DISEASE CONTROLS

BACTERIAL SPOT

Bacterial spot is best controlled by planting resistant varieties. Some susceptible varieties to avoid include: Suncling, Babygold-5, Kalhaven, Suncrest, Blake, Sunhigh, Jerseyland, Goldenest, Summercrest, Newday, Autumnglo, and certain nectarine varieties. The following spray schedule will help suppress the disease but it will not provide outstanding control, particularly in severe years for infection.

TIMING: In fall after leaf drop or spring before bud swell. This spray may reduce the amount of primary inoculation in spring, thus delaying the development of disease in summer. It also controls peach leaf curl.

Bactericide	Rate/100 gal. dilute
Bordeaux mixture	
Copper sulfate	6 lb
Spray lime	6 lb

TIMING: Shuck split and repeat application at 7-day intervals through the cover sprays. Shorter intervals may be needed during wet periods to maintain maximum protection.

Bactericide	Rate/100 gal. dilute
Cyprex** 65 WP, plus	½ lb
Captan 50 WP	1 lb
OR	
Terramycin*	12 oz (150 ppm)

*Use dilute or 2X, higher concentrates are not effective and may be phytotoxic. *Once a week spraying of the entire tree is essential.* If only one side of the tree is sprayed (alternate middle row spraying), make certain the other side of tree is sprayed within three to four days. Treatment can be applied until three weeks of harvest.

**CAUTION: Phytotoxicity may result if combined with, or applied near, solvent formulations of insecticides or sulfur. Do not apply during periods of high temperatures, at spray concentrations above 3X, or within 15 days of harvest. It also controls brown rot and scab.

VALSA CANKER

Delay pruning to pink or later to allow rapid healing. Recent studies indicate partial control of Valsa can be obtained as a benefit of using Benlate against brown rot. For best results, time the spray or sprays before rain occurs.

Cultural Practices: Cultural practices to harden-off the trees by the fall are important in reducing cold injury. These include late spring pruning, early cover cropping (by July 4) in clean, cultivated orchards. Do not leave stubs when pruning; remove and burn prunings as soon as possible. Develop trees with wide angle crotches to reduce splitting.

Check trees for dead and diseased wood after growth starts and cut out and burn.

X-DISEASE

Eradication of chokecherry bushes within at least a 500-foot radius of stone fruit orchards is important in the control of X-disease. Chokecherry bushes are commonly found in hedgerows, along property lines, in woods, and on other non-crop areas. Remove by bulldozing, deep plowing, burning, or pulling the individual bushes. Brush killers are effective in areas where cultivation is not possible or is too costly. During the growing season following treatment or cultivation, check the treated area carefully for chokecherry sprouts. Any sprouts or new chokecherry seedlings should be marked for treatment in the fall or pulled out.

X-DISEASE CONTROL

Timing	Herbicide	Amount	Method of Application	Comments
Early spring	bromacil liquid (Hyvar X-L)	1 tablespoon/stump or brush clump	Hand-gun applicator	**CAUTION**: Bromacil is a soil sterilant. Growth of most vegetation will be halted in the treated area for an extended period of time (years).
June or July	Garlon 3A plus a surfactant	2 to 3 gal/100 gal	Spray to actively growing plant	
June to September	Weedone 170	1 to 1½ gal/100 gal	Spray to foliage and stems	Do not apply Bromacil, Garlon or Weedone near ditches or where surface water may carry the material to desirable plants.
Any season	Weedone 170	3 to 4 gal/100 gal oil	Spray basal bark or cut or frilled surface with knapsack sprayer	

Injection Treatments

To obtain remission of X-disease symptoms in peach trees use Terramycin Tree Injection Formula. This is a different formulation than the one used for control of bacterial spot.

TIMING: Make a single application after harvest and before September 30 to trees exhibiting symptoms. Applications after September 30 may delay foliage development or result in terminal dieback the following spring.

Trunk Preparation: Drill two to four holes, depending on trunk diameter, 1¼ inches deep with a 7/32-¼ inch drill bit at a slight downward slant into the trunk of infected trees.

Infusion Treatment: Trees 6 to 10 years old should receive 5 grams of product per tree in one quart to 1 gallon of liquid per tree. Younger trees should be treated with somewhat less product (about 2.5 grams product per tree). Old trees with large trunks can be treated with up to 7.5 grams per tree. This treatment will provide remission of X-disease symptoms for at least one year and usually two years. Some trunk damage will result from the injection treatment but can be reduced by increasing the amount of water used to apply the chemical.

Other X-Disease Controls

1. Partial control of X-disease may be obtained as a benefit of using plum curculio, oriental fruit moth, or plant bug insecticides that also have good activity against leafhoppers.. In areas with an acute X-disease problem, a series of post-harvest insecticide sprays should be applied to control late season populations of the vector.

2. Remove infected cherry trees. Recent research indicates that X-diseased cherries on mazzard rootstock is an important source of the X-disease agent. Infested trees should be removed as soon as they are detected.

BIOLOGICAL CONTROL OF CROWN GALL

Many materials and methods have been tested to control crown gall over the past 75 years, but the most successful to date has been a biological control based on the antagonistic bacterium *Agrobacterium radiobacter* strain 84. This natural bacterium has been approved as a pesticide for use on the seeds, roots, and stems of non-bearing apricot, cherry, nectarine, peach, plum, and prunes.

The new pesticide, brand name "Galltrol-A," consists of a special culture plate (agar plate) containing concentrated amounts of a bacterial inoculant. Galltrol is used at the rate of 1 agar plate per gallon of water.

The bacterium is scraped from the agar plate into water (unchlorinated). Seeds, roots, and stems are then sprayed or dipped into the liquid. Plants should be treated soon after each handling which causes new wounds. Wash plant materials before treating. Prepare new Galltrol suspension whenever it becomes excessively dirty or after every 500-1000 seedlings. Discard prepared dip held more than two days.

Registered applications include treatment of seeds, seedlings, cuttings, and roots and stems of large bare-root stock. Possible breakdown in control may occur if insensitive or resistant strains of the crown gall pathogen are present. This treatment will not control latent or established infections.

APRICOT PRODUCTION INFORMATION

1985 Recommendations for Control of Apricot Pests

The rate of materials per 100 gallons for use on apricots is based on a standard of 300 gallons per acre dilute spray. If less gallons are used, refer to the rate-per-acre figure to insure a proper amount of pesticide is applied.

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

Pre-Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Green Fruitworm	**26g, 29g**	26. Thiodan 50 WP	1 lb	3 lb	
Tarnished Plantbug	**26g**	26. Thiodan 3 EC	1 qt	3 qt	
		29. Zolone 3 EC	1 pt	3 pt	

Red Bud Stage and Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
Brown Rot (blossom blight)	**1e, 2e, 5g, 6e**	1. Benlate 50 WP, plus	4 oz	12 oz	Begin bloom spray at red bud stage and repeat at 5- to 7-day interval. If wet, rainy weather favorable for brown rot persists, repeat application at 2- to 4-day intervals. On large trees or under severe conditions, increase rate of captan 50% WP to 8 lb/acre.
		Captan 50 WP	1½ lb	4½ lb	
		2. Funginex 18.5 EC	¾-1 pt	1-1½ qt	
		5. Captan 50 WP	2 lb	6 lb	
		6. Rovral 50 WP	10 oz	2 lb	

Petal Fall and Shuck Split

DISEASES					
Brown Rot	**1e, 2e, 5g, 6e**	1. Benlate 50 WP, plus	4 oz	12 oz	Fungicide for brown rot and scab will not control bacterial spot.
Scab	**1e, 2p, 5g**	Captan 50 WP	1½ lb	4½ lb	
		2. Funginex 18.5 EC	¾-1 pt	1-1½ qt	
		5. Captan 50 WP	2 lb	6 lb	
		6. Rovral 50 WP	10 oz	2 lb	
INSECTS					
Oriental Fruit Moth	**5g, 8e, 9e, 17g, 23e, 29e**	5. Diazinon 50 WP	1 lb	3 lb	
		8. Guthion 50 WP	½ lb	1½ lb	
Plum Curculio	**8e, 9e, 29g**	8. Guthion 2 EC	1 pt	3 pt	
Tarnished Plant Bug	**26g**	9. Imidan 50 WP	1 lb	3 lb	
		17. Parathion 15 WP	1½ lb	4½ lb	
		17. Parathion 8 F	⅓ pt	1 pt	
		23. Sevin 50 WP	2 lb	6 pt	
		23. Sevin 80 S	1¼ lb	4 lb	
		26. Thiodan 3 EC	1 qt	3 qt	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	

First Cover

DISEASES	
Brown Rot	Fungicides listed under petal fall.
Scab	
INSECTS	
Peach Tree Borer	See page 67.
Plum Curculio	See Petal Fall
Oriental Fruit Moth	See Petal Fall
Tarnished Plant Bug	See Petal Fall

Second Cover

DISEASES	
Brown Rot	Fungicides listed under petal fall.
Scab	
INSECTS	
Oriental Fruit Moth	See Petal Fall

Summer Sprays

DISEASES				
Brown Rot	Fungicides listed under petal fall.			
Scab				
INSECTS				
Apple Maggot	**5g, 8e, 9e, 23g, 29g**	5. Diazinon 50 WP	1 lb	3 lb
Mites	**10g**	8. Guthion 50 WP	½ lb	1½ lb
Oriental Fruit Moth	See Petal Fall	8. Guthion 2 EC	1 pt	3 pt
Scales (Apply sprays when crawlers appear)	**5g, 17g, 27e**	9. Imidan 50 WP	1 lb	3 lb
		10. Kelthane 35 WP	1¼ lb	3¾ lb
		17. Parathion 15 WP	1½ lb	4½ lb
		23. Sevin 50 WP	2 lb	6 lb
		23. Sevin 80 S	1¼ lb	4 lb
		29. Zolone 25 WP	1½ lb	4½ lb
		29. Zolone 3 EC	1 pt	3 pt

PRUNE AND PLUM PRODUCTION INFORMATION

1985 Recommendations for Control of Prune and Plum Pests

The rate of materials per 100 gallons are based on a standard of 300 gallons per acre dilute spray for mature trees. If less than 300 gallons are applied per acre, use the rate per acre figures to insure the proper amount of chemical is applied.

