Fruit Pesticide Handbook For Commercial Fruit Growers
Michigan State University Extension Service
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Revised January 1981
99 pages

$1.50
FILE 27.2

1981

Fruit Pesticide Handbook

For Commercial Fruit Growers

Extension Bulletin E-154, January 1981, Revised Annually — Destroy Earlier Editions
COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

T. Nichols Fruit Research Station, Michigan State University Department of Entomology, Fennville, Michigan. Photo courtesy of Michael Tierney, Crystal Lake, Illinois.

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 41 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
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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.

1P-34R—5M—1:81 Ad, $1.50, For Sale Only

1981 Fruit Pesticide Handbook

EDITED BY: A. J. Howitt, Department of Entomology
J. Hull, Department of Horticulture
A. L. Jones, Department of Botany and Plant Pathology

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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.

Rev. 1-10-81

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, North Central Regional Extension Publication No. 45. (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. *Pesticides Manual: Classification, Toxicities, Formulation, Handling, Application* by D. Cress, R. Ruppel, W. Wallner, A. Jones, G. Bird, W. Meggitt, A. Putnam, Extension Bulletin E-751. (35¢)

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 92.

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

ANN ARBOR
Poison Control Center
University of Michigan
Medical Center
Emergency Room
1405 E. Ann St. 48109
(313) 764-5102

BATTLE CREEK
Poison Control Center
Community Hospital
183 West St. 49016
(616) 963-5521

BAY CITY
Poison Control Center
Bay Medical Center
100 15th Street 48706
(517) 892-6589

BERRIEN CENTER
Poison Control Center
Berrien General Hospital
1250 Dean's Hill Rd. 49102
(616) 471-7761

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

DETROIT
Poison Control Center
Children's Hospital of
Michigan
3901 Beaubien Blvd. 48201
(313) 494-5711

Poison Control Center
Mt. Carmel Mercy Hospital
6071 W. Outer Drive 48235
(313) 864-5400, Ext. 416

ELOISE
Poison Control Center
Wayne County General
Hospital
30712 Michigan Ave. 48132
(313) 722-3748
8:00 a.m.-11:00 p.m., Mon.-Fri.; 274-3000, Ext. 6231, 11:00-p.m.-8:00a.m., Mon.-Fri. & weekends

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

GRAND RAPIDS
Western Michigan Poison
Center
Blodgett Memorial Medical
Center
1840 Wealthy, S.E. 49502
(800) 442-4571 (within 616 area code); (800) 632-2727 (rest of state)

GRAND RAPIDS, Cont.
Poison Control Center
St. Mary's Hospital
201 Lafayette, S.E. 49503
(616) 774-6794

HANCOCK
Poison Control Center
Portage View Hospital
200-210 Michigan Ave. 49930
(906) 482-1122, Ext. 209

HOLLAND
Poison Control Center
Holland Community Hospital
602 Michigan Avenue 49423
(616) 396-4661

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

KALAMAZOO
Poison Control Center
Borgess Hospital
1521 Gull Road 49001
(616) 383-4815

Poison Control Center
Bronson Methodist Hospital
252 E. Lovell St. 49006
(616) 383-6409

LANSING
Poison Control Center
St. Lawrence Hospital
1210 W. Saginaw St. 48914
(517) 372-5112, 372-5113

MARQUETTE
Poison Control Center
Marquette General Hospital
425 W. Fisher St.
(800) 562-9723

MIDLAND
Poison Control Center
Midland Hospital
4005 Orchard Dr. 48640
(517) 631-7700, Ext. 304

MONROE
Poison Control Center
Mercy Memorial Hospital
700 Stewart Road 48161
(313) 241-6509

PETOSKEY
Poison Control Center
Little Traverse Hospital
416 Connable Ave. 49770
(616) 347-7373

POISON TREATMENT CENTERS

(Provides poison information service and treatment of poisoning cases)

KALAMAZOO
Bronson Methodist Hospital
252 E. Lovell 49006
(616) 383-6401
Howard Wharton, M.D.
John H. Trestrail, III, R.Ph.

PONTIAC
St. Joseph Mercy Hospital
900 Woodward Avenue 48053
(313) 858-3000, Ext. 256
Aran Cline, M.D.

PORT HURON
Port Huron Hospital
1001 Kearney Street 48060
(313) 987-5555
Daniel Wilhelm, M.D.
Joseph S. Jehl, R.Ph.

SAGINAW
Saginaw General Hospital
1447 N. Harrison 48602
(517) 755-1111
Dale F. Schultz, R.Ph.
William Mason, M.D., Med. Dir.

TRAVERSE CITY
Munson Medical Center
Sixth Street 49684
(616) 947-6140
Philip Wiley, M.D.
Arnold J. Rohen, R.Ph.

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
Dept. of Entomology and of Botany and Plant Pathology

Plant-parasitic nematodes can cause extensive injury to fruit crops. Research has shown that many fruit crops respond to nematicides. As a first step, however, it is important to purchase high quality nursery 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 application of fumigant or nonfumigant nematicides. Soil fumigation or use of a nonfumigant nematicide prior to planting trees or vines on old fruit sites is often essential for development of healthy and productive orchards and 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 nematodes are capable of transmitting viruses to several fruit crops including blueberry, grape, raspberry, peach, cherry and apple. The ring nematode predisposes fruit trees to diseases caused by other organisms.

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.

Where need for control of plant-parasitic nematodes has been established, the following nematicides are recommended (see Extension Bulletins E-800, E-801, and E-806). Nematode control is divided into sections for tree fruit (nursery stock and orchard establishment) and small fruit (nursery stock and production site establishment. Be sure to use the appropriate recommendations for specific production situations.

I. TREE FRUIT (Apples, Apricots, Peaches, Pears, Plums, Sweet Cherries, Tart Cherries)
- *A. Nursery Stock Production*
  - *1. Preplant*
  - *2. Post-plant*
- *B. Orchard Establishment*
  - *1. Preplant*
    - *a. Broadcast*
    - *b. Row*
    - *c. Site*
  - *2. At-planting root dip*
  - *3. Non-bearing post-plant*
    - *a. Soil*
    - *b. Foliar*

II. SMALL FRUIT (Brambles, Blueberries, Grapes and Strawberries)
- *A. Preplant*
- *B. Post-plant*

TREE FRUIT NURSERYSTOCK NEMATODE CONTROL
(Preplant Application)

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons) D-D 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 Terr-o-cide D Telone C-17	Broadcast: 32 to 40 gal.	Same as 1, 3-D
EDB (Ethylene Dibromide) Soilbrom-90	 Broadcast: 11.25 gal.	Same as 1, 3-D

Continued

Nematicide	Application rate/acre	Limitations and/or Directions
EDB and Chloropicrin Terr-o-cide	Broadcast: 25 gal.	Same as 1, 3-D
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-gas Dowfume MC-2	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.
Terr-o-gel (gel formulations of methyl bromide)	Broadcast: 250-450 lb.	Same as for methyl bromide, except the airtight cover is not required.
Methyl Bromide and Chloropicrin (67% and 33%, respectively) Dowfume MC-33 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 Nemacur 3 Nemacur 15G	 Broadcast: 4-6 gal. Broadcast: 75-125 lb.	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.
Oxamyl Vydate L	Broadcast: 3 to 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!
Aldicarb Temik 10G	Broadcast: 75-100 lb.	See Michigan label for specific application directions and safety cautions.

TREE FRUIT NURSERYSTOCK NEMATODE CONTROL

(Post-Plant Treatment)

Phenamiphos Nemacur 3	Row-strip: 4-6 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.
Oxamyl Vydate L	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!
Aldicarb Temik 10G	(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.

Continued

TREE FRUIT ORCHARD ESTABLISHMENT

(Preplant Treatment)

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons) D-D Telone II	 Broadcast or row-strip: 40 gal. Broadcast or row-strip: 30 gal. Individual tree site: 30 ml.	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. 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 Terr-o-cide D Telone C-17	Broadcast or row-strip: 32-40 gal.	Same as 1, 3-D
EDB (Ethylene Dibromide) Soilbrom-90	Broadcast or row-strip: 11.25 gal.	Same as 1, 3-D
Terr-o-cide (EDB and Chloropicrin)	Broadcast or row-strip: 45 gal.	Same as 1, 3-D
MIC (Methyl isothiocyanate and chlorinated C_3 hydrocarbons) Vorlex	Broadcast or row-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. Allow 3 to 6 months to lapse between treatment and planting.
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-Gas Dowfume MC-2	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: 3-10 gal. Row-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!
	(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!

Nematicide	Application rate/acre	Limitations and/or Directions
Phenamiphos Nemacur 3	Row-strip: 4-6 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.
SMALL FRUIT PRODUCTION *(Preplant Application)*		
1,3-D (Dichloropropene and related chlorinated hydrocarbons) D-D 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 Terr-o-cide D Telone C	Broadcast: 32-40 gal.	Same as 1,3-D.
EDB (Ethylene Dibromide) Soilbrom-90	Broadcast: 6.75 gal.	Same as 1,3-D. STRAWBERRIES ONLY.
EDB and Chloropicrin Terr-o-cide	Broadcast: 25 gal.	Same as 1,3-D.
Methyl Bromide (98% plus 2% chloropicrin) Brom-o-gas Dowfume MC-2	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.
Terr-o-gel (gel formulations of methyl bromide)	Broadcast: 200-450 lb.	Same as for methyl bromide, except the airtight cover is not required.
Methyl Bromide and Chloropicrin (67% and 33%, respectively) Dowfume MC-33 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.
Oxamyl Vydate L	Broadcast: 3-10 gal. Row-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.
(Post-Plant Treatment)		
Oxamyl Vydate L	Foliar Spray: 2 qt./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!

FUNGICIDES

Tree Fruit Crops

Benomyl *(methyl 1-(butylcarbamoyl)-2-benzimidazol carbamate)* is registered for the control of scab on apples, and powdery mildew, sooty blotch, flyspeck, and 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. On both apples and pears it is used at 4 to 6 oz. per 100 gal. of water and on apples it may also be used at 2 to 3 oz. plus 1 qt. of non-phytotoxic superior type spray oil (60 to 70 sec. viscosity) per 100 gal. of water, or in combination with several other fungicides. 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, it is used on peaches, nectarines, apricots, cherries, prunes, and plums for the control of brown rot, powdery mildew, peach scab, and cherry leaf spot. It is not effective for control of peach leaf curl. Benomyl is particularly effective for the control of brown rot. Sprays may be started at early bloom and continued as necessary through harvest. Benomyl may also be used as a postharvest dip or spray. 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, it should always be combined with Captan. The combination will give at least some degree of control should benomyl-resistant strains be present. (See resistance to fruit fungicides, page 11.)

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. Home-made 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.

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° F. It should be applied 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 *(2, 3-dichloro-1, 4-naphthoquinone)* is sold as a 50% active wettable powder under the trade name Phygon. For scab control, it should be used at the ¼ lb. rate with a protectant fungicide and should be used only from bud-break through the first-cover period. It is used mainly for the control of brown rot blossom blight on peaches, plums, prunes, tart cherries and sweet cherries. For this purpose, it is applied during the bloom period at the ½ lb. rate.

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 a flowable solution containing 4 lb. of Difolatan per gallon. On apples, Difolatan is registered as a single application at green tips for apple scab as described in the section on apple scab controls (p. 38).

In tests at East Lansing and in outstate areas of Michigan, 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. Ferbam can also be used as a lead arsenate safener at ½ to ¾ lb. where lime cannot be used for this purpose. 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.

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.

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 favor-

able 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.

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. 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.

Small Fruit Crops

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 excellent control of black rot and 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.

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.

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. 78) 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 *(Manzate D or Dithane M-22 Special).* This is an 80% wettable powder 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, if one or more of these fungicides should become registered for use on tree fruit crops in Michigan, they will be 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 to 2,000 ppm for warm fruit (50° F. or higher) or 2,000 ppm for cold fruit. Use only 1,000 ppm for warm or cold Rome Beauty or Golden Delicious to avoid injury. The slight scald that may occur on Jonathan and Idared can be controlled with 1,000 ppm. The mixture must be well agitated at all times to assure a good suspension of the material. The mixture possibly may be used over a period of several weeks provided it is relatively free of dirt, debris and disease organisms and properly agitated. A fungicide should be added (see below).

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 43 pounds of commercial grade (75 to 78%) calcium chloride in 100 gallons of water. 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 in order 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. A fungicide should be 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 11.)

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 a conditional use permit in Michigan and 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 and the white apple leafhopper. It is most effective for controlling immature and adult forms of European red and two-spotted mites, but does prevent the hatching of mite eggs present at time of spraying. 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 emulsifiable 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. Under Michigan conditions, oil plus Ethion have given better control of San Jose scale than oil alone. However, the addition of a phosphate insecticide does not improve the miticidal effectiveness of oil. 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. For the past two years, it has been available through an emergency exemption as a dormant spray for pear psylla. It is now registered as a pre-bloom spray on pears. When applied at white bud 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, even if ultimately registered for post-bloom applications.

Guthion has been the most widely used insecticide in Michigan orchards since DDT and related chlorinated hydrocarbons began phasing out. 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. It also suppresses European red mite and two-spotted mite when used in a seasonal program, without significant interference to species of predatory mites important to integrated pest control. 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.

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.

Methoxychlor has moderate residual activity and, although a relative of DDT, exhibits very low toxicity to humans and other warm-blooded animals. It will restrain such major fruit invaders as plum curculio, codling moth, apple maggot and cherry fruit fly, but is generally inferior to alternative chemicals for these purposes. Also sold under the trade name *Marlate,* its only suggested use is in dust form as an optional material on blueberry insects. It is rarely plant phytotoxic.

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.

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 similar to Parathion in toxicity to predacious mites and should be used prior to June 10 or following the predator-prey interaction if practicing integrated mite control. WARNING: Cautiously mix with emulsifiable concentrates, organic solvents and some surfactants because they may damage the microcapsules. Because of the size of microcapsules, don't use screens or nozzles finer than 50 mesh.

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 pyrethroids. 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.

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. Based on research information from Michigan we feel 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.

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. It has further use on pears, in a comparable manner to Perthane, for control of pear psylla.

Numerous failures of Thiodan in controlling pear psylla have been reported in Michigan during the past 3 years. Recent research results indicate that this material is ineffective in controlling certain psylla populations that have apparently developed resistance to it.

Thiodan has excellent insecticidal effectiveness against aphids, white apple leafhopper, tarnished plant bug, rust mites, green fruitworm and leafminer adults. Plant bug control for peaches and strawberries would be difficult, if not impossible, without Thiodan. 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, non-phosphate 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 many 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 the crops indicated. Somewhat weak in its Michigan performances on plum curculio, 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. While somewhat hazardous to fish, Zolone is only moderately toxic to honeybees, comparable with diazinon in having an average mammalian toxicity and much less harmful than DDT to quail, ducks, pheasants and other birdlife. It does not persist and accumulate, but rapidly metabolizes to non-contaminants in soils.