After each insect and mite pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemical" and the letter is a rating of efficiency: e = excellent, g = good, g = fair and p = poor for the pesticide in controlling the pest.

Delayed Dormant

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Black Knot					Prune out and burn all knots in the dormant season and continue to remove knots whenever they are observed. Make pruning cuts at least 6 to 8 in. below visible swellings. Do not plant new plum orchards next to old plantings with black knot. Remove infected wild plums and cherry seedlings from fence rows and nearby wooded areas before planting.
INSECTS/MITES					
European Red Mite	24e, 27g	17. Parathion 15 WP	1 lb	3 lb	*Unless applied dilute (300 gal/A) the use of oil is questionable. Growers unable to spray dilute should consider using organic miticides applied at petal fall against motile stages of of mites.
Lecanium Scale	17 + 24e, or 24e + 27e, 27g	24. Superior Oil*	2 gal	6 gal	
		27. Trithion 4 E	½-1 pt	1½-3 pt	

Green Tip

DISEASES					
Brown Rot	1e	1. Benlate 50 WP, plus	4 oz	12 oz	Benlate plus Captan has a Section 24C registration for black knot control in Michigan.
Black Knot	1g	Captan 50 WP	1½ lb	4½ lb	Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.

Bloom

DISEASES					
Brown Rot	**1e, 2e, 7g, 14f, 15e**	1. Benlate 50 WP, plus	4 oz	12 oz	Where green tip spray is omitted, or if weather is unusually favorable for disease, begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.
Black Knot	**1g**	Captan 50 WP	1½ lb	4½ lb	
		2. Funginex 18.2 EC	¾-1 pt	1-1½ qt	
		7. Dichlone 50 WP	½ lb	1½ lb	
		7. Quintar 5 F	6.4 fl oz	19.2 fl oz	
		14. Wettable sulfur	5 lb	15 lb	
		14. Lime sulfur (Early bloom)	2 gal	6 gal	
		15. Rovral 50 WP	8 oz	1½-2 lb	

Petal Fall

DISEASES					
Brown Rot	**1e, 2e, 12g, 15e**	1. Benlate 50 WP, plus	4 oz	12 oz	Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.
Leaf Spot	**1e, 2e, 12g**	Captan 50 WP	1½ lb	4½ lb	
Black Knot	**1g**	2. Funginex 18.2 EC	¾-1 pt	1-1½ qt	
		12. Ferbam 76 WP plus	1 lb	3 lb	
		Wettable sulfur 95 WP	3 lb	9 lb	
		15. Rovral 50 WP	8 oz	1½-2 lb	
INSECTS					
Plum Curculio	**8e, 9e, 18e, 29g**	8. Guthion 50 WP	½ lb	1½ lb	
		8. Guthion 2 EC	1 pt	3 pt	
		9. Imidan 50 WP	1 lb	3 lb	
		18. Penncap-M 2 F	5 pt	5 pt	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	

Shuck Split

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	Fungicides listed under petal fall, except Funginex				
Leaf Spot					
Black Knot					
INSECTS					
Plum Curculio	See Petal Fall				

First Cover

DISEASES					
Brown Rot	Fungicides listed under petal fall, except Funginex				
Leaf Spot					
Black Knot					
INSECTS					
Scale	**5g, 17g**	5. Diazinon 50 WP	1 lb	3 lb	Sprays for scale should be timed when crawlers become active.
Peach Tree Borers	See page 67.	17. Parathion 15 WP	1½ lb	4½ lb	
Plum Curculio	See Petal Fall.	17. Parathion 8 F	⅓ pt	1 pt	

Summer Mite Control

MITES					
Mites	**10g, 16g, 21e, 27g**	10. Kelthane 35 WP	1.5 lb	4½ lb	
		10. Kelthane 18.5 EC	1 qt	3 qt	
		10. Kelthane 4 F	1 pt	3 pt	
		16. Omite 30 WP	1¼ lb	3¾ lb	
		21. Plictran 50 WP	6 oz	1⅛ lb	
		27. Trithion 4 EC	½ pt	1½ pt	

Second Cover

DISEASES					
Leaf Spot	Fungicides listed under petal fall, except Funginex				
Black Knot					

INSECTS					
Apple Maggot	**8e, 9e, 18e, 29g,**	8. Guthion 50 WP	½ lb	1½ lb	Call the local Pest Management code-a-phone or determine from the Extension agent when sprays for apple maggot should be applied.
Leafhopper	**27g**	2 EC	1 pt	3 pt	
		9. Imidan 50 WP	1 lb	3 lb	
		18. Penncap 2 FM	5 pt	5 pt	
		27. Trithion 4 E	½ pt	1½ pt	
		29. Zolone 3 EC	1 pt	3 pt	

Third and Fourth Cover

DISEASES	
Leaf Spot	Fungicides listed under petal fall, except Funginex.
INSECTS	
Apple Maggot	See Second Cover.

Pre-Harvest

DISEASES					
Brown Rot	**1e, 5g, 14f, 15e**	1. Benlate 50 WP, plus	4 oz	12 oz	Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.
Leaf Spot	**1e, 5f, 14f**	Captan 50 WP	1½ lb	4½ lb	
		5. Captan 50 WP	2 lb	6 lb	
		14. Wettable sulfur 95 WP	5 lb	15 lb	
		15. Rovral 50 WP	10 oz	2 lb	

TART CHERRY PRODUCTION INFORMATION

1985 Recommendations for Control of Tart Cherry Pests

The rates of materials per 100 gallons for use on cherry are based on a standard of 300 gallons per acre dilute spray for mature trees. If less than 300 gallons are applied per acre, refer to the rate-per-acre to insure the proper amount of chemical is applied.

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

Dormant

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Crown Gall	See page 70				
INSECTS/MITES					
Mineola Moth	**5g, 8e, 9e, 17g, 18e, 23g, 29e**	5. Diazinon 50 WP	1 lb	3 lb	
		8. Guthion 2 EC	1 pt	3 pt	
Eye-Spotted Bud Moth	**5g, 8e, 9e, 17g, 18e, 23g, 29e**	8. Guthion 50 WP	½ lb	1½ lb	
		9. Imidan 50 WP	1 lb	3 lb	
Mites	**24e, 24 + 27e, 27g**	17. Parathion 15 WP	1 lb	3 lb	
		18. Penncap 2 FM	2 pt	6 pt	
Scales	**18e, 24e, 24 + 27e, 27g**	23. Sevin 50 WP	2 lb	6 lb	
		24. Superior Oil	2 gal	6 gal	
		27. Trithion 4 EC	½-1 pt	1½-3 pt	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	

Green Tip

DISEASES

Bacterial Canker — See "Special Tart Cherry Disease Controls" page 82

Pre-Bloom (white bud stage)

DISEASES

Bacterial Canker — See "Special Tart Cherry Disease Controls" page 82

Brown Rot	**1e, 3e, 4f, 7g, 8f, 14f**	1. Funginex 18.2 EC	¾-1 pt	**1-1½ qt**
		3. Rovral 50 WP	½ lb	1½-2 lb
		4. Bravo 500 F	1½-2 pt	4½-8 pt
		7. Dichlone 50 WP	½ lb	1½ lb
		7. Quintar 5 F	6.4 fl oz	19.2 fl oz
		8. Difolatan 80% DG	¾-1¼ lb	2¼-3¾ lb
		14. Wettable sulfur 95 WP	5 lb	15 lb

Funginex, Rovral, and Bravo are for use from white bud to petal fall. Bravo may also be used at shuck split, Rovral may be used again starting 5 weeks before harvest.

Use Difolatan on mechanically harvested cherries only.

Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin M are not recommended for cherries.

INSECTS

Green Fruitworm (Apply at white bud stage)	**26f, 29f,** see note *	10. Kelthane 35 WP	1¼ lb	3¾ lb
		10. Kelthane 18.5 EC	1 qt	3 qt
		26. Thiodan 50 WP	1 lb	3 lb
		27. Trithion 4 EC	½-1 pt	1½-3 pt
		29. Zolone 3 EC	1 pt	3 pt
		25 WP	1½ lb	4½ lb
Plum Nursery Mite	**10g, 27g**			

*Control for Green Fruitworm should be applied at the popcorn stage and again at petal fall. The only effective materials at this time (pyrethroids) are not registered for use on tart cherries.

Bloom

DISEASES

Bacterial Canker — See "Special Tart Cherry Disease Controls" page 82

Brown Rot — Fungicides listed under pre-bloom.

Where pre-bloom spray is omitted, or if weather is unusually favorable for disease, begin bloom spray earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.

Petal Fall

DISEASES

Bacterial Canker — See "Special Tart Cherry Disease Controls" page 82

Brown Rot	**1e, 3e, 4f, 8f**	1. Funginex 18.2 EC	¾-1 pt	1-1½ qt
Leaf Spot	**1e, 8e, 4e, 11g**	3. Rovral 50 WP	½ lb	1½-2 lb
		4. Bravo 500 F	1½-2 pt	4½-8 pt
		8. Difolatan 80% DG	1¼ lb	3¾ lb
		11. Cyprex 65 WP	¼-½ lb	¾-1½ lb

Use high rate of Cyprex or Difolatan during wet seasons or when disease pressure is heavy.

Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin M are not recommended for cherries.

(continued on page 80)

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS					
Green Fruitworm	**26f, 29f**	8. Guthion 50 WP	½ lb	1½ lb	Peach Twig Borer is seldom a problem and there is currently no efficiency data available.
Leafrollers	**8e, 9e, 17g, 29e**	8. Guthion 2 EC	1 pt	3 pt	
Peach Twig Borer	No data	9. Imidan 50 WP	1 lb	3 lb	
Plum Curculio	**8e, 9e, 29g**	17. Parathion 8 F	⅓ pt	1 pt	
Rose Chafer	**23g**	17. Parathion 15 WP	1½ lb	4½ lb	
		23. Sevin 50 WP	2 lb	6 lb	
		23. Sevin 80 S	1¼ lb	4 lb	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	

First Cover

DISEASES					
Bacterial Canker	See "Special Tart Cherry Disease Controls" page 82				A spotting of tart cherry fruit may occur when liquid Guthion and Cyprex or Difolatan are applied at 65X concentration from aircraft, with high temperatures at application or soon thereafter.
Leaf Spot	**8e, 11g**	8. Difolatan 80% DG	¾-1¼ lb	2¼-3¾ lb	
Brown Rot	**8g**	11. Cyprex 65 WP	¼-½ lb	¾-1½ lb	
INSECTS					
American Plum Borer	No Chemical Controls				For Lesser Peach Tree Borer control apply sprays between June 3 to 10. Apply with a hydraulic gun as a coarse dilute spray concentrating on scaffold limbs, crotches and trunk.
Plum Curculio	See Petal Fall				
Lesser Peach Tree Borer	**26g, 32e**	26. Thiodan 3 EC	4-5 qts		
		32. Lorsban 4 E	3 qts		

Second Cover

DISEASES					
Leaf Spot	Fungicides listed under first cover.				
INSECTS					
Scale	**5g, 17g, 18e, 27e**	5. Diazinon 50 WP	1 lb	3 lb	Apply spray for scales when crawlers become active.
		17. Parathion 15 WP	1½ lb	4½ lb	*WARNING:* Penncap-M should not be applied if pollenators are working flowers (cover-crop) on the orchard floor (see page 26).
		17. Parathion 8 F	⅓ pt	1 pt	
		18. Penncap 2 FM	2 pt	6 pt	
		27. Trithion 4 F	½ pt	1½ pt	

Third Cover

DISEASES					
Brown Rot Leaf Spot	Fungicides listed under first cover.				
INSECTS					
Cherry Fruit Fly	**5g, 8e, 9e, 18e, 19e, 23g, 29e,**	5. Diazinon 50 WP	1 lb	3 lb	Call the local Pest Management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.
		8. Guthion 50 WP	½ lb	1½ lb	
Rose Chafer	See Petal Fall	8. Guthion 2 EC	1 pt	3 pt	
Scale	See Second Cover	9. Imidan 50 WP	1 lb	3 lb	
Bird Repellent	**19e**	18. Penncap 2 FM	**1-5 pt**	**4-5 pt**	
		19. Mesurol 75 WP	1⅓ lb	4 lb	
		23. Sevin 50 WP	2 lb	6 lb	*WARNING:* Penncap-M should not be applied if pollenators are working flowers (cover-crop) on the orchard floor (see page 26).
		23. Sevin 80 S	1¼ lb	4 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		29. Zolone 25 WP	1½ lb	4½ lb	

Cherry Fruit Fly Aerial Control

METHOD			
Flat Fan Nozzles	**4e**	4. Cythion ULV (95% technical)	12 oz
Beecomist Nozzles (40-micron)	**4e**		4-6 oz

Summer Mite Control

MITES				
European Red Mite	**10g, 27g**	10. Kelthane 35 WP	1¼ lb	3¾ lb
		10. Kelthane 18.5 EC	1 qt	3 qt
Two Spotted Mite	**10g, 27g**	27. Trithion 4 EC	1 pt	3 pt

Pre-Harvest

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.					Where leaf spot is well controlled, use wettable surfur at 5 lb./100 gal. or 15 lb./acre or captan at 2 lb./100 gal. or 6 lb./acre for additional brown rot control.
Leaf Spot	**8e, 11g**	3. Rovral 50 WP	½ lb	1½-2 lb	
Brown Rot	**3e, 8g, 11f**	8. Difolatan 80% DG	1¼ lb	3¾ lb	
		11. Dodine (Cyprex) 65 WP, plus	¼ lb	¾ lb	
		Wettable sulfur 95 WP	3 lb	9 lb	*WARNING:* Funginex has caused a ring-russet when applied in the pre-harvest period.
					Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin M are not recommended for cherries.
INSECTS					
Cherry Fruit Fly	See Third Cover				

Post-Harvest

DISEASES				
Leaf Spot	**8e, 11g**	8. Difolatan 80% DG	1-1¼ lb	3-3¾ lb
		11. Dodine (Cyprex) 65 WP	½ lb	1½ lb
INSECTS				
Peach Tree Borer	See page 80.			

SPECIAL TART CHERRY DISEASE CONTROLS

Bacterial Canker

Bacterial canker of tart cherries is caused by the bacterium *Pseudomanas syringae* pv. *morspunorum.* It is a sporadic problem and has been most serious in southwest Michigan. Additional information on this disease can be found in bulletin NCR-45, "Diseases of Tree Fruits."

To prevent blossom blight, leaf and fruit spot, use 1 lb. per 100 gallons of dilute spray or 3 lbs. per acre of Tennessee Brand Tri-Basic Copper Sulfate. Initiate sprays at bud burst stage and repeat applications at weekly intervals to late May. Later sprays may cause some leaf yellowing and defoliation. This treatment may be combined with Difolatan when leaf spot and brown rot control is needed.

SWEET CHERRY PRODUCTION INFORMATION

1985 Recommendations for Control of Sweet Cherry Pests

The rates of materials per 100 gallons for use on sweet cherries are based on a standard of 400 gallons per acre dilute spray for mature trees. If less than 400 gallons are applied per acre, refer to the rate-per-acre to insure the proper amount of chemical is applied.

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

Pre-Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Crown Gall	See page 70				
INSECTS					
Black Cherry Aphid	**5g, 18e, 26e, 27g, 29g**	5. Diazinon 50 WP	1 lb	4 lb	
		18. Penncap 2 FM	2 pt	6 pt	
		24. Superior Oil	2 gal	8 gal	
Mites	**24e, 27g**	26. Thiodan 50 WP	1 lb	4 lb	
Scales	**24e + 27e**	27. Trithion 4 EC	1 pt	4 pt	
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	

White Bud or Popcorn

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot (blossom blight)	**1e, 3e, 4f, 7g, 14f**	1. Funginex 18.2 EC	¾-1 pt	1-1½ qt	Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin M are not recommended for cherries.
		3. Rovral 50 WP	½ lb	2 lb	
		4. Bravo 500 F	1½-2 pt	4½-8 pt	
		7. Dichlone 50 WP	½ lb	2 lb	
		7. Quintar 5 F	6.4 fl oz	25.6 fl oz	**Apply control for Green Fruitworm at the popcorn stage and again at petal fall. The only effective materials at this time (pyrethroids) are not registered for use on sweet cherries.
		14. Wettable sulfur 95 WP	5 lb	20 lb	
INSECTS					
Green Fruitworm	**26f, 29f****	26. Thiodan 50 WP	1 lb	4 lb	
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	

Bloom

DISEASES					
Brown Rot (blossom blight)	See fungicides listed under pre-bloom.				Where popcorn spray is omitted, or if weather is unusually favorable for disease, begin bloom spray earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.

Petal Fall

DISEASES					
Brown Rot	**1e, 3e, 4f, 5f, 12f**	1. Funginex 18.2 EC	¾-1 pt	1-1½ qt	Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin M are not recommended for cherries.
Leaf Spot	**1e, 4e, 5f, 12f**	3. Rovral 50 WP	½ lb	2 lb	
		4. Bravo 500 F	1½-2 pt	4½-8 pt	
		5. Captan 50 WP	2 lb	8 lb	
		12. Ferbam 76 WP, plus	1 lb	4 lb	
		Wettable sulfur 95 WP	3 lb	12 lb	
INSECTS					*Penncap-M should not be used at petal fall or shuck split because of hazard to pollinating insects.
Black Cherry Aphid	See Pre-Bloom *	8. Guthion 50 WP	½ lb	2 lb	
Green Fruitworm	See Pre-Bloom	8. Guthion 2 EC	1 pt	4 pt	
Leafrollers	**8e, 17g, 29e**	17. Parathion 15 WP	1½ lb	6 lb	
Plum Curculio	**8e, 29g**	17. Parathion 8 F	⅓ pt	1⅓ pt	
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	

Shuck Split

DISEASES					
Brown Rot	Fungicides listed under petal fall, except Funginex				
Leaf Spot					
INSECTS					
Plum Curculio	See Petal Fall				
Black Cherry Aphid	See Pre-Bloom				