MONITORING OF INSECTS

The tree fruit section of the 1979 Pesticide Handbook stresses the importance of biological monitoring of insect (mite) pests. What is biological monitoring and why is it important? Simply, it is keeping track of harmful organisms and their buildup. More specifically, it refers to checking orchards for the presence of pest species and following their development through time so that control decisions can be made. For most tree fruit pests, the methods of monitoring, and stages to watch for, are mentioned in the discussion of each insect.

Why monitor insect pests? With increased costs of insecticides, miticides, labor and fuel, insect control is one aspect of a grower's production program which can be altered to maximize profits. Through biological monitoring, the pests present are identified and control programs designed 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

There are currently two trapping techniques 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 might be used for no other purpose than to determine insect presence or absence in an orchard. They may lead to an eventual systems-approach to assessing insect populations, emergence trends, and economic damage thresholds. They eliminate much of the previous guesswork in spray timing for many of the more troublesome fruit insects.

Pheromone traps have been successfully used in experimental orchards programmed to integrated mite control and new pest management concepts. These traps are supplemental re-inforcements and not replacements for other commonly used insect monitoring procedures. They can help you better know your insects; which ones are present, and when "to" or "not to" fight them.

PLANT GROWTH REGULATORS

By J. A. Flore
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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 are unique in that they are systemic and 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, injured 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: Important for two reasons. First, to be effective, most growth regulators must be applied within a narrow time interval, often within a few days. Secondly, 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. Every effort should be made to insure that the proper amount is applied in a correct manner. Uniform, thorough coverage is essential. Your sprayer should be accurately calibrated, for large trees, ⅔ of the spray volume should be directed 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: Before applying a growth regulator, know that 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.

8. Trials: These suggestions are offered as a guide to be used in conjunction with personal experience and product recommendations.

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, Jonathan, Northern Spy, and Rhode Island Greening: 4 grams of *actual* NAA per 100 gallons (10 parts per million).

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.

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, as recommended by the manufacturer, 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. Be sure to use Amid-Thin *no later* than Petal Fall on this 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. However, growers evaluating Sevin for the first time should do so on a trial basis. The following rates may serve as a guide using Sevin (50-W): (a) McIntosh and Jonathan, 2 lb./100 gal.; (b) Delicious to include red strains and Northern Spy, 1½ lb./100 gal. The single application of Sevin should be made at First Cover, selecting some other insecticide for Second Cover. Sevin used at Second Cover following thinning applications of NAA can cause overthinning. After Second Cover, Sevin may be used as an insecticide without any danger of added thinning. Sevin used on Golden Delicious at the same time suggested for thinning may cause fruit russetting. Sevin is toxic to the predator mite *Amblyseius fallacis*; a Sevin spray could be detrimental to the predator mite population (see Extension Bulletin E-825, Integrated Control of Apple Mites).

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.

- Thinning with NAA and Amid-Thin is much more excessive 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.

- 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.

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.

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)	Sevin at[2] first cover (lb. 50-W/100 gal.)
Delicious[3]	10	—	1.5
Jonathan	10	50	2.0
McIntosh	10	50	2.0
Northern Spy	10	50	1.5
R.I. Greening	10	50	—
Ida Red[4]	10	50	2.0
Winesap[4]	10	50	—
Grimes Golden	15	50	2.0
Fameuse (Snow)	15	50	—
Cortland[4]	15	50	—
Rome Beauty	20	—	—
Yellow Transparent[5]	20	50	—
Wealthy	20	50	—
Baldwin	20	—	—
Golden Delicious[6]	20	—	2.0
Dutchess	—	50	—
Early McIntosh	—	50	—
Paulared	10-15	50	—
Other summer varieties[7]	—	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]*Thinning with Sevin is not concentration dependent, if not used as an insecticide rates of ½-2 lb./100 gal. will result in equal responses.*

[3]*Some spur type Delicious may require higher concentrations.*

[4]*Based on recommendations from fruit growing areas other than Michigan.*

[5]*NAA may cause pre-mature ripening and fruit cracking.*

[6]*Sevin may cause fruit russetting of Golden Delicious.*

[7]*Varieties which mature before McIntosh.*

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. An application of ethephon at 200 ppm 10 to 14 days after bloom has effectively removed all developing fruit without causing foliage injury.

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. Some growers are using DN compounds in early bloom, but results differ so greatly from orchard to orchard and from year to year that they cannot be suggested generally.

N-1-naphthylphthalamic acid has been sold as Nip-A-Thin and has been tried experimentally and by growers in Michigan and in other states. This chemical has performed very erratically under Michigan conditions and thus cannot be suggested for thinning peaches except on a trial basis. Fruitone 3 CPA is available for peach thinning, but has performed poorly in Michigan. Peach thinning chemicals should be used according to the directions on the label.

Pre-Harvest Drop Control of Apples

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

Apply NAA at first sign of fruit drop. It becomes effective in 1 to 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 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 1980 growing season.

Alar on Apples

Alar-85 *(Succinic Acid 2,2-Dimethyl Hydrazide)* 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.), are to promote flower bud formation and to reduce the amount of vegetative growth. If applied to fruiting trees, particularly weak trees, some reduction of fruit size is likely to occur that same season. 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 pro-

nounced nor as consistent. In general, the earlier the application, or the higher the concentration, the greater the effect on 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. Trees low in vigor should not be sprayed with Alar. If fruit size is a problem, consider eliminating Alar from your program the year following such a response. Don't 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 150 ppm (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 seems to be 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 tion (1,000 ppm) is recommended to increase firmness drop control for 2-4 weeks. A previous Alar applica- to facilitate mechanical harvesting of sweet and tart 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 cherries. Response will depend upon the variety, concentration and time of application, and the environmental conditions during and after harvest.

Research shows that 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 an 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 fruits should be enlarging rapidly (Stage III of growth) 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 seem to be 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 has shown 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. Lower concentrations of 1 to 2 lb./100 gal. will result in improved firmness at the end of harvest without affecting maturity or the other responses associated with the higher application rates.

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

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.

WILDLIFE CONTROL IN ORCHARDS

MICHAEL E. DECAPITA
U. S. Fish and Wildlife Service

Mouse Control

Mouse control in orchards should begin in the spring with regular mowing of the orchard vegetation. Mowing orchards reduces habitat for mice.

Protective Wire Guards

Small ¼ inch mesh wire guards around the base of young trees will provide several years of protection against mice. This wire should be cut in strips long enough to enclose the tree and wide enough to extend three to four inches below the surface and at least 18 inches above the ground. Mature trees may also be protected by this method. In areas of extreme snow, it may be advisable to have the guards 24 inches above the soil. Guards will also protect trees from rabbit and woodchuck damage.

Baiting Methods

A bait of two-percent zinc phosphide-treated cracked corn and oats, or cracked corn alone, broadcast by aircraft or ground seeder is the most effective control method. Rates should be 10 pounds per acre when using aircraft, and six to eight pounds per acre when using ground methods. Seeders which may be set to apply materials only under the drip-line of the trees should be calibrated for the six pound per acre rate. Treatment of border areas will decrease reinfestation of mice into the treated area.

Pelletized rodenticides containing an anticoagulant, such as diphacinone, are available and may be applied by air or ground broadcast at a rate of 6-10 lbs. per acre.

Treatment in apple orchards should begin after harvest and all apple drops have been picked up. Treatments should begin when weather conditions will be dry and sunny for at least three days. Rain or snow will decrease mouse activity and control success.

A follow-up hand broadcast baiting program is recommended for areas in the orchard where control was not achieved after the first baiting. During followup, control may be improved by hand baiting with zinc-phosphide-treated apple cubes.

Rabbit Control

No toxicants are available for rabbit control. Common control methods are shooting, trapping and wire tree guards.

Various spray or paint-on chemical repellents containing thiram are available for rabbit control.

Common sense habitat management is the most important consideration in rabbit control. Do not allow good rabbit cover, such as brush, brush piles and tall grass to exist in and around orchards subject to rabbit damage.

Woodchuck Control

Certified private applicators may use gas cartridges to suffocate woodchucks in their dens. Trapping and shooting are effective control methods.

Deer Control

Tankage, a livestock feed supplement and animal by-product, can be used to discourage deer browsing in young orchards. Tankage, available from local feed stores or elevators, has a strong odor that is apparently objectionable to deer. Place two to three teaspoonsful of tankage in small 3″ x 5″ cloth bags and hang one bag in each young tree in the orchard. One hundred pounds of tankage will fill 600 bags if each is filled about three-fourths full.

The small bags of tankage should remain effective about 4 to 5 months—ample time to stop spring and summer browsing and antler rubbing. Bags freeze during winter months and do not provide repellent effect.

Most of the same chemical repellents registered for rabbit control may also be used for deer control.

Expanding popularity of dwarf fruit trees means that deer damage will increase. The best available means of protecting orchards is a deer proof fence. Studies have shown that fencing is an economical control measure. This method should be given serious consideration where damage is severe.

Deer are protected by the Department of Natural Resources and if it is necessary to remove the animals, a shooting permit must be obtained from the local conservation officer. Legal hunting, especially of does, should be encouraged by landowners with deer problems.

Bird Control

Starlings and robins cause the greatest amount of bird damage to fruit in Michigan. No single control method is 100 percent effective; therefore, growers should utilize a combination of methods.

Trapping

Large decoy traps baited with a variety of moist foods such as apples, lettuce, and potatoes can be used to selectively remove and destroy starlings, which are unprotected. All other protected species can be released unharmed. Traps should be moved every year or two to increase effectiveness. Smaller, portable traps can be moved frequently to maximize trap effect.

Auditory Repellents

Propane exploding cannons and electronic distress call equipment are most effective in reducing bird damage to fruit when frequently moved to prevent birds from becoming accustomed to them. Varying the rate of operation also increases the effectiveness of auditory scare devices. Two-stage exploding cartridges fired from a 12-gauge shotgun have a range of 75-150 meters and are effective when used with other control methods.

Chemical Control

Mesurol, a wettable powder insecticide, is currently registered to prevent damage to ripening cherries by birds. Application is by conventional hydraulic sprayer prior to seven days before harvest. The material is distasteful to birds. Additional registrations for Mesurol as a bird repellent in grapes and blueberries should be available soon.

Publications

Plans for deer proof fencing and bird traps as well as technical assistance with wildlife problems are available from the U.S. Fish and Wildlife Service, Lewis Cass Building, Lansing, Michigan 48909 (phone: 517/373-8033).

WEED CONTROL IN FRUIT CROPS

By A. R. Putnam, J. Hull, J. Hancock
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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.

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.

Napropamide (Devrinol). Napropamide can be applied at 4 lb/A in newly planted or established orchards. 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.

Oryzalin (Surflan) can be used safely on newly planted trees after the soil has settled and no cracks are present. Areas to be treated should be free of established weeds. It controls many annual grasses and broadleaf weeds but will not completely control nightshade, comon ragweed and some mustards. Apply 2 to 4 lb/A, the lower rate being adequate on lighter soils. Can be applied in combination with Paraquat.

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.

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. The only registration for Michigan fruit crops at present is for blueberries.

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.

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. Several varieties of strawberries have shown good tolerance to the herbicide. 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.

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.

1981 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.
		Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
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.
		diuron (Karmex)	2 to 3	In spring before weeds emerge.	
		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.
	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.
	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.
		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.
	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.
		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.

Crop	Weed Problem	Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
	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)	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.
		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.
		Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
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.
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.
			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.
		simazine (Princep)	2 to 4	Late fall or in spring before growth starts.	Use low rate on young plantings.
	Quackgrass and annuals	dichlobenil (Casoron)	4 to 6	November.	Granular formulation is most effective on quackgrass. Do not exceed 4 lb./acre on brambles.
		pronamide (Kerb)	1 to 2	November.	Apply to dormant quackgrass or before emergence of annual weeds. Do not use on muck soils.
		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.
		simazine (Princep)	4	October or November.	Granular formulation is most effective on quackgrass.

Crop	Weed Problem	Chemical	Pounds Per Acre Active Ingredient	Time of Application	Remarks and Limitations
	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.
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.
		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.**
		simazine (Princep)	2 to 4	In spring before weed growth starts.	Same as above.
	Annuals and perennials	paraquat (Paraquat CL) plus simazine (Princep)	½ plus 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.
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' variety. Check the label for crops that can be planted after strawberries.

Tree Fruit

APPLE PRODUCTION INFORMATION

INSECT AND MITE CONTROL

Non-Bearing Trees

White Grubs

The larvae of the June beetle are called white grubs and are whitish curved grubs from ½ to 1 inch long with brown heads. They feed on roots of plants and when orchards are planted on ground that has not been properly worked or treated, the larvae migrate to young trees and feed on the roots and prevent them from growing properly. Injury is usually most severe to crops following sod. To prevent damage, the soil must be worked thoroughly to mechanically destroy the pest. Fumigation for nematodes will also control grubs. There are no currently labeled chemicals for grub control.

Rose Chafer

This is a long legged brownish beetle about ⅜ inches long. In early June the adults emerge and begin feeding voraciously. For a three week period they will eat foliage and gnaw holes in most fruits. The females lay their eggs in sandy soils in grassy areas, hence in locations of lighter soils the pest will be most severe. By cultivation, local populations can be controlled. Chemically, Sevin and Penncap-M appear to be the best material to control the adults.

Pre-Bloom Pest Problems

(Includes the old silver tip, green tip, pre-pink and pink cover sprays.)

Climbing Cutworms

The climbing cutworms are a complex of species which overwinter as late instar larvae in ground litter. Early in the spring they become active, climb trees and feed on developing buds. When mature, the larvae pupate in ground litter. Adults emerge and lay eggs on cover crop plants. Larvae feed on these plants during the summer. It is difficult to detect the presence of these insects in an orchard as they are hidden in grass and litter at the base of the tree during the day. Night-time inspection for activity early in the spring is one method of detection but is usually impractical. Insecticide residues must be present on the buds and branches when the cutworms start feeding.

With the loss of DDT and other persistent chlorinated hydrocarbons, there are no good remaining pesticides which effectively control this pest. In experimental plots, suppression has been achieved with Lorsban. The synthetic pyrethroids are excellent in controlling cutworms, and Experimental Use Permits have been applied for. Check with your local agent to see if Emergency-Use applications will be approved by next spring.

European Red Mite

The European Red Mite passes the winter in the egg stage on the tree. Eggs begin hatching about the time Red Delicious are in the pink bud stage and is usually completed in 7 to 10 days. The young mites move to the opening leaves and begin feeding. In about 9 days the mites reach maturity, mate and females begin laying eggs. There are several generations per year and numbers can increase very rapidly during the warm

dry months of the year. About the middle of August the oviposition of overwintering eggs begins. The presence of mite eggs can be noted by visual inspection of smaller twigs and branches early in the year. Active stages can be detected by inspecting the leaves, especially the lower leaf surface. Only the adult stage is readily visible to the naked eye and a hand lens is useful in searching for these pests. The lower center of the tree is the best location to search for mites. Leaf samples can be picked and the leaves brushed and counted to determine the density of mites in an orchard.

The presence of predator mites can be detected in this manner and the need for sprays determined based on the ratios of red mites to predator mites. For more detailed information concerning integrated mite control, refer to Extension Bulletin E-825, "Integrated Control of Apple Mites," by B. A. Croft. It is important to control this pest early in the year before populations build up too high. An oil applied as a dilute spray before pink will effectively kill mite eggs. If the oil schedule is not followed then organic miticides should be applied about pink or when eggs begin to hatch. During the summer, miticides should be applied as mite populations begin to build.

Suggested chemicals for the pre-bloom control of the European red mite are superior oils, Carzol, Morestan or chloropropylate (Acaralate). Chemicals suggested for summer control are Plictran, Vendex, Omite, Kelthane, Carzol, or chloropropylate (Acaralate). **Do not use morestan or sulfur compounds, dichlone (Phygon), captan, Dikar, and dinocap (Karathane) with oil or near time of oil treatment.** In an integrated mite control program, use Kelthane, Carzol, and chloropropylate (Acaralate) as early in the season as possible, and before June 1.

San Jose Scale

The San Jose Scale passes the winter as partially grown scale. As temperatures warm and sap begins to flow in the spring, the scale resumes growth. Maturity is reached in late May or early June when males emerge and mate with females. The female scale is a quiescent organism whose sole function is to produce young. Young scale, called crawlers, are born alive and crawl about for some time before settling down. There are two generations a year with all stages present during the growing season. San Jose scale can be detected by a visual inspection of the tree trunk and scaflold limbs. Scale are usually found in protected areas beneath loose bark.

If high populations are present they may be observed on the fruit at harvest. This pest is best controlled by dormant sprays. Phosphate-oil combinations give better control of San Jose scale than oil alone. The phosphate-oil combination must be applied as a *dilute spray* at the rate per acre shown to be effective. If scale is a problem add ethion 1 lb. active ingredients, flowable parathion 0.6 lb. active ingredients, Diazinon 2 lb. active ingredients, Trithion 1 lb. active ingredients, or 1-2 lb. Penncap-M active ingredients per acre to 8 gal. of oil per acre.

Do not add parathion to oil when spraying McIntosh and related varieties. Do not use sulfur compounds, dichlone, captan, Dikar, or dinocap with oil, or near time of oil applications.

Scales may also be controlled when the crawlers are active and searching for a feeding site. During this 3-7 day period around mid-June, Diazinon and Penncap-M give excellent control. Once they begin feeding and secrete the waxy protective covering, no chemicals will adequately control them.

Rosy Apple Aphid

Rosy apple aphids spend winter in the egg stage on the apple tree. The eggs are dark green, shiny, and oval. Eggs hatch in early spring about the time buds start to break. The young aphids seek the opening buds, work their way inside them and suck plant sap until leaves and flowers are formed. Their feeding causes leaves to curl offering them protection from sprays and natural enemies. Young aphids mature about bloom (2 weeks average required) and soon begin producing young. There are 3 generations on apple per year with peak activity from mid-May to late June. Most 3rd generation adults migrate from apple to alternate summer hosts.

In the fall, winged immigrants return to apple and lay overwintering eggs. Of all the aphids, this is the most important since it can cause direct damage to the fruit when present in low numbers. This aphid is generally found on the foliage of fruiting spurs and is readily detected by the presence of curled leaves. Visual inspection is the only reliable means of detection. The best time to attack this pest is as the overwintering eggs hatch or at some time prior to or immediaely after bloom before the aphids have tightly curled leaves and are difficult to kill. Systemics provide better control after bloom period. Insecticides suggested for use against this pest are Thiodan, Zolone, Imidan, Lannate, Dimethoate, demeton (Systox), Diazinon or Phosphamidon. While all will control aphids adequately, some, like Methomyl, Zolone, Imidan, or Dimethoate, provide broad spectrum control of other early season pests.

Green Apple Aphid

The winter is spent in the egg stage. Eggs are small, shiny, and black. They hatch at about the same time as the eggs of the rosy apple aphid.

The young nymphs move to the opening buds and suck plant juices. As these insects mature, some winged forms are produced and they migrate throughout the orchard. The green apple aphid is generally found on growing terminals and water sprouts. High populations may result in a curling of the leaves on which aphids are present.

Visual inspection of water sprouts is the best method of detection early in the season, check water sprouts or growing terminals later in the summer. Timing of early season sprays to control the rosy apple aphid will also control the green apple aphid. Unlike the rosy apple aphid, this pest may be present late in the summer months. However, chemicals used to control other apple pests will usually suppress populations of this aphid so that specific chemical control may not be required. Use the same chemicals as suggested for the rosy apple aphid. During the summer when the rosy apple aphid is no longer present, the suggested chemicals are Methomyl or Dimethoate.

Cat-Facing Insects

Plant bugs spend the winter as adults in protected sites outside the orchard. As temperatures warm in the spring they become active and seek out early season food sources. Damage results when these adults feed on developing apple buds and later on young developing fruit. After this early feeding the adults migrate to preferred weed or vegetable plants where they lay eggs and produce many summer generations. While present in the orchard cover crop during the summer they will not damage the fruit. There are no effective biological monitoring tools to detect their presence. Visual observation is the best method. Pre-bloom plus petal fall sprays are needed in apples. In peaches, pink, petal fall and shuck split sprays with Thiodan are required to control this pest. The registered chemicals Guthion and Parathion have provided some control on apples but not on peaches. Zolone, Dimethoate, Thiodan, or Imidan applied for aphid control during pink have also provided some control of plant bugs but not on peaches. Where these pests are severe problems, Thiodan or Dimethoate are the preferred materials.

Oblique-Banded Leafroller

This insect passes the winter as partially grown, 2nd- or 3rd-instar larvae, in hibernacula beneath, or on, trees in the orchard. Activity resumes when buds begin opening in the spring. The young larvae bore into and feed on the buds. As leaves open, the more mature larvae fold one leaf into a tubular chamber where it remains while feeding. If mature larvae are present, they may feed on newly developed fruit shortly after petal fall. First moths appear about mid-June in Michigan with peak activity in late June or early July.

Egg masses are laid on foliage and require 10 to 12 days to hatch. Summer, or first generation larvae are present from mid-July to early August and are most commonly found on young growing shoots of apple and other orchard trees. Second generation adults are first detected by the first of September. Larvae hatching from eggs laid by these adults develop to the 3rd instar and then seek overwintering sites.

The oblique-banded leafroller is present in most Michigan apple orchards in low numbers and some feeding damage to apple has been associated with it in recent years. At present, it does present a threat to fruit production. The oblique-banded leafroller has developed resistance to some commonly used orchard pesticides and caused considerable fruit damage in some orchards in Michigan.

Pheromone traps are available for monitoring the presence and seasonal activity of the oblique-banded leafroller. Detection of larvae is relatively easy by making visual inspections of rolled leaves, especially on terminals, during periods when larvae are present. Optimum timing of control sprays for this leafroller are at pink and again in mid-July. Growers should be on the alert for sudden buildups of this leafroller which may be a possible sign of resistance problems. Methomyl will control leafrollers resistant to organic phosphates.

Green Fruitworm

The green fruitworm is actually a complex of species which can be considered as one since their life history (seasonal occurrence), damage and control are similar. They overwinter as both pupae and adults. Adults become active as temperatures warm in the spring. Egg laying begins as foliage appears. The eggs start hatching at pink apple flower bud stage. The young larvae feed on opening buds and foliage until petal fall when their attention is focused on developing fruit. When the larvae are mature, they spin to the ground and enter the soil where they pupate.

The speckled green fruitworm caused significant damage to apple and cherry crops. The primary problem areas were Oceana, Manistee, Benzie, Leelanau and Mason counties, but fruit damage was noted in other counties, too. Tremendous variability was reported in the ability of the same chemicals to control this insect. Full coverage of the foliage is important and spraying every row is recommended.

Recent research has indicated that insecticide sprays applied at white bud and petal fall provide adequate control of the green fruitworm larvae. Zolone and Penncap-M have provided fair control. Guthion is registered on apple for green fruitworm control but field screening studies have demonstrated that it did not provide

satisfactory control. Thiodan and Methomyl have provided good control but green fruitworm is not included on their label.

If Thiodan or Methomyl sprays are applied for control of other apple pests at pink or petal fall, other controls for the green fruitworm should not be necessary.

Bloom

(No insecticides should be applied during bloom period.)

Post Bloom Pest Problems

(Includes the old petal fall, first, second, third, fourth, fifth, sixth, seventh, and eighth cover sprays. Refer to the pre-bloom period for biology, timing and monitoring information on: Rosy Apple Aphid, Green Apple Aphid, and the European Red Mite.)

Plum Curculio

This insect overwinters as an adult in ground litter outside the orchard. As temperatures warm in the spring, adults become active and fly to orchards. Adult activity begins about bloom and continues for several weeks. After mating, egg laying proceeds. The eggs hatch in about 1 week and larvae bore into the fruit. After reaching maturity, the larvae crawl out of the fruit and into the soil where pupation takes place. In late summer, the adults emerge from the soil and may return to the orchard to do some feeding on the fruit before seeking overwintering quarters.

There are several formulas to predict when the adult curculio will become active in the spring, but generally it is present by petal fall. Visual observation is the best way to detect its presence. Since the primary damage caused by the plum curculio is the result of spring egg laying activities, the critical time to spray is petal-fall followed by another spray in 7 to 10 days. Suggested materials include Guthion, Imidan, Parathion, Zolone, and Penncap-M.

Red-Banded Leafroller

The red-banded leafroller spends the winter as a pupa in the ground. Moths emerge in the spring about the time the first green tissue appears, with peak flight about full pink. First brood eggs are laid on the trunk or scaffold limbs. Hatching occurs about bloom and the First brood larvae reach maturity in July and young larvae seek out foliage on which to feed. First brood larvae reach maturity in July and pupate in the shelter of leaves they have rolled up. Second brood moths begin emerging in late July and deposit eggs on the foliage. Another generation cycle is completed with most full grown larvae spinning to the ground and pupating in the soil.

Generally, only two generations are completed a year but in some years a partial 3rd may be produced. The presence and peak activity of this moth can be monitored using pheromone traps. This pest is a general feeder and the numbers caught in traps may not reflect potential damage. First brood egg batches can be located on trunks or scaffold limbs. First egg hatch can be determined by frequent checking.

Applications should be made when first eggs hatch and again in 10 days, or at petal fall and then again in 10 days. Spray coverage of the lower leaf surface is especially important. Good first brood control may eliminate the need for second brood control. If second brood control is required, apply sprays in late July or early August. The suggested chemicals for control are Guthion, Imidan, Zolone, or Penncap-M.

White Apple Leafhopper

The white apple leafhopper completes two generations in Michigan. It passes the winter as an egg. Eggs hatch in late April or early May. Nymphs migrate to the foliage and begin feeding. Adults first appear in early June. Egg laying begins in about 7 days with second generation eggs hatching in late July. Nymphs are active during August with second generation adults showing up in late August. Overwintering eggs are laid beginning in mid-September.

Visual inspection of the undersurface of the leaves for the presence of nymphs is the best monitoring technique. Weekly checks of the orchard, starting in early May, should give an indication of the presence and density of this pest. It is important to apply sprays when a majority of the nymphs are still young– in the first 3 instars. As nymphs get older or when they reach the adult stage, they are difficult to kill. It is also important to control the first generation to avoid problems later in the summer. Traditionally, sprays to control the first generation have been applied at pink or petal fall. Suggested chemicals are Dimethoate, Carzol, Thiodan, Methomyl, Diazinon, Systox or Sevin (second generation only). To achieve maximum kill, it is important to get thorough coverage of the lower leaf surface.

Wooly Apple Aphid

The winter is spent as eggs and young nymphs on elm trees. The eggs hatch in early spring and feed on developing buds of the elm tree. After 2 generations on elm, a winged 3rd generation

is produced which migrates to apple usually in late June or early July. Several generations are produced on apple during the remainder of the summer. In the fall, winged aphids are again produced and these migrate back to elm to deposit overwintering eggs. Continuously reproducing colonies of this aphid can survive below ground surface on the roots of apple. Due to the losses of elm trees to Dutch Elm disease during the past several years, population reservoirs on apple roots have become more and more significant.

These aphids are purplish and characteristically covered with a white, waxy secretion. Their presence can be detected by visual observations of the scaffold limbs. They are usually found where there are wounds from pruning or at the base of water sprouts. During most years, the activities of a parasite regulates aphids so that sprays are not required. Excessive spraying with Methomyl or Vydate may cause outbreaks of this pest.

Codling Moth

The codling moth overwinters as a mature larva spun up in a silken cocoon found under loose bark scales on the tree. Pupation occurs about bloom time. Adult moths usually start emerging at petal fall with peak emergence 4 to 5 days later. However, cool weather conditions at this time may delay peak emergence as much as 10 to 12 days. Egg laying is initiated 2 to 3 days following emergence and mating. Newly hatched larvae seek out the fruit and enter by chewing a hole in the apple cuticle. Upon entering, they feed near the surface for a short time, then bore into the center of the apple where they feed on the developing seeds.

In 3 to 4 weeks, the larva is mature and leaves the apple to pupate. In 14 to 21 days, the second brood moths emerge, usually around the first week of July. Another life cycle is completed with the mature larvae leaving apples in August to seek overwintering sites. Pheromone traps can be used to detect the presence and activity patterns of the adult codling moth.

A grower is encouraged to purchase commercially available traps and monitor his own acreage. The Michigan Apple Pest Management Project monitors the activity of the codling moth and regional information is available through the county extension office. In general, egg hatch begins within 10 to 16 days of the first brood moth emergence. This period may vary somewhat depending upon prevailing temperatures. Note that in orchards with extremely low codling moth levels, the first pheromone trap catch may not be as good an indicator of first emergence as trap catches in orchards with higher numbers of this pest.

Sprays should be applied so that effective residues are present throughout egg hatch. This is true for both the first and second generation. Guthion, Sevin, Imidan, phosalone, Diazinon, Penncap-M, or Methomyl give good control of the codling moth. Sevin, phosalone, and Diazinon are toxic to predator mites and their use should be avoided after June 1 if integrated mite control is practiced. If green aphids become a problem when codling moth sprays are applied, Diazinon, Imidan, or phosalone will control them as well.

Tentiform Leafminer

This insect overwinters as a pupa inside the leaf mine constructed the fall of the preceding year. Adults emerge in the spring as buds begin to open and deposit eggs on the leaves as they appear. Upon hatching, the larvae bore into the leaf and begin constructing a mine between the two surfaces of the leaf. When mature, the larvae pupate within the mine. Just prior to adult emergence, the pupa wiggles halfway out of the mine. Second generation adults appear in late June or early July. There are four generations per year.