First Cover

DISEASES						
Brown Rot	**5f, 12f**	5.	Captan 50 WP	2 lb	8 lb	*Lorsban is phytotoxic to sweet cherry leaves. Apply Lorsban by hydraulic gun to the trunks and scaffolds to minimize contact with the leaves.
Leaf Spot	**5f, 12f**	12.	Ferbam 76 WP, plus	1 lb	4 lb	
			Wettable Sulfur 95 WP	3 lb	12 lb	
INSECTS						
American Plum Borer	No Chemical Controls					
Black Cherry Aphid	See Pre-Bloom					
Leafrollers	See Petal Fall					
Lesser Peach Tree Borer	**26g, 32e** *see note	26.	Thiodan 3 EC	4-5 qts		For Lesser Peach Tree Borer control apply sprays between June 3 to 10. Apply with a hydraulic gun as a coarse dilute spray concentrating on scaffold limbs, crotches and trunk.
Plum Curculio	See Petal Fall	32.	Lorsban 4 E	3 qts		
Rose Chafer	See Third Cover					

Summer Mite Control

MITES					
European Red Mite	**10g, 27g**	10.	Kelthane 4 F	1 pt	3 pt
Two Spotted Mite	**10g, 27g**	10.	Kelthane 35 WP	1¼ lb	5 lb
		10.	Kelthane 18.5 EC	1 qt	4 qt
		27.	Trithion 4 EC	1 pt	4 pt

Second Cover

DISEASES	
Brown Rot	Fungicides listed under first cover
Leaf Spot	
INSECTS	
Black Cherry Aphid	See Pre-Bloom
Leafrollers	See Petal Fall
Rose Chafer	See Third Cover

Third Cover

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	Fungicides listed under first cover.				
Leaf Spot					
INSECTS					
Cherry Fruit Fly	**5g, 8e, 18e, 23g, 29e, 19e**	5. Diazinon 50 WP	1 lb	4 lb	Call the local Pest Management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.
Rose Chafer	**23g**	8. Guthion 50 WP	½ lb	2 lb	
		8. Guthion 2 EC	1 pt	4 pt	
Bird Repellent	**19e**	18. Penncap 2 FM	2 pt	6 pt	
		19. Mesurol 75 WP	1⅓ lb	4 lb	*WARNING:* Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 26).
		23. Sevin 50 WP	2 lb	8 lb	
		23. Sevin 80 S	1¼ lb	4 lb	
		29. Zolone 3 EC	1 pt	4 pt	
		29. Zolone 25 WP	1½ lb	6 lb	6 pt. is the maximum legal rate of Penncap-M on sweet cherries.

Pre-Harvest

DISEASES					
Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.					Benlate and Topsin M not recommended for cherries because Benlate-resistant brown rot and leafspot are widespread in Michigan.
Brown Rot	**3e, 5g, 12f**	3. Rovral 50 WP	½ lb	2 lb	
Leaf Spot	**5f, 12f**	5. Captan 50 WP	2 lb	8 lb	
		12. Ferbam 76 WP, plus	1 lb	4 lb	
		Wettable sulfur 95 WP	3 lb	12 lb	*WARNING:* Funginex has caused a ring-russet when applied in the pre-harvest period.
INSECTS					
Cherry Fruit Fly	See Third Cover				

Post-Harvest

DISEASES					
Leaf Spot		Dodine (Cyprex) 65 WP	⅜-½ lb	1½-2 lb	
INSECTS					
Peach Tree Borers	See page 64				

Small Fruit

Grape Spray Schedule

D. C. Ramsdell, *Department of Botany and Plant Pathology* and A. J. Howitt, *Department of Entomology*

The rate of materials for use on grape is based on a standard of 200 gal./acre dilute spray. Vines trained to Geneva double curtain trellis should receive 300 gal./acre of dilute spray after vines are in full leaf. If you are concentrate spraying—(less than 200 gal. of water/acre), use the rate/acre columns, regardless of the amount of water you are spraying/acre.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
Dormant season (during pruning)	Eutypa dieback	Benlate 50 WP	1 lb	2 lb	*Eutypa armeniacae* ascospores infect pruning wounds during the winter when the temperature is above 32°F and rain occurs. Pruning wounds must be sprayed with thorough coverage after pruning but *before* a rain occurs to prevent new infections. All vines that have been pruned should be sprayed.
		Captan 50 WP	2 lb	4 lb	
		OR			
Bud Swell (*Shoots 1 to 3 in. long*)	Phomopsis leaf and cane spot disease	Folpet (Phaltan) 50 WP	2 lb	4 lb	
		OR			
		Dithane FZ	1 qt	2 qt	
		OR			
		Mancozeb (Dithane M-45 or Manzate 200)	¾ lb	1½ lb	
	*Grape flea beetle — no effective pesticides registered				Where Phomopsis leaf and cane spot disease is a problem, repeat this spray when shoots are 4 to 6 in. long. This second spray will suffice as the first black rot spray.
	*Climbing cutworms — Lorsban 4 E		1 pt	1 qt	

*Lorsban will not control Grape Flea Beetles.

*Check with your county agent for late registration of Pydrin for flea beetle.

Eutypa Dieback Disease vs. Phomopsis Leaf and Cane Spot Disease

Eutypa Dieback, formerly called "dead arm" is caused by the fungus *Eutypa armeniacae*. The symptoms consist of dying arms and yellowed, cupped leaves on new growth in the spring. As canes and leaves grow out, the symptoms tend to be masked. This disease is a deep-seated systemic fungus disease of the woody part of the trunk and arms. Infected vines have a blackish, corky fungal "stroma" on the surface of the trunk near large, old pruning wounds. In this stroma are ascospores of the causal fungus. Whenever it rains, these ascospores are "shot off" into the air. The main period of spore dispersal is from October through May. These spores infect pruning wounds throughout the pruning season. Unfortunately, a change in pruning time is not feasible as a control strategy. Vines can be sprayed immediately after pruning with Benlate as a possible means of control. Removal and burning of infected vines is necessary to reduce inoculum in the vineyard.

Phomopsis Leaf and Cane Spot Disease

This disease is caused by *Phomopsis viticola*. The symptoms consist of small, angular, necrotic lesions on the expanding leaves in the spring and later elongated, brownish/purple lesions on canes, tendrils, petioles and cluster stems.

Continued

It can also cause a fruit rot late in the season. This disease is probably responsible for the fruit falling off the clusters ahead of the mechanical harvester in some years. This disease is controlled by spraying at the 1- to 3-inch shoot stage and again when shoots are 4 to 6 inches long. Captan, Folpet, Dithane or Mancozeb are the best materials to use. If this disease has been severe in a given vineyard, later cover sprays should contain these materials (be careful of cut-off date between date of last spray and harvest) to ensure control of the fruit rot phase of this disease.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
FIRST COVER *(Pre-bloom shoots 4 to 6 in. long)*	Black rot	Ferbam 76 WP OR Benlate* 50 WP	1½ lb ½ lb	3 lb 1 lb	Ferbam slightly controls downy mildew. Benlate gives no control of downy mildew.
	Black rot + downy mildew	Folpet 50 WP OR **Dithane FZ** OR Mancozeb	2 lb **1½ qt** 1 lb	4 lb **3 qt** 2 lb	Folpet applied here will give further control of phomopsis leaf and cane spot disease. Captan is excellent against this disease and downy mildew, but weak against black rot.
SECOND COVER *(Blossom opening)*	Black rot OR Black Rot & Powdery Mildew	Ferbam 76 WP OR Benlate 50 WP OR Bayleton 50 WP	1½ lb ½ lb 1½-3 oz	3 lb 1 lb 3-6 oz	Dinocap (Karathane WD) should be added to Dithane FZ or Mancozeb only for powdery mildew control. While Benlate is fair to good and Bayleton is excellent for control of black rot and powdery mildew, neither control downy mildew. To insure control of downy mildew, add Dithane FZ, Mancozeb, Phaltan, or captan as a tank mix at the recommended rates. NOTE: If black rot disease pressure is heavy, increase Bayleton rate to 6 oz./acre. If fixed copper is used with organic phosphates, spray immediately as these materials may lose some insecticidal effectiveness when combined with lime or in alkaline solutions. NOTE: It is important to apply controls for downy mildew beginning with first bloom! Cover sprays for downy mildew should be continued through the growing season. During the 1980 and 1982 seasons, downy mildew was very serious. A strong effort directed toward better control is necessary.
	Black rot, downy and powdery mildew	Folpet 50 WP OR **Dithane FZ** plus Dinocap 25 WP (Karathane WD) OR Mancozeb plus Dinocap 25 WP (Karathane WD) OR Fixed copper (actual) plus Hydrated lime	2 lb **2 qt** **¾ lb** 2 lb **¾ lb** 1½ lb 6 lb	4 lb **4 qt** **1½ lb** 4 lb **1½ lb** 3 lb 12 lb	

Do not use Benlate alone repeatedly throughout the season. Either use it in combination with another fungicide as a tank mix or use it alternately with other chemicals. Repeated use of Benlate alone will hasten tolerance of fungi to Benlate.