The tentiform leafminer continues to be a pest in certain regions of the state this past year. Problems appeared to spread from the centers of infestations to adjacent areas. Where the leafminer has caused severe problems it appears immune to most commonly used orchard insecticides. Recent research has indicated that Thiodan and Lannate are effective against adults. The larvae within mines are immune to Thiodan and other contact insecticides. Lannate and Vydate, with their systemic activity, have given best control results against larvae.

To maintain control of the tentiform leafminer it is imperative to get good suppression of the first generation. First sprays should be directed at the emerging first generation adults. This usually occurs about tight cluster, but pheromone traps are now available to monitor this activity and growers should check with county or district extension agents for the best timing of spray applications. Thiodan, though effective against the adult leafminer, is not labeled for control of this pest. Adult leafminer control sprays should be applied by all growers within an area at the same time to reduce the spread of the leafminer from untreated to treated orchards. During bloom, leaves should be checked for the presence of new mines as a check on adult control success. If additional sprays are required, Methomyl should be applied at petal fall. If problems with leafminers are encountered in the second and third generations, apply Methomyl timed against early stages of the larvae in the leaves.

Apple Maggot

The apple maggot passes the winter as a pupa in the soil. Flies emerge in late June or early July and fly around the orchard, landing on apple trees and plants adjacent to the orchard in search of food. Eight to 10 days following emergence, the female has mated, developed and begins laying eggs. The eggs are placed beneath the skin of the apple and hatch in about 7 days. The larva then burrows around in the flesh of the apple for 3 to 4 weeks until mature. When mature, the larvae leave the apple and burrow into the soil where they pupate and remain until the following spring.

The activity of this insect can be monitored using a commercially available attractant trap. The trap consists of a yellow piece of heavy paper coated with a sticky substance and treated with a material which attracts the adults. Growers are encouraged to monitor their own orchards using the bait-lure trap. These traps are not as sensitive as pheromone traps and should be placed in areas traditionally known to be problem areas. The Apple Pest Management Project monitors abandoned apple orchards using the attractant traps. Apple maggot populations are high in these orchards and a reliable estimate of the first fly emergence can be gained. This information is made available on a regional basis through the county extension office.

The apple maggot must be controlled in the adult stage before egg laying begins. Therefore, it is very important to know when the first fly emerges. Control sprays should be applied 7 days after the first fly emergence is reported in your area. Additional sprays should then be applied every 10 to 14 days until flies stop emerging, usually in mid-September. Insecticides which will give good control of the apple maggot are Imidan, Guthion, phosalone (Zolone), and Diazinon. Sevin will provide control on a 10-day treatment schedule where apple maggot pressure is not severe.

APPLE SCAB CONTROL

Fungicide Programs

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 general approaches to primary scab control are described.

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.
dodine 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 3 gal. or at 5 gal./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 3 gal./acre rate and initiate a strong powdery mildew control program in early pink. See powdery mildew control on page 47.

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, diclone (Phygon), captan, Dikar, or dinocap (Karathane) with oil, or near oil applications.

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 dodine 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.			
Dodine (Cyprex) 65% WP	⅜ to ½ lb.	1½ to 2 lb.	¼ lb.	1 lb.	
Diclone (phygon) 50% WP plus protectant	¼ lb. ½ strength	1 lb. ½ strength			
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 4 F	5 qt.	5 gal.			Single application only of Difolatan 4F—see item 4 on page 39.
Difolatan 4 F	3 qt.	3 gal.			

How to Use The 1981 Fruit Pesticide Recommendations

The evaluation of how well certain insecticides control specific insects found in the 1981 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, 26e, 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 excellent 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, then you would 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.

Hopefully with the above explanation of how to use this manual you will be able to more effectively manage the pests in your fruit crops.

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
PESTS	Apple Maggot	Adult			G	E		E	E			P	P			F	E	P		G						G	
	Codling Moth	Adult			E	G		E	E		E	P	P			G	E	P		E				F		E	P
	Cutworms	Larvae							F		F					F											
	European Red Mite	Active	G	G		P	E			G				G	G	P			E		E			F	E	F	E
	Fruit Tree Leafroller	Larvae			G			E	E		E					G	E			F						E	P
	Green Apple Aphid	Active			F	E	E	P	F		G	P	P			P	P	E		P	E	E	E	F		G	P
	Green Fruitworm	Larvae			F			F	F		E					F	G	P					E			G	P
	Oblique Banded Leafroller	Larvae			G			E	E		E					G	E			F						E	P
	Plum Curculio	Adult				P		E	E		F	P	P			F	E			P						G	G
	Red Banded Leafroller	Larvae			G	P		E	E		E	P				G	E	P		F						E	P
	Rose Chafer	Adult															G			G							
	Rose Apple Aphid	Active			F	E	E	F	F		G	P	P			P	F	E		P	E	E	E	G		G	E
	Rust Mite	Active	G	E	F	P		P	P	G				G	G		P	P	G	G		F	E		G	G	E
	San Jose Scale	Adult					E										F				E			G			
		Crawler			G												G							E			
	Spotted Tentiform Leafminer	Adult						F	F		G						P						E		G	
		Larvae			F	F					E						P	P				G	P			G	E
	Tarnished Plantbug	Active			F	E		F	F		G					F	F						E			F	
	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
	Wooly Apple Aphid	Active			F	G					P					G	G	G					E	G		G	P
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	MT	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	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	HT	HT

[1]Second generation only

[2]Use only before pre- pink stage

1981 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.

Green Tip

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Spotted Tentiform Leaf Miner (adult)	26e	26. Thiodan 50 WP*	1 lb	4 lb	Timing for this spray should be based on pheromone trap catches. Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		3 EC	⅔ qt	2⅔ qt	

APPLE SCAB CONTROL

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.			Because Benlate-resistant apple scab is widespread in Michigan, Benlate is not recommended for apples.
Dodine (Cyprex) 65% WP	⅜ to ½ lb.	1½ to 2 lb.	¼ lb.	1 lb.	
Diclone (phygon) 50% WP plus protectant	¼ lb. ½ strength	1 lb. ½ strength			
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 4 F	5 qt.	5 gal.			Single application only of Difolatan 4F—see item 4 on page 39.
Difolatan 4 F	3 qt.	3 gal.			

Pre-Pink

DISEASES					
Apple Scab (Primary)	See Silver Tip and page 39.				
Powdery Mildew	See "Special Apple Disease Controls," page 47.				
INSECTS/MITES					
European Red Mite	**24e**	24. Superior Oil*	2 gal	8 gal	Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.
San Jose Scale	**24e**	26. Thiodan, 50 WP*	1 lb	4 lb	
Spotted Tentiform Leaf Miner (adult)	**26e**	3 EC	⅔ qt	2⅔ qt	

Pink

DISEASES					
Apple Scab (Primary)	See Silver Tip and page 39.				Mildew control is critical at this time. If a severe problem exists, start at green tip.
Powdery Mildew	See "Special Apple Disease Controls," page 47.				
INSECTS/MITES					
European Red Mite	**1g, 3g, 15g, 30e**	1. Acaralate 2 EC	1 qt	4 qt	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.
Aphids	**5g, 6e, 11g, 20e, 25e, 26e, 27g, 29g, 30g**	3. Carzol 92 SP*	¼-½ lb	1-2 lb	
		5. Diazinon 50 WP*	1 lb	4 lb	
Tarnished Plantbug	**3g, 6e, 11g, 26e, 29g**	6. Dimethoate 2.67 EC*	1½ pt	6 pt	
		25 WP	2 lb	8 lb	
Green Fruitworm	**11e, 26e, 29g**	8. Guthion 50 WP	½ lb	2 lb	
Spotted Tentiform Leaf Miner	**11e, 25g, 26e, 30g**	9. Imidan 50 WP	1 lb	4 lb	
		11. Methomyl 1.8 EC	2 pt	8 pt	
		90 SP	½ lb	2 lb	
Resistant Oblique Banded Leafroller	**11e**	15. Morestan 25 WP	½ lb	2 lb	
		20. Phosphamidon	¼ pt	1 pt	
		25. Systox 6 EC	⅓ pt	1⅓ pt	
Non-Resistant Oblique Banded Leafroller	**8e, 9e, 11e, 29e**	26. Thiodan 50 WP*	1 lb	4 lb	
		27. Trithion 4 EC	½ pt	2 pt	
		29. Zolone 3 EC	1 pt	4 pt	
		30. Vydate 2 L	1 pt	4 pt	

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

Bloom

DISEASES	
Apple Scab (Primary)	See Silver Tip and page 39.
Powdery Mildew	See "Special Apple Disease Controls," page 47.
Fire Blight	

Petal Fall

DISEASES	
Apple Scab (Primary)	See Silver Tip and page 39.
Powdery Mildew	See "Special Apple Disease Controls," page 47.
Fire Blight	

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
White Apple Leafhopper	**5g, 6g, 11e, 25g, 27g**	5. Diazinon 50 WP*	1 lb	4 lb	*WARNING:* Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 16). 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. 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.
		6. Dimethoate 2.67 EC*	1½ pt	6 pt	
		25 WP	2 lb	8 lb	
Tarnished Plantbug	**6e, 11g, 26e, 29g**	8. Guthion 50 WP*	½ lb	2 lb	
Green Fruitworm	**11e, 18g, 26e, 29g**	9. Imidan 50 WP*	1 lb	4 lb	
Plum Curculio	**8e, 9e, 18e, 29g**	11. Methomyl 1.8 EC	2 pt	8 pt	
Leafrollers	**8e, 9e, 11e, 18e, 29e**	90 SP	½ lb	2 lb	
Spotted Tentiform Leaf Miner (Larvae)	**11e**	18. Penncap-M*	1 pt	4 pt	
		25. Systox 6 EC	⅓ pt	1⅓ pt	
Resistant Oblique Banded Leafroller	See Pink	26. Thiodan 50 WP*	1 lb	4 lb	
		27. Trithion 4 E	½ pt	2 pt	
Non-Resistant Oblique Banded Leafroller	See Pink	29. Zolone 3 EC	1 pt	4 pt	
		25 WP	1½ lb	6 lb	
First Cover					
DISEASES					
Apple Scab (Primary)	See Silver Tip and page 39.				
Powdery Mildew	See "Special Apple Disease Controls," page 47.				
Fire Blight					
INSECTS/MITES					
Plum Curculio	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.
Leafrollers	See Petal Fall				
Second Cover					
DISEASES					
Apple Scab (Secondary)	See Silver Tip and page 39.				
Powdery Mildew	See "Special Apple Disease Controls," page 47.				
INSECTS/MITES					
Codling Moth	**5e, 8e, 9e, 11e, 17g, 18e, 23e, 29e**	5. Diazinon 50 WP*	1 lb	4 lb	Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		8. Guthion 50 WP*	½ lb	2 lb	
San Jose Scale (crawlers)	**5g, 18g, 27g**	9. Imidan 50 WP*	1 lb	4 lb	
		11. Methomyl 1.8 EC	2 pt	8 pt	
		Methomyl 90 SP	½ lb	2 lb	

		17. Parathion 15 WP*	1½ lb	6 lb
		8 F	¼ pt	1 pt
		18. Penncap-M	1 pt	4 pt
		23. Sevin 50 WP	2 lb	8 lb
		80 S	1¼ lb	5 lb
		27. Trithion 4 E	½ pt	2 pt
		29. Zolone 3 EC	1 pt	4 pt
		25 WP	1½ lb	6 lb

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 and codling moth 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.

a.i. means the amount of active ingredient.

Summer Mite Control

Mites		1. Acaralate 2 EC	1 qt	4 qt
adults:	**1g, 3g, 10g, 16g, 21e, 28e, 30e**	3. Carzol 92 SP	¼-½ lb	1-2 lb
		10. Kelthane EC	1 qt	4 qt
		35 WP	1¼ lb	5 lb
immatures:	**1g, 3g, 10g, 16g, 21e, 28e, 30e**	16. Omite 30 WP*	1¼ lb	5 lb
		21. Plictran 50 WP*	4-6 oz	1-1½ lb
eggs:	**3g**	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 39.

Powdery Mildew — See "Special Apple Disease Controls," page 47.

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, 20g, 25e, 27g, 30g**	27. Trithion	½ pt	2 pt
		30. Vydate 2 L	1 pt	4 pt

Fourth Cover

DISEASES

Apple Scab (Secondary) — See Silver Tip and page 39.

Powdery Mildew — See "Special Apple Disease Controls," page 47.

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS/MITES					
Apple Maggot	**5g, 8e, 9e, 18e, 23g, 29g**	5. Diazinon 50 WP*	1 lb	4 lb	Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		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	Call the local Pest Management code-a-phone or determine from the Extension agent when sprays for apple maggots should be applied.
		23. Sevin 50 WP	2 lb	8 lb	
		80 S	1¼ lb	5 lb	
		29. Zolone 3 EC	1 pt	4 pt	
		25 WP	1½ lb	6 lb	

Fifth Cover

DISEASES					
Apple Scab (Secondary)	See Silver Tip and page 39.				
Powdery Mildew	See "Special Apple Disease Controls," page 47.				
INSECTS/MITES					
Apple Maggot	See Fourth Cover				
Codling Moth	See Second Cover				
Red-banded Leafroller	See Petal Fall				

Sixth, Seventh and Eighth Covers (If Needed)

DISEASES					
Apple Scab (Secondary)	See Silver Tip and page 39.				
INSECTS/MITES					
Aphids	See Third 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.
Apple Maggot	See Fourth Cover	11. Methomyl 1.8 EC	1 pt	4 pt	
Codling Moth	See Second Cover	90 SP	¼ lb	1 lb	
Red-banded Leafroller	See Petal Fall	23. Sevin 50 WP	1 lb	4 lb	
		80 S	10 oz	2½ lb	
Spotted Tentiform Leaf Miner (adult and larvae)	**11e, 30e**	27. Trithion 4 E	½ pt	2 pt	Star (*) denotes preferred materials for use in integrated mite and aphid control program.
		30. Vydate 2 L	1 pt	4 pt	
White Apple Leafhopper	**5g, 11e, 23e, 27g, 30e**				

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. Applications 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
Dikar 80% WP**	2 lb	2 lb
OR		
Scab fungicide plus		
Wettable Sulfur	2 lb	8 lb
OR		
Scab fungicide plus		
Dinocap (Karathane) 25% WP	½ lb	2 lb

**Benlate is no longer recommended for general use on apples because of the widespread development of Benlate-resistant apple scab in Michigan. If Benlate is used for apple powdery mildew, the scab fungicide should be used at the full rate. Moreover, if apple scab becomes a problem in orchards where Benlate was used to control powdery mildew, do not rely on Benlate for eradicating or suppressing scab lesions. Resistant apple scab may have built-up in the orchard even though the purpose for the Benlate was mildew control. The possibility also exists of developing Benlate-resistant powdery mildew.*

***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	1 lb	4 lb
Zineb (75% WP)	1 lb	4 lb
OR		
Captan (50% WP)	2 lb	8 lb

Cedar-Apple Rust

TIMING: Pink to third cover

Ferbam 76% WP	2 lb	8 lb
OR		
Ferbam 76% WP plus	¾ lb	3 lb
Scab fungicide	½ strength	½ strength
OR		
Thiram (Thylate) 65% WP	2 lb	8 lb

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 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	50 to 100 ppm

Streptomycin sprays: Use streptomycin when maximum temperatures above 65° F. exist or are likely, and are accompanied by precipitation or follow rainy days. Use 100 parts per million (ppm) when moderate to severe conditions occur. When temperatures slightly above 65° F. are anticipated with moisture, use 50 to 75 ppm.

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.**

Continued

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) and many Crab apple varieties. In some years, Golden Delicious 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 100 ppm sprays 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

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

Includes the old dormant, delayed dormant, green tip, pre-pink, and pink spray timing periods.

Pear Psylla

The pear psylla overwinters as an adult both inside and outside pear orchards. Early in the spring (usually about mid-April), eggs are deposited on the bark, usually at the base of buds. As eggs hatch, the young nymphs move to the opening buds and begin sucking plant sap. There are three, and sometimes four, overlapping generations per year in Michigan. The presence and numbers of adult psylla can be detected using a beating tray and tapping lightly on a limb. Eggs and nymphs can be found on the foliage predominantly on the lower leaf surface.

Pear psylla has developed resistance to a number of phosphate and carbamate insecticides. Where this has occurred, it is important to control the overwintering adults in the spring before eggs are laid. Summer sprays should be applied when most of the psylla nymphs are young (first 3 instars). Area wide spraying programs initiated when the first eggs are reported will reduce the problem of psylla escaping control applications by moving to unsprayed blocks.

Psylla resistance to Thiodan and Perthane are widespread in Michigan, limiting the usefulness of these materials in pear psylla control programs.

BAAM has a conditional registration for use on pears for controlling pear psylla. Pydrin is registered for prebloom applications. In prebloom applications Pydrin gives outstanding control of pear psylla, green fruitworm, and plant bugs. Pydrin (Fenvalerate) can be used prebloom. (See page 16.)

Tarnished Plant Bug

Refer to the apple section for a discussion of the life history and monitoring techniques for this insect. Apply sprays at pre-pink to pink or petal fall for best results. Registered chemicals are Guthion and Sevin, but where severe problems occur they may not provide adequate control. Thiodan has provided good tarnished plant bug control when applied to control overwintering psylla at pre-pink to pink.

Green Fruitworm

Refer to the apple section for a discussion of the life history and monitoring of this insect. The green fruitworm caused considerable damage in some pear orchards last year and has been an increasing problem in recent years. Special attention should be paid to this pest if you noted damage last season. Apply controls at petal fall. Guthion is registered for controlling this pest, but in some areas has not provided adequate control. Thiodan applied at petal fall to control aphids has provided control of the green fruitworm. Penncap-M has provided control of green fruitworms. Check foliage during blooms to determine the need for a control spray.

Leafrollers

The red-banded and fruit tree leafrollers are the principal leafroller pests of pear in Michigan. Apply control sprays when eggs begin to hatch. For the fruit tree leafroller, this has traditionally been between the pre-pink and pink stage of flower bud development. For the red-banded leafroller, it has been at, or shortly after, petal fall. Suggested chemicals for control of the fruit tree leafroller are Guthion or Imidan. For the red-banded leafroller, Guthion, Imidan, or phosalone (Zolone), and Penncap-M are suggested.

Mites

The European red mite and two-spotted mite are the principal mite pests on pears in Michigan. Refer to the apple section for a discussion of the

life histories of these mites. During the summer, these mites may be monitored much as they are on apples. Leaf samples passed through a leaf-brushing machine can be used to determine the relative density of the mites, or a visual inspection of leaves from the low-centers of the tree will provide the first indications of a mite build-up. It should be noted that pear trees cannot withstand mite populations as high as apple before damage is evident. Thus, control measures must be applied when mites are present in relatively low numbers.

A preventive program provides the best control for the European red mite. An oil applied in the delayed dormant period will kill mite eggs, or an organic miticide applied at pre-pink to pink will kill active stages as eggs hatch. For two-spotted mite control, apply 2 consecutive summer miticides 7 to 10 days apart when mites are noted increasing in your orchard. Superior oil during the delayed dormant or chloropropylate (Acaralate), morestan or Carzol at pre-bloom are suggested for early European red mite control. Plictran, Vendex, Omite, chloropropylate (Acaralate), Carzol, or Kelthane are suggested for summer control of European red mite or two-spotted mite. *WARNING:* do not use morestan in an oil spray schedule.

Bloom

No insecticides should be applied during the bloom period.

Post Bloom Pest Problems

Includes the old petal fall, first, second, third, fourth and fifth cover sprays.

Plum Curculio

Refer to the apple section for the life history and monitoring techniques for this insect. Apply sprays at petal fall and again in 12 to 14 days. Suggested chemicals are Guthion, Imidan, Zolone, Penncap-M and parathion.

Codling Moth

Refer to the apple section for life history, monitoring and critical timing information. Detection of codling moth and timing of sprays may be determined using pheromone traps. Traditionally, cover sprays for codling moth have been applied beginning in second sover. Suggested chemicals are Guthion, Imidan, phosalone (Zolone), Diazinon, Penncap-M and parathion.

Aphids

The primary aphid pest on pears is the green apple aphid. Refer to the apple section for the life history of this insect. The green apple aphid will usually appear in early shummer on the foliage of growing shoots. Inspection of these growing shoots will give an indication of the intensity of the aphid problem. Apply sprays as aphid populations build up. Suggested chemicals are demeton (Systox), dimethoate, or Thiodan. If Thiodan, Imidan, Diazinon, or Zolone are applied for insect control, additional chemicals should not be needed for controlling aphids.

Pear Rust Mite

This minute mite overwinters under the bud scales. It becomes active in the spring as buds begin to open and moves into these to feed on the developing foliage. Considerable fruit russet due to the activities of this mite have been noted in several Michigan pear orchards. The presence of this mite can be detected by a visual inspection of buds or foliage with a high powered hand lens or examination under a microscope. Contact District Extension Horticultural Agent for assistance. Apply control sprays when mites become active in the spring, usually pre-pink to pink. Suggested chemicals are Carzol and Plictran. Thiodan no longer controls pear rust mite, and control with Sevin is erratic.

San Jose Scale

Refer to the specific instructions for control of this insect in the apple section (page 34).

1981 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	½ pt	1½ pt	

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		18. Penncap-M	1 pt	4 pt	
European Red Mite	**24e**	24. Superior Oil	2 gal	6 gal	Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.
San Jose Scale	**24e, 18e, 27e**	27. Trithion 4 E	½-1 pt	1½-3 pt	

White Bud

DISEASES					
Pear Scab	Fungicides listed under Green Tip to Pre-Pink.				
INSECTS/MITES					
European Red Mite	**1g, 3g, 15g**	1. Acaralate 2 EC	1 qt	3 qt	European Red Mite control is not necessary if dormant oil was applied. However, if synthetic pyrethroids (Pydrin, Ambush or Pounce) are used expect pear rust mite problems and control with 3, 21, 23, or 26.
Leafrollers	**8e, 9e, 29e**	3. Carzol 92 SP	¼-½ lb	¾-1½ lb	
Green Fruitworm	**26g, 29g, 31e**	8. Guthion 50 WP	½ lb	1½ lb	
Tarnished Plantbug	**3g, 26e, 31e**	9. Imidan 50 WP	1 lb	3 lb	
Pear Psylla	**31e**	15. Morestan 25 WP	½ lb	1½ lb	
Pear Rust Mite	**3e, 21g, 23f**	21. Plictran 50 WP	4-6 oz	¾-1⅛ lb	
		23. Sevin 50 WP	2 lb	6 lb	
		80 S	1¼ lb	4 lb	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		31. Pydrin 2.4 E	½ pt	1½ pt	

Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Fireblight	See Fire Blight of Apple and Pear, page 47.				
Pear Scab	See Green Tip.				

Petal Fall

DISEASES					
Fireblight	See Fire Blight of Apple and Pear, page 47.				
Pear Scab	See Green Tip.				
INSECTS/MITES					
Plum Curculio	**8e, 9e, 18e, 29g**	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 16).
Green Fruitworm	**18g, 26e, 29g**	9. Imidan 50 WP	1 lb	3 lb	
Tarnished Plantbug	**26e**	18. Penncap-M	1-2 pt	3-6 pt	
		26. Thiodan 50 WP	1 lb	3 lb	
		3 EC	1 qt	3 qt	
		29. Zolone 3 EC	1 pt	3 pt	

First Cover

DISEASES					
Fireblight	See Fire Blight of Apple and Pear, page 47.				
Pear Scab	See Green Tip.				
INSECTS					
Plum Curculio	See Petal Fall				

Summer Mite Control

Mites		1. Acaralate 2 EC	1 qt	3 qt	
adults:	**1g, 3g, 10g, 16g, 21e, 28e**	3. Carzol 92 SP	¼-½ lb	¾-1½ lb	
		10. Kelthane 35 WP	1¼ lb	3¾ lb	
immatures:	**1g, 3g, 10g, 16g, 21e, 28e**	18.5 EC	1 qt	3 qt	
		16. Omite 30 WP	1¼ lb	3¾ lb	
eggs:	**3g**	21. Plictran 50 WP	4-6 oz	¾-1⅛ lb	
		28. Vendex 50 WP	4-8 oz	¾-1½ lb	

Summer Covers

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

INSECTS

Codling Moth	**2g, 5e, 8e, 9e, 17g, 18e, 23e, 29e**	2.	BAAM 1.5 EC	1½-2 pt	2-3 qt
		5.	Diazinon 50 WP	1 lb	3 lb
		8.	Guthion 50 WP	½ lb	1½ lb
		9.	Imidan 50 WP	1 lb	3 lb
		17.	Parathion 15 WP	1 lb	3 lb
			8 F	⅓ pt	1 pt
		18.	Penncap-M	1-2 pt	3-6 pt
		23.	Sevin 50 WP	2 lb	6 lb
			80 S	1¼ lb	4 lb
		27.	Trithion 4 E	½ pt	1½ pt
		29.	Zolone 3 EC	1 pt	3 pt
San Jose Scale crawlers:	**5g, 17g, 18e, 27g**				
Pear Psylla	**2e**				

Codling Moth control is usually not necessary for first generation as the pear is too hard for the larvae to enter successfully. Check with your local Extension agent for timing of second generation sprays.

PEACH AND NECTARINE PRODUCTION INFORMATION

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

Climbing Cutworms

Refer to the apple section for the life history of these pests. Climbing cutworms at times cause considerable bud damage from early spring feeding activities. To detect their presence, check under the leaf litter and grass around the tree.

Cat-Facing Insects

Refer to the apple section for the life history and monitoring techniques for these insects. Apply sprays at pink, petal fall and shuck split. Thiodan is the most specific chemical for plant bugs.

Green Fruitworm

Refer to the apple section for the life history and monitoring of this insect. Injury resulting from the feeding activities of the green fruitworm has increased in recent years. No effective insecticides are registered for controlling the green fruitworm on peaches or nectarines. However, Thiodan or Zolone applied at pink and petal fall for aphid and plum curculio, respectively, have provided control of the green fruitworm.

Bloom

No insecticides should be applied during bloom.

Post Bloom Pest Problems

Includes the old petal fall, shuck split, first, second, third, fourth, fifth and pre-harvest sprays.

Plum Curculio

Refer to the apple section for the life history and monitoring of this insect. Sprays should be applied at the *beginning* of shuck split followed by another spray 7 to 10 days later. This should protect the developing fruit during the major egg laying period of the plum curculio. In unusually cool years, a third spray 7 to 10 days following the second may be required. Suggested chemicals for control are Guthion or Imidan, phosalone (Zolone) and Penncap-M.

Oriental Fruit Moth

The oriental fruit moth spends the winter as a full grown larva in cocoons on the tree or debris on the ground. Pupation occurs in early spring and adult emergence starts at, or shortly after, bloom. Eggs are deposited on the foliage shortly after adult emergence. Following egg hatch, about shuck split, the first brood larvae seek out and bore into growing shoot tips. First generation larvae are full grown by mid- to late June.

Pheromone traps are available to monitor this insect. The relationship between trap catch and shoot tip or fruit injury is not currently known but traps can provide information on the presence and seasonal activity of the moths and act as a guide for deciding the need for late season spray applications. A post bloom spray applied at petal fall or shuck split will control first generation. Plum curculio sprays applied at shuck split will provide control of the first generation oriental fruit moth. It is important to achieve good control of the oriental fruit moth during first generation to avoid problems with later broods. Additional controls are necessary in early July and August to protect the fruit. Chemicals suggested for control are Guthion, carbaryl (Sevin), Imidan, Zolone, Penncap-M, Diazinon, parathion or Zolone.

Green Peach Aphid

The winter is passed as black shiny eggs on the bark of peach, plum, apricot, or cherry. Hatch occurs about peach tree bloom and the young nymphs move to the foliage to begin feeding. There, 2 to 3 generations are produced on stone fruit hosts before winged forms appear and migrate to summer host plants. With the approach of cold weather in the fall, winged

adults return to stone fruits and lay overwintering eggs. Visual inspection of twigs during pre-bloom will indicate the presence of eggs. At petal fall, an examination of the growing shoots provides an indication of the severity of the infestation. Apply controls when aphids start to build. Since aphids migrate to summer host plants, a spray applied just prior to migration may be wasted. Suggested chemicals for control are demeton (Systox) or Thiodan.

Mites

The European red mite and the two-spotted spider mite may create problems during summer months. If mite populations start to increase, apply Omite, Kelthane or Plictran.

Lecanium Scale

This insect overwinters as a partially grown scale. They appear as brown, soft-bodied, spindle-shaped lumps on the underside of smaller branches and twigs. Crawlers are produced in late June or early July (June 25 to July 15). Apply insecticides when crawlers first appear. Make a second application 10 to 14 days later. Suggested chemicals are Trithion, parathion, Sevin or Diazinon.

Peach Tree Borers

There are two borer species which attack peach, plum, apricot and cherry in Michigan, the regular peach tree borer and the lesser peach tree borer. Both spend the winter as larvae under the bark in the cambium layer. The larvae are present in various stages of development. Adult moths of the lesser borer start emerging in late May or early June. Regular borer adults start emerging in early July. Both moths continue emerging through September.

Egg laying begins about 2 weeks after emergence. The lesser borer lays eggs on the trunk and scaffold limbs, the regular borer lays only on the trunk. The eggs hatch in 9 or 10 days and the new larvae bore through the bark to the cambium layer where they start feeding. These insects can be detected by the occurrence of frass or the presence of empty pupal skins protruding from tree wounds. Only a low degree of control of borers is obtained where organic insecticides are used in regular cover sprays and applied with an air blast sprayer. In orchards where only the regular peach tree borer is a problem use Thiodan (3 lb./gal. EC) at 1½ qt./100 gal. (4½ qt./acre) or Thiodan (50% WP) at 1½ lb./100 gal. (4½ lb./acre), or Lorsban (4 lb./gal. EC) at 2 qt./100 gal. (3 qt./acre) to the trunk of the tree. Apply first spray the first week of July.