	Grape berry moth, **5g, 8e, 9e, 17g, 18e, 23e, 29e** Rose chafer, **18e** Grape phyloxera **26e, 29e**	5. Diazinon 50 WP	1 lb	2 lb	The grape berry moth overwinters as a pupa. Adults start emerging the first or second week of June. There are 3 generations/year. Pheromone traps are available to detect the presence and seasonal activity of these moths.
		8. Guthion 50 WP	½ lb	1 lb	
		8. Guthion 2 EC	1 pt	2 pt	
		9. Imidan 50 WP	1 lb	2 lb	
		17. Parathion 15 WP	2 lb	4 lb	
		17. Parathion 8 F	⅓ pt	⅔ pt	
		18. Penncap 2 FM	4 pt	8 pt	
		23. Sevin 50 WP	2 lb	4 lb	
		23. Sevin 80 S	1¼ lb	2½ lb	
		26. Thiodan 2 F	2 pt	4 pt	
		26. Thiodan 50 WP	1 lb	2 lb	
		29. Zolone 25 WP	4 lb	8 lb	
		29. Zolone 25 WP	2 pt	4 pt	
THIRD COVER *(Immediately after bloom, 90% of blossoms open)*	Black rot, downy and powdery mildew	See Second Cover			At this point and in later sprays, wettable sulfur can be used on sulfur tolerant grapes (see list) at rate of 2 lb/100 gal water or 4 lb/acre. Sulfur is compatible with the above recommended fungicides. Do not apply sulfur when temperatures are expected to be 85° F. or above soon after application.
	Grape berry moth (See Second Cover) Grape leaf hopper, **5g, 8f, 9f, 18e, 23e, 29e** Rose chafer, **18e, 23g**	5. Diazinon 50 WP	1 lb	2 lb	Timing for second brood berry moth is announced by your county ag. agent. Control mites as populations increase.
		8. Guthion 50 WP	½ lb	1 lb	
		8. Guthion 2 EC	1 pt	2 pt	
		9. Imidan 50 WP	1 lb	2 lb	
		18. Penncap-M 2 F	4 pt	8 pt	
		23. Sevin 50 WP	2 lb	4 lb	
		23. Sevin 80 S	1¼ lb	2½ lb	
		29. Zolone 25 WP	4 lb	8 lb	
		29. Zolone 3 EC	2 pt	4 pt	
FOURTH COVER *(10 to 14 days after* THIRD COVER)	Black rot, downy and powdery mildew	See Second Cover			Guthion is restricted to three applications per year. NOTE: Time interval between last spray and harvest for Mancozeb is 66 days, but for Dithane FZ it is 7 days.
	Grape berry moth	See Second Cover			
	Grape phyloxera	See Second Cover			
	Grape leaf hopper	See Third Cover			
	Rose chafer	See Third Cover			

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
FIFTH COVER *(Time to be announced)*	Black rot, downy and powdery mildew	See Second Cover			
	Grape berry moth	See Second Cover			
	Grape leaf hopper	See Third Cover			
	Mites, **10e**	10. Kelthane 35 WP	1.5 lb	3 lb	
		10. Kelthane 18.5 EC	1 qt	2 qt	
SIXTH COVER *(10 to 14 days after* FIFTH COVER)	Grape berry moth	See Second Cover			
	Mites, **10e**	10. Kelthane 35 WP	1-5 lb	3 lb	
		10. Kelthane 18.5 EC	1 qt	2 qt	
SEVENTH COVER *(About August 7)*	Powdery mildew	Bayleton 50 WP	1½-3 oz	3-6 oz	Bayleton gives superior control of powdery mildew on French hybrid grapes.
		Benlate 50 WP	½ lb	1 lb	
		OR			
		Folpet 50 WP	2 lb	4 lb	
		Wettable sulfur	2 lb	4 lb	Refer to sulfur tolerance list for grapes. Sulfur can cause severe injury to certain grape varieties.
		OR			
		Dinocap (Karathane WP)	¾ lb	1½ lb	
	Grape berry moth	See Second Cover			Required only if third brood grape berry moth is present.
EIGHTH COVER *(About August 20)*	Grape berry moth	See Second Cover			Required only if third brood grape berry moth is present.

Disease susceptibility[1] and sulfur sensitivity[2] of American, French Hybrid, and Vinifera (European) grape varieties.

Variety	Rot Black	Downy Mildew	Powdery Mildew	Botrytis	Sulfur Sensitive? *(e.g. does sulfur cause injury?)*
Aurora (S5279)	+	+	+++	+++	No
Baco Noir (Baco #1)	?	?	++	?	No
Cascade (S13053)	+	+	++	?	No
Catawba	+++	+++	++	?	No
Chancellor (S7053)	?	+++	+++	?	?
Chardonnay (Pinot Chardonnay)	+++	+++	+	?	No
Chelois (S10878)	?	+	+++	+	No
Concord	+++	+	++	?	Yes
DeChaunac (S9549)	?	++	++	?	No
Delaware	+	+++[3]	++	?	No
Dutchess	+++	++	++	+	?
Elvira	+	++	++	+	No
Foch (Marechal Foch)	?	+	++	?	Yes
Niagara	+++	+++	++	?	No
Rosette (S1000)	?	+	+++	?	No
Rougeon (S5898)	?	++	+++	+	Yes
Seyval (SV5-276)	++	++	+++	+	No
Verdelet (S9110)	?	?	?	?	No
Vignoles (Ravat 51)	?	+	+	+	No

[1]*Question mark (?) means relative susceptibility not established; + = slightly susceptible, ++ = moderately susceptible, +++ = very susceptible.*
[2]*Sulfur injury can occur on tolerant varieties when temperatures of 85° F. or higher occur during or immediately after spray application.*
[3]*Berries are not susceptible.*

Strawberry Spraying Schedule

The rates of materials for use on strawberry are based on a standard of 200 gal./acre dilute spray. If you are concentrate spraying (less than 200 gal. of water/acre), use the rate/acre column, regardless of the amount of water you are spraying/acre.

Pre-Plant Treatment for White Grubs, Root Weevils, and Strawberry Aphids

The label restricts Lindane to 2 lbs. per acre. It requires 5 lbs. active ingredient of Lindane per acre to control white grubs and root weevils. This amount can be legally used if application is restricted to 4 ft. strips, then rotovated into the soil after which the strawberries are planted down the center of this strip.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
FIRST COVER *(New leaves expanded and blossom buds visible)*	Stem end rot, leaf blight, leaf spot	Benlate* 50 WP **Plus**	½ lb	1 lb	*Repeated use of Benlate will result in the rapid build-up of tolerance in fungi. Use Benlate with Captan together as a tank mix.
		Captan 50 WP	2½ to 3 lb	5 to 6 lb	
	Spittlebug, **8g, 23e, 26e**	8. Guthion 50 WP	½ lb	1 lb	
		10. Kelthane 35 WP	1¼ lb	2½ lb	
	Mites, **10g,**	18.5 EC	1 qt	2 qt	Apply as two-spotted mites begin to increase.
	Strawberry** clipper, **34e**	23. Sevin 50 WP	2 lb	4 lb	**Strawberry clipper: Apply first spray when first buds become visible followed by a second spray 10 days later.
		80 S	1¼ lb	2½ lb	
		26. Thiodan 50 WP	1 lb	2 lb	
		2 EC	1 qt	2 qt	
		34. Lorsban 4 E	1 pt	1 qt	
	Slugs, **36g**	36. Metaldehyde baits			
	White grubs, **38e**	38. Lindane 25 WP		2 lb	
	Root Weevils, **38e**				
		Various formulations of Metaldehyde and Metaldehyde-Sevin baits have a label for slugs on strawberries. However, these products are usually packaged for the homeowner and are not available for commercial use.			
SECOND COVER *(Pre-bloom—just as flowers start to open)*	Gray mold, stem and fruit rot, leaf blight, leaf spot	Benlate 50 WP or	½ lb	1 lb	Do not use Ronilan, Benlate or Topsin M without captan. Ronilan's activity is rather narrow and is primarily for control of Botrytis gray mold.
		Topsin M 70 WP or	⅜ lb	¾ lb	
		Ronilan 50 W, plus	¾ lb	1½ lb	
		Captan 50 WP	2½ to 3 lb	5 to 6 lb	
	Tarnished plant bug, **26e**	8. Guthion 50 WP	½ lb	1 lb	Tarnished plant bug control is critical at this time. Best results are achieved with a specific Thiodan application at or before 10% King Bloom.
		2 EC	1 pt	2 pt	
	Spittlebug, (See First Cover)	23. Sevin 50 WP	2 lb	4 lb	
		80 S	1¼ lb	2½ lb	
	Strawberry leaf-roller, **8e, 23e**	26. Thiodan 50 WP	1 lb	2 lb	
		3 EC	1 qt	2 qt	
	Strawberry clipper	See First Cover			