Apply Thiodan at the above rates for control of the lesser peach tree borer. Apply first spray between June 3 to 10 and another 3 weeks later being aware of days between last spray and harvest for the material used.

Make all applications with a high-pressure hand gun. Apply as a coarse dilute spray to the entire tree concentrating on scaffold limbs, crotches, and trunk of the tree to ground level. Thorough coverage, particularly of susceptible areas mentioned above, is a must for good borer control. NOTE: Plastic type mouse guards encourage peach tree borer problems and interfere with effective spray coverage. In problem orchards, a post harvest spray can reduce the late season infestations.

PRE-PLANT TREATMENT TO CONTROL PEACH TREE BORER

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.

1981 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	**6e, 12e**	12. Ferbam	1½-2 lb	4½-6 lb	Apply in autumn after leaf drop or spring before bud swell.
Bacterial Spot	**6f**	6. Bordeaux mixture			
Valsa Canker	See page 60.	Copper sulfate	6 lb		
Crown Gall	See page 61.	Spray lime	6 lb		

Pink

DISEASES					
Brown Rot	See Bloom.				
Valsa Canker	See page 60.				
INSECTS/MITES					
Tarnished Plant Bug	**26g**	26. Thiodan 3 EC	1 qt	3 qt	
Green Fruitworm	**26g, 29g**	50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	

Bloom

DISEASES					
Brown Rot	**1e, 7g, 14f**	1. Benomyl (Benlate)			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 60.	50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		7. Dichlone (Phygon)			
		50 WP	½ lb	1.5 lb	
		14. Wettable Sulfur 95 WP	5 lb	15 lb	
		14. Lime sulfur (Balloon pink only)	2 gal	6 gal	

Petal Fall

DISEASES					
Brown Rot	1e, 14f	1. Benomyl (Benlate)			Powdery mildew is sometimes an economic problem in S.W. Michigan, particularly on Reo-Oso-Gem and Redskin.
Powdery Mildew	1e, 14g	50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		14. Wettable sulfur 95 WP	5 lb	15 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.
INSECTS					
Plum Curculio	8e, 9e, 29g	5. Diazinon 50 WP	1 lb	3 lb	
Oriental Fruit Moth	5g, 8e, 9e, 17g, 23e, 29e	8. Guthion 50 WP	½ lb	1½ lb	
		2 EC	1 pt	3 pt	
Rose Chafer	18g, 23g	9. Imidan 50 WP	1 lb	3 lb	
Tarnished Plant Bug	26g	17. Parathion 15 WP	1½ lb	4½ lb	
Green Peach Aphid	25e, 29g	8 F	⅓ pt	1 pt	
		23. Sevin 50 WP	2 lb	6 lb	
		80 S	1¼ lb	4 lb	
		25. Systox 6 EC	⅓ pt	1 pt	
		26. Thiodan 3 EC	1 qt	3 qt	
		50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		25 WP	1½ lb	4½ lb	

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 60.				

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
INSECTS					
Plum Curculio	See Petal Fall	5. Diazinon 50 WP	1 lb	3 lb	Sprays for borer control should be applied with a hand gun.
Oriental Fruit Moth	See Petal Fall	12. Lorsban 4 EC	1 qt	3 qt	
Rose Chafer	See Petal Fall	17. Parathion 8 F	⅛ pt	1 pt	
Lecanium Scale	**5g, 17g, 23g, 27e**	15 WP	1½ lb	4½ lb	
Peach Tree Borer	**12e, 26g**	23. Sevin 80 S	1¼ lb	4 lb	
Tarnished Plant Bug	**26g**	50 WP	2 lb	6 lb	
		26. Thiodan 50 WP	1½ lb	4½ lb	
		3 EC	1½ qt	4½ qt	
		27. Trithion 4 E	½ pt	1½ pt	
		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 60.				
X-Disease	See page 60.				
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					
Bacterial Spot		18. Penncap-M	2 pt	6 pt	
INSECTS					
Oriental Fruit Moth	See Petal Fall **+18e**				
		Third Cover			
DISEASES					
Peach Scab	Fungicides listed under first cover.				
Powdery Mildew					
Bacterial Spot					
INSECTS					
Oriental Fruit Moth	See Second Cover				
Lecanium Scale	See Shuck Split				

Mites		10. Kelthane 35 WP	1½ lb	4½ lb
adults:	**10g, 16g, 21e, 27g**	18.5 EC	1 qt	3 qt
immatures:	**10g, 16g, 21e, 27g**	16. Omite 30 WP	1½ lb	4½ lb
eggs:		21. Plictran 50 WP	4-6 oz	12-18 oz
		27. Trithion 4 E	½ pt	1½ pt

Fourth Cover

DISEASES
Brown Rot
Bacterial Spot — Fungicides listed under first cover.

INSECTS
Oriental Fruit Moth — See Second Cover

Pre-Harvest

DISEASES
Brown Rot — **1e, 5g, 14f**

1. Benomyl (Benlate) 50 WP, plus	4 oz	12 oz
Captan 50 WP	1½ lb	4½ lb
5. Captan 50 WP	2 lb	6 lb
14. Wettable sulfur 95 WP	5 lb	15 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.

INSECTS
Oriental Fruit Moth — See Petal Fall

Post-Harvest

DISEASES
X-Disease — See page 60.

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
Dodine (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

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

There are no insects or mites on which control treatments are suggested during this period.

Bloom

No insecticides should be applied during bloom.

Post Bloom Pest Problems

Includes the old petal fall, shuck split, first, second and summer cover sprays.

Plum Curculio

Refer to the apple section for a discussion of the life history and biological monitoring of this pest. Apply first spray at the *beginning* of shuck split followed by a second spray 7 to 10 days later. On unusually cool years, a third spray 7 to 10 days following the second may be required if curculio activity persists. Suggested chemicals for control are Guthion, Sevin, parathion, or Imidan. NOTE: If curculio is a serious pest, increase suggested parathion or Guthion rates by 25% or increase Imidan to 4½ lb./acre. Apply sprays 7 days apart.

Oriental Fruit Moth

Refer to the peach section for life history and monitoring of this insect. Timing of sprays is the same as mentioned for the oriental fruit moth in peaches. Suggested chemicals for control are Guthion, Zolone, Sevin, Imidan or parathion.

Peach Tree Borers

Refer to life history, monitoring, and control information in the peach section. Thiodan may be used up to 21 days of harvest for the peach tree borer and 30 days for the lesser peach tree borer. NOTE: Lorsban is not registered for use on apricots.

Special Problems

Apple Maggot

This insect has been reported to attack apricots but is considered a minor problem. Refer to the apple section for the life history and monitoring techniques of this insect. Timing of first fly emergence in your area can be obtained from your District Extension Horticultural Agent. If a history of a problem exists, or damage was noted last year, apply first spray 7 days following first fly emergence. Apply additional sprays at 14-day intervals until harvest noting days between final spray and harvest for the chemical used. The suggested chemical for control is Imidan.

Mites

The European red mite may increase to injurious levels, usually in mid to late summer. Apply controls, two between shuck split and end of season, when mite populations begin to increase. Kelthane is the suggested control.

1981 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	**26e, 29g**	26. Thiodan 50 WP	1 lb	3 lb	
Tarnished Plantbug	**26g**	3 EC	1 qt	3 qt	
		29. Zolone 3 EC	1 pt	3 pt	

Red Bud Stage and Bloom

Brown Rot (blossom blight)	**1e, 5g**	1. Benomyl (Benlate) 50 WP, plus Captan 50 WP	4 oz 1½ lb	12 oz 4½ lb	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.
		5. Captan 50 WP	2 lb	6 lb	

Petal Fall and Shuck Split

DISEASES					
Brown Rot	**1e, 5g**	1. Benomyl (Benlate) 50 WP, plus Captan 50 WP	4 oz 1½ lb	12 oz 4½ lb	Fungicide for brown rot and scab will not control bacterial spot.
Scab	**1e, 5g**	5. Captan 50 WP	2 lb	6 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	
		2 EC	1 pt	3 pt	
Plum Curculio	**8e, 9e, 29g**	9. Imidan 50 WP	1 lb	3 lb	
Tarnished Plant Bug	**26g**	17. Parathion 15 WP	1½ lb	4½ lb	
		8 F	⅓ pt	1 pt	
		23. Sevin 50 WP	2 lb	6 pt	
		80 S	1¼ lb	4 lb	
		26. Thiodan 3 EC	1 qt	3 qt	
		50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		25 WP	1½ lb	4½ lb	

First Cover

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	Fungicides listed under petal fall.				
Scab					
INSECTS					
Peach Tree Borer	See page 53				
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, 27g**	8. Guthion 50 WP	½ lb	1½ lb	
Oriental Fruit Moth	See Petal Fall	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	
		80 S	1¼ lb	4 lb	
		27. Trithion 4 E	½ pt	1½ pt	
		29. Zolone 25 WP	1½ lb	4½ lb	
		3 EC	1 pt	3 pt	

PRUNE AND PLUM PRODUCTION INFORMATION

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

Includes pest problems traditionally encountered and treated in the delayed dormant period.

European Red Mite

Refer to the apple section for life history of this mite. Monitoring to detect the presence and determine relative abundance of mites is accomplished exactly as on aphids. Integrated mite control, usually associated with apples, can be applied to plum production as well. For further information, consult Extension Bulletin E-825. A pre-bloom preventive program is suggested for European red mite control. Superior oil applied in the delayed dormant gives good control of overwintering eggs. If mite populations increase during the summer, apply organic miticides. Chemicals suggested for summer mite control are Omite, Plictran or Kelthane. Do not repeat Kelthane application within 30 days of last application. Thorough coverage of both sides of leaves is important for good control with Omite.

Lecanium Scale

Refer to the peach section for a discussion of life history and monitoring for the insect. Overwintering scale may be controlled by adding parathion (15% WP) at 3 lb./acre to the oil applied for European red mite control. If oils are not applied for mite control, then scale can be controlled in the crawler stage. Sprays should be applied when first crawlers appear (usually June 25 to July 15). Make a second application 10 to 12 days later. Suggested chemicals for control are parathion (with oil in pre-bloom or against crawlers) or Diazinon (against crawlers only).

Bloom

No insecticides should be applied during bloom.

Post Bloom Pest Problems

Includes old spray timing periods of petal fall, shuck split, first, second, third and fourth covers.

Plum Curculio

Refer to the apple section for life history and monitoring for this insect. Apply sprays at the *beginning* of shuck split followed by another cover within 7 to 10 days. A third spray may be required on unusually cool years if curculio remains active. Suggested chemicals for control are Guthion, Imidan, or Zolone.

Peach Tree Borers

Refer to the peach section for life history and monitoring as well as timing and application procedures. Thiodan at 2¼ lb. act. ingred./acre (same rate as in peaches) is suggested.

Apple Maggot

While not a common problem, this insect can do considerable damage. Refer to the apple section for life history, monitoring and timing for this insect. Where severe or historical problems with this pest have occurred, follow the same schedule suggested for apples or establish a monitoring system to detect the presence and activity of maggots. Suggested chemical for control is Imidan.

1981 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	
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. Benomyl (Benlate)			Benlate plus Captan has a Section 24C registration for black knot control in Michigan.
Black Knot	**1g**	50 WP, plus	4 oz	12 oz	
		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, 7g, 14f**	1. Benomyl (Benlate)			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. 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.
Black Knot	1g	50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		7. Dichlone (Phygon) 50 WP	½ lb	1½ lb	
		14. Wettable sulfur 95 WP	5 lb	15 lb	
		14. Lime sulfur (Early bloom)	2 gal	6 gal	

Petal Fall

DISEASES					
Brown Rot	**1e, 12g**	1. Benomyl (Benlate)			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, 12g**	50 WP, plus	4 oz	12 oz	
Black Knot	1g	Captan 50 WP	1½ lb	4½ lb	
		12. Ferbam 76 WP plus	1 lb	3 lb	
		Wettable sulfur 95 WP	3 lb	9 lb	
INSECTS					
Plum Curculio	**8e, 9e, 18e, 29g**	8. Guthion 50 WP	½ lb	1½ lb	
		2 EC	1 pt	3 pt	
		9. Imidan 50 WP	1 lb	3 lb	
		18. Penncap-M	2 pt	6 pt	
		29. Zolone 3 EC	1 pt	3 pt	
		25 WP	1½ lb	4½ lb	

Shuck Split

DISEASES	
Brown Rot	Fungicides listed under petal fall.
Leaf Spot	
Black Knot	
INSECTS	
Plum Curculio	See Petal Fall

First Cover

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	Fungicides listed under petal fall.				
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 55.	17. Parathion 15 WP	1½ lb	4½ lb	
Plum Curculio	See Petal Fall.	8 F	⅓ pt	1 pt	

Summer Mite Control

MITES					
Mites	**16g, 21e, 27g**	16. Omite 30 WP	1¼ lb	3¾ lb	
		21. Plictran 50 WP	4-6 oz	¾-1⅛ lb	
		27. Trithion 4 EC	½ pt	1½ pt	

Second Cover

DISEASES					
Leaf Spot	Fungicides listed under petal fall.				
Black Knot					
INSECTS					
Apple Maggot	**8e, 9e, 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.
Leaf Hopper	**27g**	2 EC	1 pt	3 pt	
		9. Imidan 50 WP	1 lb	3 lb	
		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.				
INSECTS					
Apple Maggot	See Second Cover.				

Pre-Harvest

DISEASES					
Brown Rot	**1e, 5g, 14f**	1. Benomyl (Benlate)			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**	50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		5. Captan 50 WP	2 lb	6 lb	
		14. Wettable sulfur 95 WP	5 lb	15 lb	

TART CHERRY PRODUCTION INFORMATION

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

Green Fruitworm

Refer to the apple section for life history of this insect. The green fruitworm has been an increasing problem on cherries in recent years and its activity resulted in considerable damage in some orchards last year. The best time to apply controls for this pest is when the larva is present but prior to fruit feeding. For cherries this is at white bud, petal fall, and shuck split. Thiodan applied for aphid control at petal fall has provided green fruitworm control.

Mineola Moth

The mineola moth completes one and a partial second generation in Michigan. It overwinters as a partially grown larvae in a hibernaculum on the tree. In late April or early May, the larvae leaves the hibernaculum and begin feeding on buds. This feeding activity continues until petal fall. Pupation occurs shortly after petal fall with adult emergence beginning about 3 weeks after bloom. Eggs are laid shortly after emergence and upon hatching the larvae enter fruit. They feed on the flesh and are present at harvest.

About 5% of the first generation complete a second generation with adults appearing the end of July. Second generation larvae feed on the foliage until fall when hibernacula are constructed. The presence and seasonal activity of the moth can be monitored using a blacklight trap. Controls can be applied against either, or both, the overwintering larvae or adult moths during emergence, depending on the severity of the problem.

Apply sprays directed against the overwintering larvae when they leave the hibernacula and start feeding on the buds, usually between green tip and popcorn stage. Apply sprays against adults at the beginning and again at the peak of emergence (peak emergence usually 2 weeks following first emergence). Regardless of which stage is controlled, apply sprays to both sides of the row for adequate control. Guthion is suggested as a control.

Eye-Spotted Bud Moth

This insect passes through one generation a year in Michigan. It overwinters as a half grown larva in a hibernaculum on the tree. In early May, larvae leave the hibernaculum and feed on opening buds or foliage. Pupation takes place soon after shock split and adult emergence begins in late June or early July. Larvae are present by mid-July and feed primarily on foliage, though some fruit may be attacked. Apply control sprays in the popcorn stage to control overwintering larvae or in the summer as adults emerge. Suggested chemicals are Guthion or parathion. The insect has not been a problem in commercial orchards for the past few years, but growers should be aware of it and check for it as a precaution.

Post Bloom Pest Problems

Includes petal fall, first, second, third, and fourth cover sprays in the old spray calendar.

Plum Curculio

Refer to the apple section for life history and monitoring for this insect. Apply first spray at the *beginning* of shuck split followed by a second spray 10 to 14 days later. Suggested chemicals for control are Guthion, Imidan, or parathion.

Scale

The primary scale pest is Forbes scale. It passes the winter as a partially grown scale. The scales are about the size and shape of San Jose scale. Female scale are mature by May with crawlers being produced usually in late May or June. One generation is produced per year. This insect is only considered an important pest on tart cherries. Apply sprays in the summer when crawlers appear (usually second and third cover). Suggested chemicals are Guthion (50% WP) at 3¾ lb./acre, Guthion (2 lb./gal. EC) at 3¾ pt./acre, Sevin (50% WP) at 6 lb./acre, or Sevin (liquid) at 3 lb. act. ingred./acre.

Peach Tree Borers

Refer to the peach section (page 55) for a life history of the peach tree borer and lesser peach tree borer. Thiodan may be used in two applications during the fruiting season but not within 21 days of harvest. On some varieties of sweet cherries, only one application can be made and still stay within the 21-day interval to harvest.

Regular Peach Tree Borer—Apply Thiodan (50% WP) 1½ lb./100 gal. (6 lb./acre) three weeks before harvest. Apply with handgun as a coarse dilute spray on the trunk of the tree to the ground line. To avoid excess residues, do not spray the scaffold limbs, fruit or foliage. Apply a *post* harvest spray if necessary.

Lesser Peach Tree Borer—Lesser peach tree borer has become a serious problem on tart cherry trees due to mechanical harvesting. Shaking the trees bruises and breaks the bark of the trunk and scaffold limbs, thus attracting and providing egg-laying sites for the moth. Apply Thiodan (50% WP) 1½ lb./100 gal. (4½ lb./acre) between June 3 to 10 depending on harvest date. Two applications are possible before harvest in northern counties, the second applied June 16 to 23. Guthion or parathion applied in regular cover sprays do not control this insect.

Apply controls with a handgun as a coarse dilute spray to the entire tree concentrating on the scaffold limbs, crotches, cankers and trunk to the ground level. Thorough coverage, particularly of the susceptible areas mentioned above, is a must for borer control. Lesser peach tree borer is present until October. In problem orchards, a post-harvest spray of Thiodan will reduce late season infestations. There are no restrictions for post harvest use of Thiodan.

Mites

Two Spotted and European Red mites infest cherries. These have increased during the past few years in the Traverse City area. Growers may want to apply Kelthane during the growing season before they develop into damaging population. When the leaves become bronzed, the trees are weakened and may go into winter in a less hearty condition and are subject to winter injury. In addition, heavy populations may affect fruit set in the succeeding crop.

Plum Nursery Mites—These are very small vermiform (carrot shaped), invisible to the naked eye, mites. They overwinter as females under bud scales. As the leaves unfold, the females move to them to lay their eggs. Treatment (Kelthane) must be applied pre bloom to be effective.

American Plum Borer—This is a major pest of sweet and tart cherries in Michigan. Winter injury and mechanical shaking produce wounds in the bark. These are very attractive as oviposition sites for the females. Larvae feed under the bark on the cambium layer, and this greatly reduces tree longevity. At this time, there are no registered compounds that will control this pest, and none are expected in the near future.

Cherry Fruit Flies

There are two species of fruit flies which infest cherries in Michigan, the cherry fruit fly and the black cherry fruit fly. Life history and control methods are so similar that they may be considered as one pest. The winter is passed as a pupa in the soil. The beginning of adult emergences varies with geographical location but generally starts in early June in southern Michigan and late June in northern counties.

The adult fly passes through an 8 to 10 day preoviposition period before it is capable of laying eggs. Eggs are deposited in the fruit and upon hatching the larva tunnels through the flesh of the cherry. The larva is mature in about 2 weeks and exits the fruit, dropping to the ground where it burrows in an inch or so and pupates. Monitoring for cherry fruit flies is the same as for the apple maggot (see discussion in apple section). Apply first control spray 7 days after the emergence of first flies in your area.

Adult emergence information will be available from your District Extension Horticultural Agent based on the detection of flies in monitored bait traps. Apply subsequent covers at 10 to 14 day intervals until harvest keeping in mind the interval between last spray and harvest for the material used. NOTE: recent research has indicated good control by AERIAL APPLICATION and there may be economic advantages utilizing such a technique. Suggested chemicals for control are Guthion, Penncap-M, Diazinon, Sevin, Imidan, phosalone (Zolone) or Cythion (aerial only). Sevin is recommended primarily as an emergency treatment near harvest.

1981 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
INSECTS/MITES					
Mineola Moth	5g, 8e, 9e, 17g, 23g, 29e	5. Diazinon 50 WP	1 lb	3 lb	
		8. Guthion 2 EC	1 pt	3 pt	
		50 WP	½ lb	1½ lb	
Eye-Spotted Bud Moth	5g, 8e, 9e, 17g, 23g, 29e	9. Imidan 50 WP	1 lb	3 lb	
		17. Parathion 15 WP	1 lb	3 lb	
Mites	24e, 24 + 27e, 27g	23. Sevin 50 WP	2 lb	6 lb	
Scales	24e, 24 + 27e, 27g	24. Superior Oil	1-2 gal	3-6 gal	
		27. Trithion 4 EC	½-1 pt	1½-3 pt	
		29. Zolone 3 EC	1 pt	3 pt	
		25 WP	1½ lb	4½ lb	

Pre-Bloom

DISEASES					
Brown Rot	1e, 7g, 8f, 14f	1. Benomyl (Benlate)			Use Difolatan on mechanically harvested cherries only. Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and does not control Benlate-resistant brown rot.
		50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		7. Dichlone (Phygon)			
		50 WP	½ lb	1½ lb	
		8. Difolatan 4 F	2 pt	6 pt	
		14. Wettable sulfur 95 WP	5 lb	15 lb	
INSECTS					
Green Fruitworm (Apply at white bud stage)	26g, 29g	10. Kelthane 35 WP	1¼ lb	3¾ lb	
		18.5 EC	1 qt	3 qt	
Plum Nursery Mite	10g, 27g	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	

Bloom

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
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					Use high rate of Cyprex or Difolatan during wet seasons or when disease pressure is heavy.
Brown Rot	**1e, 8f**	1. Benomyl (Benlate)			
Leaf Spot	**1e, 8e, 11g**	50 WP, plus	4 oz	12 oz	A marked increase in Benlate-resistant leaf spot was detected on tart and sweet cherries in 1979. The use of Benlate plus Captan in orchards with prior Benlate usage could intensify the level of resistant strains. Topsin M does not control Benlate-resistant leaf spot or brown rot and its use will increase the resistance problem in Michigan orchards.
		Captan 50 WP	1½ lb	4½ lb	
		8. Difolatan 4 F	1-2 pt	3-6 pt	
		11. Dodine (Cyprex) 65 WP	¼-½ lb	¾-1½ lb	
INSECTS					
Green Fruitworm	**26g, 29g**	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**	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**	15 WP	1½ lb	4½ lb	
		23. Sevin 50 WP	2 lb	6 lb	
		80 S	1¼ lb	4 lb	
		26. Thiodan 50 WP	1 lb	3 lb	
		29. Zolone 3 EC	1 pt	3 pt	
		25 WP	1½ lb	4½ lb	

First Cover

DISEASES					A spotting of tart cherry fruit may occur when liquid Guthion and dodine (Cyprex) or Difolatan are applied at 65X concentration from aircraft, with high temperatures at application or soon thereafter.
Leaf Spot	**8e, 11g**	8. Difolatan 4 F	1-2 pt	3-6 pt	
Brown Rot	**8g**	11. Dodine (Cyprex) 65 WP	¼-½ lb	¾-1½ lb	

INSECTS					
American Plum Borer	See page 70.				
Plum Curculio	See Petal Fall				
Peach Tree Borers	See page 55.				

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 16).
		8 F	⅓ pt	1 pt	
		18. Penncap-M	1-2 pt	3-6 pt	
		27. Trithion 4 F	½ pt	1½ pt	

Third Cover

DISEASES					
Brown Rot	Fungicides listed under first cover.				
Leaf Spot					
INSECTS					
Cherry Fruit Fly	**5g, 8e, 9e, 18e, 23g, 29e, 31e**	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	
		2 EC	1 pt	3 pt	
Rose Chafer	See Petal Fall	9. Imidan 50 WP	1 lb	3 lb	
Scale	See Second Cover	18. Penncap-M	1-2 pt	3-6 pt	If Mesurol is used at this rate, it works very effectively as a bird repellent.
		23. Sevin 50 WP	2 lb	6 lb	
		80 S	1¼ lb	4 lb	
		29. Zolone 3 EC	1 pt	3 pt	*WARNING:* Penncap-M should not be applied if pollenators are working flowers (cover-crop) on the orchard floor (see page 16).
		25 WP	1½ lb	4½ lb	
		31. Mesurol 75 WP	1⅓ lb	4 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

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
MITES					
European Red Mite	10g, 27g	10. Kelthane 35 WP	1¼ lb	3¾ lb	
		18.5 EC	1 qt	3 qt	
Two Spotted Mite	10g, 27g	27. Trithion 4 EC	½-1 pt	1½-3 pt	

Pre-Harvest

DISEASES					
Leaf Spot	1e, 8e, 11g	1. Benomyl (Benlate)			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.
Brown Rot	1e, 8g, 11f	50 WP, plus	4 oz	12 oz	
		Captan 50 WP	1½ lb	4½ lb	
		8. Difolatan 4 F	2 pt	6 pt	
		11. Dodine (Cyprex)			
		65 WP, plus	¼ lb	¾ lb	
		Wettable sulfur 95 WP	3 lb	9 lb	
INSECTS					
Cherry Fruit Fly	See Third Cover				

A marked increase in Benlate-resistant leaf spot was detected on tart and sweet cherries in 1979. The use of Benlate plus Captan in orchards with prior Benlate usage could intensify the level of resistant strains. Topsin M does not control Benlate-resistant leaf spot or brown rot and its use will increase the resistance problem in Michigan orchards.

Post-Harvest

DISEASES				
Leaf Spot	8e, 11g	8. Difolatan 4 F	1½-2 pt	4½-6 pt
		11. Dodine (Cyprex)		
		60 WP	½ lb	1½ lb
INSECTS				
Peach Tree Borer	See page 55.			

SWEET CHERRY PRODUCTION INFORMATION

INSECT AND MITE CONTROL

Pre-Bloom Pest Problems

Green Fruitworm

Refer to the tart cherry section for a discussion of this insect.

Black Cherry Aphid

This insect is a problem on *sweet* cherries. Winter is passed in the egg stage. Hatching begins as buds open and young nymphs seek out foliage in the opening buds. Several generations are produced on cherry by mid-summer when winged forms appear and migrate to summer hosts. In September and October, aphids fly back to cherry and deposit overwintering eggs. Overwintering eggs may be detected on buds or bark of small branches prior to bloom. If present, controls should be applied in the spring before their feeding curls the leaves. Apply sprays at pink or petal fall.

Bloom

No insecticides should be applied during bloom.

Post Bloom Pest Problems

Includes petal fall, first, second, third, and fourth cover sprays in the 1980 recommendations.

Plum Curculio

Refer to the tart cherry section for a discussion of this insect.

Peach Tree Borer and Lesser Peach Tree Bore

Refer to the tart cherry section for a discussion of this insect including correct timing and application procedures. Thiodan is the suggested chemical for control.

Cherry Fruit Flies

Refer to the tart cherry section for a discussion of this insect. Suggested chemicals for control are Guthion, Penncap-M, Diazinon, Sevin, phosalone (Zolone), or Cythion (by air only). Sevin is suggested primarily as an emergency treatment near harvest.