THIRD COVER *(50% bloom and green fruit)*	Gray mold, stem end fruit rot, leaf blight, leaf spot	Benlate 50 WP or Topsin M 70 WP or Ronilan 50 W, plus Captan 50 WP OR Captan 50 WP	¼ lb ⅜ lb ¾ lb 2 lb 2½ to 3 lb	½ lb ¾ lb 1½ lb 4 lb 5 to 6 lb	As per label, after fruit formation, the maximum allowable rate of Benlate is ½ lb 50 WP/acre. Therefore, combine with captan as a tank mix. The addition of captan will aid in the control of leather rot (Phytophthora cactorum).
	No insecticides should be used during bloom.				
FOURTH COVER *(Berries half grown, or 7 to* 10 days after THIRD COVER)	Gray mold, stem end fruit rot, leaf blight, leaf spot	See Third Cover			A repeat application of Thiodan may be necessary when the tarnished plant bug continues as a problem. Do not re-apply Thiodan within 15 days of a previous application or more than twice within a 35-day interval once fruit is present. Use no closer than 4 days to harvest.
	Tarnished plant bugs	See Second Cover			
PRE-HARVEST *(At least 10 days before harvest)*	Gray mold, stem end fruit rot, leaf blight, leaf spot Strawberry sap beetle, **5g, 8g**	Benlate 50 WP or Topsin M 70 WP or Ronilan 50 W, plus Captan 50 WP OR Captan dust (7.5 captan) 5. Diazinon 50 WP 4 EC 8. Guthion 50 WP 2 EC	¼ lb ⅜ lb ¾ lb 2 lb 1 lb 1 pt ½ lb 1 pt	½ lb ¾ lb 1½ lb 4 lb 4 lb 2 lb 1 qt 1 lb 1 qt	Use dust only as a relatively poor alternate choice. Apply Guthion or Diazinon through the overhead irrigation system at the end of the sprinkling period. Introduce material over a time interval of at least 15 minutes. Begin applications when beetles first become numerous or when injury first appears. Repeat as necessary, but not within 5 days of harvest.
DURING HARVEST	Gray mold, stem end fruit rot, leaf diseases	See recommendations and comments for Pre-harvest 10. Kelthane 35 WP 18.5 EC	 1¼ lb 2 pt	 2½ lb 4 pt	Under certain circumstances cyclamen mites may become established in a planting. Usually the infestation is limited to small areas in the field. These can be *spot treated* with one of the suggested chemicals. Both materials should be applied so the plants are thoroughly drenched. The addition of a wetting agent will improve control. NOTE: be aware of days between final sprays and harvest (Kelthane 2 days and Thiodan 4 days).
	Cyclamen mites, **10g, 26g**	26. Thiodan 2 EC 50 WP	1 qt 1 lb	2 qt 2 lb	

POST HARVEST AND NEW PLANTINGS	Leaf spot	Benlate 50 WP	½ lb	1 lb	This treatment is especially for new plantings, starting 10 days to 2 weeks after harvest and repeated 2 weeks later. These treatments will keep new plants relatively disease free and will allow maximum growth to occur in the fall.
		OR			
		Captan 50 WP	2 lb	4 lb	
	Strawberry leaf-roller, **5g, 8e, 17g, 23e**	5. Diazinon 15 WP	1 lb	2 lb	
		4 EC	1 pt	2 pt	
		8. Guthion 50 WP	½ lb	1 lb	
	Leafhoppers, **5g, 25e**	8. Guthion 2 EC	1 pt	2 pt	See label for restriction of Thiodan use.
		17. Parathion 15 WP	2 lb	4 lb	
	Strawberry aphids, **25e, 26e**	8 F	⅔ pt	⅔ lb	Slugs: (see note page 92).
		23. Sevin 50 WP	2 lb	4 lb	
	Slugs, **38g**	80 S	1¼ lb	2½ lb	Fall application of metaldehyde bait can ease slug problems the following spring. Bait should be applied during a period of clear and dry weather for best results.
		25. Systox 6 EC	⅓ pt	⅔ pt	
		26. Thiodan 2 EC	1 qt	2 qt	
		38. Metaldehyde bait			

Bramble Spraying Schedule

(Red Raspberries, Black Raspberries, Dewberries, and Blackberries)

The rates of materials for use on brambles are based on a standard of 200 gal./acre dilute spray

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
DELAYED DORMANT *(When new leaves are exposed ¼ to ¾ in.)*	Anthracnose	Lime sulfur solution	10 gal	20 gal	CAUTION: If unable to apply the first mentioned eradicative spray for anthracnose, a lime-sulfur spray at 5 gal/100 gal of water when a few leaves have unfolded from buds will give effective control. There is greater risk of lime-sulfur burn, however, by spraying at this later time.
(When a few leaves have unfolded)		Lime sulfur solution	5 gal	10 gal	
PRE-BLOSSOM *(When blossom buds are breaking or new canes are 6 to 8 in. long)*	Anthracnose	Captan 50 WP	2 lb	4 lb	If Guthion is used with Bordeaux, spray tank mix immediately as Guthion's insecticide effectiveness is lessened if left standing.
		OR			
	Spur blight	Ferbam 76 WP	1½ lb	3 lb	
		Bordeaux:			
		Powdered bluestone	3 lb	6 lb	
		plus			
		Hydrated lime	3 lb	6 lb	
	Leafrollers, **5g, 8e**	5. Diazinon 50 WP	1 lb	2 lb	
	Raspberry sawfly, **8e, 13g**	5. Diazinon 4 EC	1 pt	2 pt	
		8. Guthion 50 WP	½ lb	1 lb	
		8. Guthion 2 EC	1 pt	2 pt	
		13. Malathion 50 WP	2 lb	4 lb	

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
	Raspberry fruit worm, **8e, 13g**	8. Guthion 50 WP	1 lb	2 lb	Cane borer: To control, remove and burn all infested canes.
		8. Guthion 2 EC	2 pt	4 pt	
	Cane borers	13. Malathion 50 WP	2 lb	4 lb	
EARLY BLOOM *(5 to 10% blossoms open)*	Anthracnose	Captan 50 WP OR	2 lb	4 lb	Benlate will give excellent control of spur blight and anthracnose diseases as well as control of fruit rots although Benlate is not labeled for control of spur blight and anthracnose per se.
		Ferbam 76 WP	1½ lb	3 lb	
	Botrytis rot (grey mold), penicillium rot, powdery mildew	Benlate 50 WP	⅜ lb	¾ lb	
FULL BLOOM	Botrytis rot, penicillium rot, powdery mildew	Benlate 50 WP	⅜ lb	¾ lb	
POST BLOOM	Botrytis rot, penicillium rot, powdery mildew	Benlate 50 WP	⅜ lb	¾ lb	Up to 3 post bloom sprays of Benlate on a 14-day schedule are allowed up to within 3 days of harvest. Fruit rot incidence is worst when fruit is ripening and when rainy, wet conditions prevail.
FIRST COVER *(At petal fall)*	Leafrollers	See Pre-blossom			
	Cane borers	See Pre-blossom			
	Aphids	See Pre-harvest			
PRE-HARVEST *(15 days before harvest)*	Aphids, **5g, 17f**	5. Diazinon 50 WP	1 lb	2 lb	Apply Parathion when mite populations begin increasing.
	Mites, **10g**	5. Diazinon 4 EC	1 pt	2 pt	
		10. Kelthane 35 WP	1¼ lb	2½ lb	
		10. Kelthane 18.5 EC	2 pt	4 pt	
		17. Parathion 15 WP	2 lb	4 lb	
		17. Parathion 8 F	⅓ lb	⅔ pt	
POST HARVEST	Aphids, **5g, 25e**	5. Diazinon 50 WP	1 lb	2 lb	Where raspberry crown borers are a major problem, apply a drenching crown spray using Diazinon. Use 400 to 500 gal. of spray/acre. Apply the spray any time from mid-October to mid-November or as a drench to the crown area in early April to kill the overwintering stage.
	Raspberry crown borer, **5e**	5. Diazinon 4 EC	1 pt	2 pt	
		25. Systox 6 EC	¼ pt	½ pt	

Control of Virus Diseases in Raspberries

There are at least five severe virus diseases in Michigan. Two of these diseases are Raspberry Mosaic and Raspberry Leaf Curl. Both are vectored (spread) by Raspberry aphids, which live on diseased wild raspberries and on diseased cultivated raspberries. A third virus disease is tomato ringspot virus, which is soil-borne and vectored by the dagger nematode, *Xiphinema americanum*. Two other viruses causing disease in Michigan raspberries are raspberry bushy dwarf virus and tobacco streak virus. All of these virus diseases are devastating to raspberry production. *Follow these principles to grow raspberries which will stay free from virus diseases for as long as possible:*

1. Prior to planting, sample the planting site thoroughly for nematodes at 6 to 8 in. and 18 in. depths. Send the sample to the MSU Nematode Laboratory (See Extension Bulletin E-800, "Nematode Detection"). If there are dagger nematodes *(Xiphinema americanum)* or root lesion nematodes (*Pratylenchus* spp.), you should fumigate the soil thoroughly the fall before spring planting (see section on soil fumigation for nematode control).

2. Buy registered virus-free or virus tested raspberry stock that are part of the Michigan Department of Agriculture virus-tested certification program. Do not plant stock grown by your neighbor or from any nursery source that does not grow them as part of a regulated virus-tested program. The quickest way to lose money growing raspberries is to plant virus-diseased stock.

3. Try to plant the field such that it is located 500 to 1200 ft. away from existing wild raspberries or existing old cultivated raspberries. If this cannot be done, attempt to eradicate wild raspberries for a radius of 500 to 1200 ft. with herbicides.

4. Spray the new planting with systemic aphicides regularly throughout the first and succeeding growing seasons. This should be done from first growth in the spring through leaf drop in the fall on a regular basis.

Currants and Gooseberry Spraying Schedule

The rate of materials for use on currant and gooseberry are based on a standard of 200 gal./acre dilute spray. If less than 200 gal. water is applied/acre, refer to the rate/acre column to insure that the proper amount of pesticide is applied.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
DORMANT GREEN TIP *(Gooseberries only)*	Currant aphid Powdery mildew	Elgetol (318) Lime sulfur solution	1 qt 5 gal	2 qt 10 gal	Thorough coverage is essential.
FIRST COVER *(Gooseberries only as soon as fruit has set)*	Powdery mildew Imported currant worm, **13g, 17g** Currant aphid, **13g**	Lime sulfur solution 13. Malathion 25 WP 17. Parathion 15 WP 8 F	5 gal 2 lb 1½ lb ⅓ pt	10 gal 4 lb 3 lb ⅔ pt	Thorough coverage is essential.
SECOND COVER *(Gooseberries and currants, 2 to 3 weeks after bloom)*	Leaf spot Imported currant worm, aphids	Ferbam 76 WP See First Cover	2 lb	4 lb	The timing of the spray for leaf spot varies with the individual planting. However, for best disease control, spray when leaf spot is first noticed. Generally it is observed first on the lower leaves of the bushes. If leaf spot is present at harvest time, spray immediately after harvest with the fungicide suggested for second cover.

Blueberry Spraying Schedule

Disease Control

THE BLUEBERRY SCHEDULE IS REVISED FOR AIRPLANE APPLICATION OF CHEMICALS

Rates of materials for blueberry are based on standard amounts/acre used in air applications. NOTE: Do not apply any fungicides ***(except Funginex)*** listed by airplane. Thorough coverage by ground sprayers is essential with the recommended fungicides. See Extension Bulletin E-840 for calibration of sprayers.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
GREEN TIP STAGE *(When the new leaf buds are showing 1/16 green tip)*	Fusicoccum canker	Difolatan 80% "Sprills"	1¼ lb	2½ lb	A new label registration for Difolatan on blueberries allows for chemical control of Fusicoccum canker. Although Phomopsis canker is not on the label, Difolatan will give some control. Conidiospores of both fungi are spread from cankers on stems with each rain beginning at bud break and continuing into the fall.
		Difolatan 4F	1 qt	2 qt	
	Mummyberry (Shoot blight phase)	Funginex 20 EC*	12 fl oz	24 fl oz	
		*Apply in 20 gallons water/acre by ground sprayer or in 5 gallons water/acre by airplane. **Do Not** apply Difolatan by airplane. Coverage is too poor to get good results.			
7-10 days later (when new buds and leaves showing 1/4"-1/2" green)	Mummyberry (shoot blight phase)	Funginex 20 EC		24 fl oz	NOTE: "Sprills" are an 80% water disposable granule formulation of Difolatan.
PINK BUD STAGE *(When blossom buds are full pink but just before first bloom)*	Mummyberry (blossom infection stage), Fusicoccum canker, Anthracnose and Alternaria fruit rots	Benlate 50W plus	½ lb	1 lb	Phomopsis canker will be partially controlled by Difolatan.
		Difolatan 80% "Sprills" OR	1½ lb	2½ lb	
		Difolatan 4F* OR	1 qt	2 qt	
		Funginex 20 EC plus	12 fl oz	24 fl oz	Funginex controls mummyberry only. Difolatan or Captan needed for control of the other diseases listed.
		Difolatan 4F* (or "Sprills")	1 qt	2 qt	
25% BLOOM	Mummyberry (blossom infection stage), Fusicoccum canker, Anthracnose and Alternaria fruit rots	Benlate 50W plus	½ lb	1 lb	Phomopsis canker will be partially controlled by Difolatan.
		Difolatan 80% "Sprills" OR	1½ lb	2½ lb	
		Difolatan 4F* OR	1 qt	2 qt	
		Funginex 20 EC		24 fl oz	Funginex controls mummyberry only.

*Substitute Captan 50W at 5 lb/acre for Difolatan if allergic to Difolatan.

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
FULL BLOOM OR EARLY PETAL FALL	Mummyberry (blossom infection stage), Fusicoccum canker, Anthracnose and Alternaria fruit rots	Benlate 50W plus	½ lb	1 lb	Phomopsis canker will be partially controlled by Difolatan.
		Difolatan 80% "Sprills" OR	1¼ lb	2½ lb	
		Difolatan 4F* OR	1 qt	2 qt	Funginex controls mummyberry only.
		Funginex 20 EC	12 fl oz	24 fl oz	
	*Substitute Captan 50W at 5 lb/acre for Difolatan if allergic to Difolatan.				
FIRST COVER *(Completion of petal fall. About June 1-5).*	Fusicoccum canker, Anthracnose and Alternaria fruit rots	Difolatan 80% "Sprills" OR	1¼ lb	2½ lb	Phomopsis canker will be partially controlled. NOTE: ULV Malathion + Difolatan can burn blueberry fruit and leaves when applied as a tank mix.
		Difolatan 4F*	1 qt	2 qt	
	*Substitute Captan 50W at 5 lb/acre for Difolatan if allergic to Difolatan.				
SECOND COVER *(10-14 days after First Cover)*	Fusicoccum canker, Anthracnose and Alternaria fruit rots	Difolatan 80% "Sprills" OR	1¼ lb	2½ lb	Phomopsis will be partially controlled.
		Difolatan 4F OR	1 qt	2 qt	
		Captan 50W	2½ lb	5 lb	
THIRD COVER *(10-14 days after Second Cover)*	Fusicoccum canker, Anthracnose and Alternaria fruit rots	Difolatan 80% "Sprills" OR	1¼ lb	2½ lb	Interval between last application and harvest for Difolatan is 21 days. Phomopsis canker will be partially controlled.
		Difolatan 4F OR	1 qt	2 qt	
		Captan 50W	2½ lb	5 lb	
FOURTH COVER *(Time to be announced by Dist. Hort. Agent)*	Fusicoccum canker	Difolatan 80% "Sprills" OR	1¼ lb	2½ lb	If canker is a serious problem, make fungicide application about 4 to 6 weeks after Third Cover. If this application occurs within 21 days of harvest, use Captan instead of Difolatan.
		Difolatan 4F OR	1 qt	2 qt	
		Captan 50W	2½ lb	5 lb	
PRE-HARVEST COVER *(During Blueberry Maggot Fly emergence)*	Fusicoccum canker	Captan 50W	2½ lb	5 lb	If canker is a serious problem, and it has been 4 to 6 weeks since the last canker spray, apply a spray at this time.
AFTER HARVEST COVER	Fusicoccum canker	Difolatan 80% "Sprills"	1¼ lb	2½ lb	If canker is a serious problem, apply the spray if it has been 4 ot 6 weeks since the previous canker spray. Continue spray application on a 4 to 6 week interval through leaf drop in the fall.
		Difolatan 4F	1 qt	2 qt	

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
	GROUND OR AERIAL APPLICATION (Use Rate/acre values if spraying by air.)				
FIRST COVER *(Early petal fall 7 to 10 days after bloom)*	Plum curculio, **5g, 8e, 23g** Blueberry tip borer, **8e, 13g, 17e, 23e**	5. Diazinon 50 WP 8. Guthion 2 SC 9. Imidan 50 WP 13. Malathion 25 WP 17. Parathion 15 WP 23. Sevin 80 S	1 lb ½ qt 1 lb 4 lb 2 lb 1¼ lb	2 lb 1 qt 2 lb 8 lb 4 lb 2½ lb	Use Sevin whenever lakes, ponds or streams are nearby. NOTE: ULV malathion + Difolatan can burn blueberry fruit and leaves when applied as a tank mix.
SECOND COVER *(10 days after first)*	Plum curculio, (See First Cover); Cranberry fruitworm, **5g, 8e, 13g, 23g;** Blueberry tip borer, (See First Cover); White tussock moth, **23e;** Leafrollers, **5g, 8e, 13g, 23g;** Aphids, **4g, 13g, 11**	4. Cythion ULV 95 Tech 5. Diazinon 50 WP 8. Guthion 2 SC 11. Methomyl 1.8 EC Methomyl 90 SP 13. Malathion 25 WP 23. Sevin 80 S	— 1 lb ½ qt 1 pt ¼ lb 4 lb 1¼ lb	10 oz 2 lb 1 qt 2 pt ½ lb 8 lb 2½ lb	For control of aphid vectors of blueberry shoestring virus: Malathion should be applied with a ground sprayer (air blast or boom type).
THIRD COVER *(10 days after second)*	Cranberry fruitworm	See Second Cover			
FOURTH COVER *(Time to be announced by Dist. Hort. Agent)*	Blueberry maggot, **4e, 5e, 8e, 13g, 17g, 19e** Blueberry borer, **17g** Bird repellent, **19e**	4. Cythion ULV 95 Tech 5. Diazinon 50 WP 8. Guthion 2 SC 9. Imidan 50 WP 13. Malathion 25 WP 17. Parathion 15 WP 17. Parathion 8 F 19. Mesurol 75 WP	— 1 lb ½ qt 1 lb 4 lb 1½ lb ⅓ pt 2 lb	10 oz 2 lb 1 qt 2 lb 8 lb 3 lb ⅔ pt 4 lb	The blueberry maggot fly emergence can be monitored with attractant traps. When first flies are caught the Dist. Hort. Agent will alert growers—this usually occurs about July 1. If Mesurol is used at this rate, it is a very effective bird repellent.
PRE-HARVEST COVER *(During Blueberry Maggot Fly emergence)*	Blueberry maggot	See Fourth Cover			Additional applications should be continued on a 10 to 14 day interval after Fourth Cover and until harvest. Extending the intervals between applications or using less than the recommended rate/acre may not give control of the blueberry maggot.
AFTER HARVEST COVER	White tussock moth	See Second Cover			

Compatibility Chart

(Primarily for apples; may be incomplete for other crops.)

1 Materials compatible

2 Decomposes on standing; residual action reduced

Q Questionable, compatibility not clear

■ Not compatible

Except when using ferbam, streptomycin is most favorably applied as a separate application, although it is compatible with ferbam or captan when necessary for scab control. Urea formulated for foliar application is compatible with the commonly used pesticides. However, it doesn't seem to be compatible with fixed copper or Bordeaux.

	Benomyl, Topsin M	Bordeaux	Captan	Carzol	Chloropropylate	Fixed Copper	Diazinon	Dichlone (Phygon)	Dikar	Dimethoate	Dinocap (Karathane)	Dodine (Cyprex)	Ferbam, Thiram, Maneb, Polyram	Guthion	Imidan	Kelthane	Lannate	Lime	Malathion, Trithion	Methoxychlor	Morestan	Niacide M	Omite	Parathion, Ethion	Perthane	Phosphamidon	Plictran	Sevin	Elemental Sulfur	Lime Sulfur	Superior oil	Systox	Thiodan	Vendex	Ziram, Zineb	Zolone	Penncap-M	Ambush, Payoff, Pounce	Pydrin
Benomyl, Topsin M																																							
Bordeaux	■																																						
Captan	1	■																																					
Carzol	1	■	1																																				
Chloropropylate	1	Q	1	Q																																			
Fixed Copper	■	1	■	Q	■																																		
Diazinon	1	Q	1	Q	1	Q																																	
Dichlone (Phygon)	1	Q	1	1	■	Q	1																																
Dikar	1	Q	1	Q	1	2	1	1																															
Dimethoate	1	1	1	Q	1	1	1	1	1																														
Dinocap (Karathane)	1	Q	1	1	1	Q	1	1	1	1																													
Dodine (Cyprex)	1	■	1	1	■	■	1	1	1	1	1																												
Ferbam, Thiram, Maneb, Polyram	1	■	1	Q	1	■	1	1	1	1	1	1																											
Guthion	1	Q	1	1	1	Q	1	1	1	1	1	1	1																										
Imidan	1	Q	1	1	Q	Q	Q	1	1	1	1	1	1	1																									
Kelthane	1	■	1	Q	1	■	1	1	1	1	1	1	1	1	1																								
Lannate	1	■	1	Q	Q	1	1	Q	1	1	1	1	1	1	1	1																							
Lime	■	1	■	■	Q	1	2	Q	Q	1	Q	■	■	2	■	■	Q																						
Malathion, Trithion	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	Q																					
Methoxychlor	1	1	1	Q	1	1	1	1	1	1	1	1	1	1	Q	1	Q	Q	1																				
Morestan	1	Q	1	Q	Q	Q	1	Q	Q	1	Q	1	1	1	1	Q	1	Q	1	Q																			
Niacide M	1	Q	1	Q	1	Q	1	1	1	1	1	1	1	1	1	1	1	■	1	1	1																		
Omite	1	Q	1	Q	Q	1	■	1	1	Q	Q	1	1	1	1	Q	Q	■	1	Q	Q	Q																	
Parathion, Ethion	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	Q	1	1																
Perthane	1	1	1	Q	Q	1	1	1	1	1	1	1	1	1	Q	1	Q	Q	1	1	Q	1	Q	1															
Phosphamidon	1	Q	1	Q	1	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	1	1	1	Q	1	1														
Plictran	1	Q	1	Q	Q	1	1	1	1	Q	1	1	1	1	1	1	Q	Q	1	Q	1	1	Q	1	Q	1													
Sevin	1	■	1	1	1	Q	1	1	1	1	1	1	1	1	1	1	1	■	1	1	1	1	1	1	1	1	1												
Elemental Sulfur	1	1	1	1	■	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	1	■	1	1	1	1	1	Q	1											
Lime Sulfur	■	■	■	■	Q	■	Q	Q	1	Q	Q	■	Q	Q	■	■	Q	1	2	Q	Q	Q	■	2	Q	1	Q	■	1										
Superior oil	1	■	■	1	■	1	1	■	■	1	■	1	1	1	1	1	Q	1	1	1	■	1	■	1	Q	1	1	1	■	■									
Systox	1	Q	1	Q	1	Q	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	Q	1								
Thiodan	1	■	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	1	1	1	1	1	1	■	1	1							
Vendex	1	Q	1	Q	Q	1	1	1	Q	Q	1	1	1	1	1	1	Q	Q	Q	Q	1	1	Q	1	Q	1	1	1	1	Q	1	1	1						
Ziram, Zineb	1	Q	1	Q	Q	Q	1	1	1	1	1	1	1	1	1	1	Q	■	1	1	Q	1	1	1	1	1	1	1	1	Q	1	1	1	1					
Zolone	1	■	1	Q	Q	1	1	Q	1	1	1	■	1	Q	Q	1	Q	Q	1	Q	Q	1	1	1	Q	1	1	1	■	1	1	1	1	1	1				
Penncap-M	1	Q	1	1	Q	1	1	1	1	1	1	1	1	1	1	1	1	■	1	Q	1	1	1	1	Q	1	1	1	1	■	1	1	1	1	1	1			
Ambush, Payoff, Pounce	1	1	■	1	1	■	1	1	1	1	1	1	1	1	1	1	1	■	1	1	Q	1	1	1	1	1	1	1	1	■	1	1	1	1	1	1	1		
Pydrin	1	1	■	1	1	■	1	1	1	1	1	1	1	1	1	1	1	■	1	1	Q	1	1	1	1	1	1	1	1	■	1	1	1	1	1	1	1	1	
Lorsban	1	■	1	1	Q		1	1		1	1	1	1	1	1	1	1	Q	1	1	1		■	1	1	1	1	1	■	■	1	1	1	1	Q	1	1	1	

DAYS BETWEEN FINAL SPRAY AND HARVEST

Listed below are some of the commonly used pesticides and the intervals from last application to harvest for each crop. See spray schedules for recommended materials.

Pesticides	Apples	Pears	Peaches	Plums and Prunes	Cherries	Grapes	Straw-berries	Rasp-berries	Currants and Goose-berries	Blue-berries	Apricots
Fungicides											
Bayleton						14					
Dikar	31										
*Difolatan					0(Sour)					21	
Botran			1j		0j(Sweet)						
Captan	0	0	0j	0	0j	0	0	0		0	0
Copper (copper-lime mixtures)	h	h			h	h	h	h			
Dodine (Cyprex)	7		15		0		14				
Dichlone (Phygon)	1		7	3	3						
Ferbam	7	7		7	0	7		40	14	40	
Folpet (Phaltan)						0				0	
†Funginex										40	
Glyodin	0e				7(Sour)						
Dinocap (Karathane)	21					21	21	7			
Ronilan							**0**				
Streptomycin	50	30									
Sulfurs	h		h	h	h						
Thiram (Thylate)	0		7				3e				
Topsin-M	**0**		**1**	**1**	**1**		0				
Zineb	30			30		7					
Polyram	30										
Benomyl (Benlate)	0j	0j	0j	0j	0j	7	0	3		21	0j
Benomyl + Mancozeb	30										
Benomyl + Captan	0	0	0	0							
Benomyl + Polyram	30										
Mancozeb						66					
Dithane FZ						7					
Rovral			**0**	**0**	**0**						
Insecticides											
Ambush		**14**	**14**								
Chloropropylate (Acaralate)	14	14									
BAAM		7									
Carzol	7f	7f									
Cythion ULV					1					0	
Diazinon	14	14	20	10	10	10	5	7		7	10
Dimethoate (Cygon)	28	28									
Ethion	60f	60f	30f	21f	f	30f	2				f
Guthion	7	7	21	15	15	0	5	14		14i	21
Imidan	7f	7f	14f	7	7	7					14
Kelthane	7	7	14	7b	7b	7	2	2			14
Lannate	8										
Lorsban			14								
*Malathion	3	1	7	3	3	3	3	1	1,3f	0-1f	7
Mesurol					7					7	
Methoxychlor	7	7	21	7	7	14	3	3	14g	14	21
Morestan	35f	35f	a,e	a,e	a,e						a
Omite	7f	14f	14f	28f							
Parathion	14	14	14	14	14	14	14	15	30,15f	14	14
Penncap-M	14	14	14	**14**	14	14					
Pay-off	**14**	14									
Phosphamidon	30				f						
Plictran	14f	14f									
Pounce	**21**		**14**								
Pydrin		c									
Sevin	1	1	1	1	1	0	1	7		0	3
Superior oil	e	e	e	e	e	e	e	e	e	e	e
Systox	21f	21f	30f	30f	f	21	21	d	d		30
Thiodan	30f	30l	30f	7f	21f	7	4f				30f
Trithion	30	30	30	30	30	30	3				30
Vendex	14f	14f									
Vydate L	14										
Zolone	14	14	14f	14f	14f	14					14f

**Difolatan flowable fungicide and aqua malathion when tank mixed and applied with ground spray equipment can cause foliar injury and damage to the fruit.*

†Application of Funginex after fruit formation has occurred may result in russeting of fruit.

Legend:
- a = Not after fruit begins to form.
- b = Do not repeat application within 30 days.
- c = Pre-bloom or Post-harvest application only.
- d = Post-harvest application only.
- e = No residue if used according to recommendations.
- f = See label restrictions on use.
- g = Remove excess residues at harvest.
- h = Sulfurs and copper plus lime mixtures are exempt if used as recommended.
- i = 4 hours of harvest using 3% dust at 20lb/acre.
- j = May be used as Post-harvest treatment—See label.
- k = 3 weeks after full bloom.
- l = 21 days if only 2 sprays are applied.

Notes

Cut along this line

SPRAY RECORD SHEET

GROWER	YEAR
CROP	HARVEST DATE

DATE APPLIED	MATERIAL	RATE/ APPLIED	VARIETY	COMMENTS (Weather Conditions, Etc.)

Tree Fruit

Apples

Pears

Peaches-Nectarines

Apricots

Plums-Prunes

Red Tart Cherries

Sweet Cherries

Small Fruit

Grapes

Strawberries

Brambles

Currants-Gooseberries

Blueberries

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