1981 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					
Brown Rot (blossom blight)	**1e, 7g, 14f**	1. Benomyl (Benlate) 50 WP, plus	¼ lb	1 lb	Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin M will increase problems with fungicide resistance and will not control Benlate-resistant brown rot.
		Captan 50 WP	1½ lb	6 lb	
		7. Dichlone (Phygon) 50 WP	½ lb	2 lb	
		14. Wettable sulfur 95 WP	5 lb	20 lb	
INSECTS					
Black Cherry Aphid	**5g, 26e, 27g, 29g**	5. Diazinon 50 WP	1 lb	4 lb	
Green Fruitworm	**26e, 29g**	24. Superior Oil	1-2 gal	4-8 gal	
Mites	**24e, 27g**	26. Thiodan 50 WP	1 lb	4 lb	
Scales	**24e + 27e**	27. Trithion 4 EC	½-1 pt	2-4 pt	
		29. Zolone 3 EC	1 pt	4 pt	
		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, 5g, 12f**	1. Benomyl (Benlate) 50 WP, plus	4 oz	1 lb	A marked increase in Benlate-resistant leaf spot was detected on tart and sweet cherries in 1979. The use of Benlate plus Captan in orchards with prior Benlate usage could intensify the level of resistant strains. Topsin M will increase the resistance problem and does not control Benlate-resistant leaf spot or brown rot.
Leaf Spot	**1e, 5f, 12f**	Captan 50 WP	1½ lb	6 lb	
		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				
Black Cherry Aphid	See Pre-Bloom	8. Guthion 50 WP	½ lb	2 lb
Green Fruitworm	See Pre-Bloom	2 EC	1 pt	4 pt
Leafrollers	8e, 17g, 29e	17. Parathion 15 WP	1½ lb	6 lb
Plum Curculio	8e, 29g	8 F	⅔ pt	1⅓ pt
		29. Zolone 3 EC	1 pt	4 pt
		25 WP	1½ lb	6 pt

Shuck Split

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

First Cover

DISEASES	
Brown Rot	Fungicides listed under petal fall.
Leaf Spot	
INSECTS	
American Plum Borer	See page 70
Black Cherry Aphid	See Pre-Bloom
Leafrollers	See Petal Fall
Peach Tree Borers	See page 55
Plum Curculio	See Petal Fall
Rose Chafer	See Third Cover

Summer Mite Control

MITES				
European Red Mite	10g, 27g	10. Kelthane 35 WP	1¼ lb	5 lb
Two Spotted Mite	10g, 27g	18.5 EC	1 qt	4 qt
		27. Trithion 4 EC	½-1 pt	2-4 pt

Second Cover

PESTS	Efficiency	Suggested Chemicals	Rate/ 100 gal	Rate/acre	Comments
DISEASES					
Brown Rot	Fungicides listed under petal fall.				
Leaf Spot					
INSECTS					
Black Cherry Aphid	See Pre-Bloom				
Leafrollers	See Petal Fall				
Rose Chafer	See Third Cover				

Third Cover

DISEASES					
Brown Rot	Fungicides listed under petal fall.				
Leaf Spot					
INSECTS					
Cherry Fruit Fly	5g, 8e, 9e, 18e, 23g, 29e, 31e	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. If Mesurol is used at this rate, it is a very effective bird repellent.
Rose Chafer	23g	8. Guthion 50 WP	½ lb	2 lb	
		2 EC	1 pt	4 pt	
		9. Imidan 50 WP	1 lb	4 lb	
		18. Penncap-M	1-2 pt	3-6 pt	*WARNING:* Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 16).
		23. Sevin 50 WP	2 lb	8 lb	
		80S	1¼ lb	4 lb	
		29. Zolone 3 EC	1 pt	4 pt	
		25 WP	1½ lb	6 lb	6 pt. is the maximum legal rate of Penncap-M on sweet cherries.
		31. Mesurol 75 WP	1⅓ lb	4 lb	

Pre-Harvest

DISEASES					
Brown Rot	Fungicides listed under petal fall.				
Leaf Spot					
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 55				

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
Bud Swell *(Shoots 1 to 3 in. long)*	Phomopsis leaf and cane spot disease	Captan 50 WP	2 lb	4 lb	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.
		OR			
		Folpet (Phaltan) 50 WP	2 lb	4 lb	
		OR			
		Dithane M22 Special	¾ lb	1½ lb	
		OR			
		Mancozeb (Dithane M-45 or Manzate 200)	¾ lb	1½ lb	
	Grape flea beetle	No chemical controls			An emergency permit has been requested from the Environmental Protection Agency for pre-bloom applications of permethrin. These materials will give effective control of grape flea beetle and climbing cutworms. Check with your county agent for latest information on the availability of these materials.
	Climbing cutworms	No chemical controls			

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. Fungicide tests are in progress towards a program where vines can be sprayed immediately after pruning 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. 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.

First Cover *(Pre-bloom shoots 4 to 6 in. long)*	Black rot	Ferbam 76 WP	1½ lb	3 lb	Ferbam slightly controls downy mildew. Benlate gives no control of downy mildew.
		OR			
		Benlate* 50 WP	½ lb	1 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.

Continued

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
	Black rot + downy mildew	Folpet 50 WP	2 lb	4 lb	Folpet applied here will give further control of phomopsis leaf and cane spot disease.
		OR			
		Dithane M22 Special	1¼ lb	2½ lb	Captan is excellent against this disease and downy mildew, but weak against black rot.
		OR			
		Mancozeb	1 lb	2 lb	
SECOND COVER *(Blossom opening)*	Black rot	Ferbam 76 WP	1½ lb	3 lb	Dinocap (Karathane WD) should be added to Dithane M22 Special or Mancozeb only for powdery mildew control. While Benlate is excellent for control of black rot and powdery mildew, it does not control downy mildew. To insure control of downy mildew, add Dithane M22 Special, Mancozeb, Phaltan, or captan as a tank mix at the recommended rates.
	OR	OR			
	Black rot + powdery mildew	Benlate 50 WP	½ lb	1 lb	
	Black rot, downy and powdery mildew	Folpet 50 WP	2 lb	4 lb	
		OR			
		Dithane M22 Special	1¼ lb	2½ lb	
		plus			
		Dinocap 25 WP (Karathane WD)	2 lb	4 lb	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.
		OR			
		Mancozeb	2 lb	4 lb	
		plus			
		Dinocap 25 WP (Karathane WD)	2 lb	4 lb	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 season, downy mildew was very serious. A strong effort directed toward better control is necessary.
		OR			
		Fixed copper (actual)	1½ lb	3 lb	
		plus			
		Hydrated lime	6 lb	12 lb	
	Grape berry moth, **5g, 8e, 9e, 17g, 18e, 23e, 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	
		2 EC	1 pt	2 pt	
		9. Imidan 50 WP	1 lb	2 lb	
		17. Parathion 15 WP	2 lb	4 lb	
		8 F	⅓ pt	⅔ pt	
		18. Penncap-M 2 F	1-4 pt	2-8 pt	
		23. Sevin 50 WP	2 lb	4 lb	
		80 S	1¼ lb	2½ lb	
	Grape phyloxera **26e, 29e**	26. Thiodan 2 F	2 pt	4 pt	
		50 WP	1 lb	2 lb	
		29. Zolone 25 WP	4 lb	8 lb	
		3 EC	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)	5. Diazinon 50 WP	1 lb	2 lb	Timing for second brood berry moth is announced by your county ag. agent.
	Grape leaf hopper, **5g, 8f, 9f, 18e, 23e, 29e**	8. Guthion 50 WP	½ lb	1 lb	
		2 EC	1 pt	2 pt	
		9. Imidan 50 WP	1 lb	2 lb	
		18. Penncap-M 2 F	4 pt	8 pt	
	Rose chafer, **18e, 23g**	23. Sevin 50 WP	2 lb	4 lb	Control mites as populations increase.
		80 S	1¼ lb	2½ lb	
		29. Zolone 25 WP	4 lb	8 lb	
		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.
	Grape berry moth	See Second Cover			NOTE: Time interval between last spray and harvest for Mancozeb is 66 days, but for Dithane M-22 Special it is 7 days.
	Grape phyloxera	See Second Cover			
	Grape leaf hopper	See Third Cover			
	Rose chafer	See Third Cover			
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			
SIXTH COVER *(10 to 14 days after* FIFTH COVER)	Grape berry moth	See Second Cover			
SEVENTH COVER *(About August 7)*	Powdery mildew	Benlate 50 WP	½ lb	1 lb	Benlate gives superior control of powdery mildew on French hybrid grapes.
		OR			
		Folpet 50 WP	2 lb	4 lb	

Continued

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
		Wettable sulfur OR	2 lb	4 lb	Refer to sulfur tolerance list for grapes. Sulfur can cause severe injury to certain grape varieties.
		Dinocap (Karathane WP)	2 lb	4 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

To reduce white grub and root weevil injury and to avoid root aphid injury in strawberry plantings, be sure soil is thoroughly worked the season prior to bed establishment.

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	½ lb	1 lb	*Repeated use of Benlate will result in the rapid build-up of tolerance in fungi. Either use Benlate in an alternating schedule with Captan or use the two together as a tank mix.
		OR			
		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, **8f**	23. Sevin 50 WP	2 lb	4 lb	
		80 S	1¼ lb	2½ lb	**Strawberry clipper:** Apply first spray when first buds become visible followed by a second spray 10 days later.
		26. Thiodan 50 WP	1 lb	2 lb	
		2 EC	1 qt	2 qt	
	Slugs, **32g**	32. Metaldehyde baits			
		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	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.
		OR			
		Captan 50 WP	2½ to 3 lb	5 to 6 lb	
	Tarnished plant bug, **26e**	8. Guthion 50 WP	½ lb	1 lb	
		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			

Timing	Insect/Disease (Efficiency)	Suggested Chemicals	Rate/100 gal	Rate/acre	Comments
THIRD COVER *(50% bloom and green fruit)*	Gray mold, stem end fruit rot, leaf blight, leaf spot	Benlate 50 WP plus	¼ lb	½ 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.
		Captan 50 WP	2 lb	4 lb	
		OR			
		Captan 50 WP	2½ to 3 lb	5 to 6 lb	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	Benlate 50 WP plus	¼ lb	½ lb	Use dust only as a relatively poor alternate choice.
		Captan 50 WP	2 lb	4 lb	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.
	Strawberry sap beetle, **5g, 8g**	OR			
		Captan dust (7.5 captan)		4 lb	
		5. Diazinon 50 WP	1 lb	2 lb	
		4 EC	1 pt	1 qt	
		8. Guthion 50 WP	½ lb	1 lb	
		2 EC	1 pt	1 qt	
DURING HARVEST	Gray mold, stem end fruit rot, leaf diseases	See recommendations and comments for Pre-harvest			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).
		10. Kelthane 35 WP	1¼ lb	2½ lb	
		18.5 EC	2 pt	4 pt	
	Cyclamen mites, **10g, 26g**	26. Thiodan 2 EC	1 qt	2 qt	
		50 WP	1 lb	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	
		2 EC	1 pt	2 pt	
	Leafhoppers, **5g, 25e**	17. Parathion 15 WP	2 lb	4 lb	See label for restriction of Thiodan use.
	Strawberry aphids, **25e, 26e**	8 F	⅓ pt	⅔ lb	Slugs: (see note page 83).
		23. Sevin 50 WP	2 lb	4 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.
	Slugs, **32g**	80 S	1¼ lb	2½ lb	
		25. Systox 6 EC	⅓ pt	⅔ pt	
		26. Thiodan 2 EC	1 qt	2 qt	
		32. 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		
		plus			
		Hydrated lime	3 lb		
	Leafrollers, **5g, 8e**	5. Diazinon 50 WP	1 lb	2 lb	
	Raspberry sawfly, **8e, 13g**	4 EC	1 pt	2 pt	

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.
		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	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.
		OR			
		Ferbam 76 WP	½ 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**	4 EC	1 pt	2 pt	
		10. Kelthane 35 WP	1¼ lb	2½ lb	
		18.5 EC	2 pt	4 pt	
		17. Parathion 15 WP	2 lb	4 lb	
		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**	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

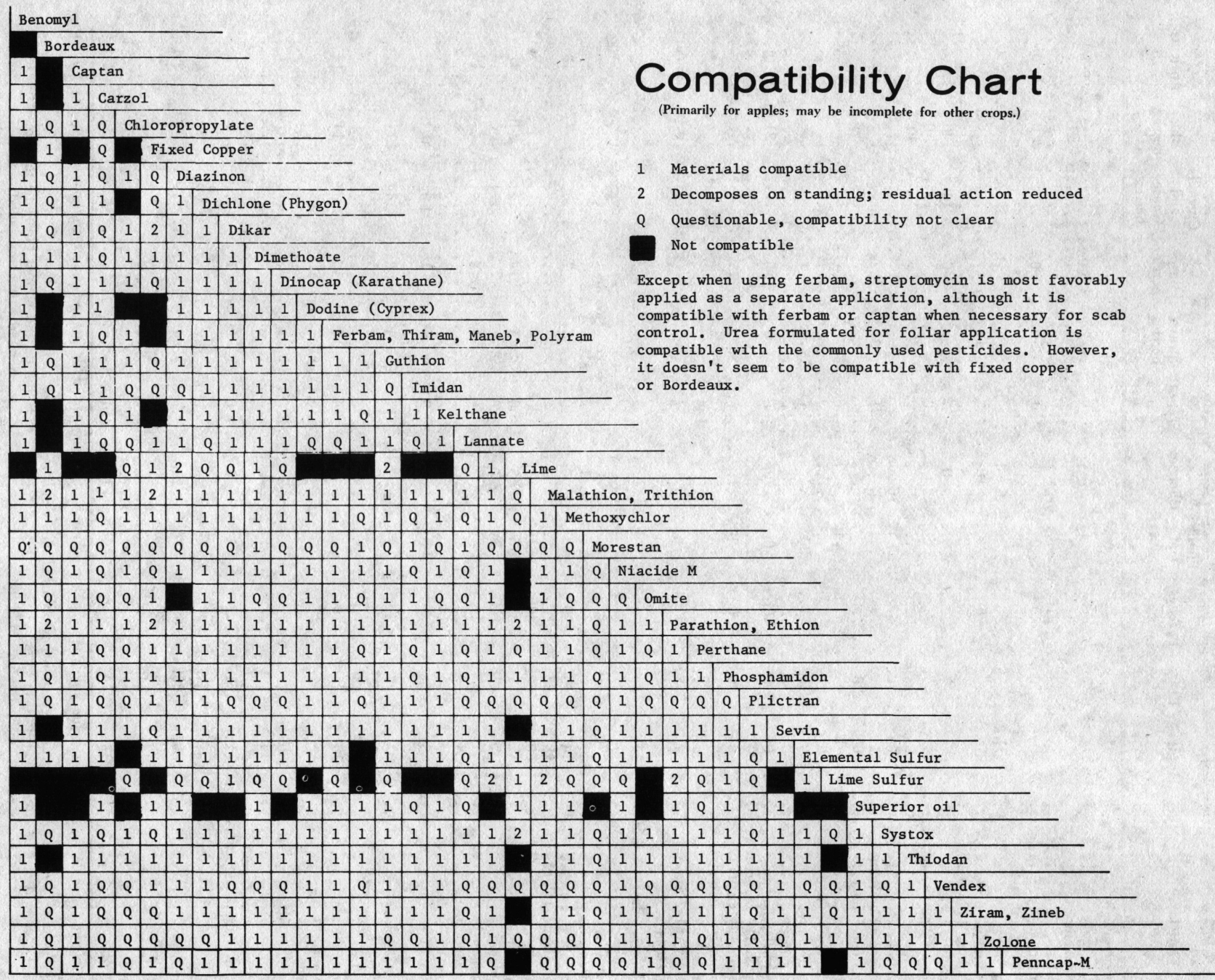
Rates of materials for blueberry are based on standard amounts/acre used in air applications. NOTE: Do not apply any fungicides *(except Funginex)* listed by airplane. Thorough coverage by ground sprayers is essential with the recommended fungicides. See Extension Bulletin E-840 for calibration of sprayers.

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 Mummyberry (Shoot blight phase)	Difolatan 4F	1 qt	2 qt	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. Conidiaspores of both fungi are spread from cankers on stems with each rain beginning at bud break and continuing into the fall.
		Funginex 20 EC*		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	
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 4F* OR	1 qt	2 qt	
		Funginex 20 EC plus		24 fl oz	Funginex controls mummyberry only. Difolatan or Captan needed for control of the other diseases listed.
		Difolatan 4F*	1 qt	2 qt	
	*Substitute Captan 50W at 5 lb/acre for Difolatan if allergic to Difolatan.				
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 4F* OR	1 qt	2 qt	
		Funginex 20 EC		24 fl oz	Funginex controls mummyberry only.

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 4F*	1 qt	2 qt	
		OR			
		Funginex 20 EC		24 fl oz	Funginex controls mummyberry only.
	*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 4F*	1 qt	2 qt	Phomopsis canker will be partially controlled. NOTE: ULV Malathion + Difolatan can burn blueberry fruit and leaves when applied as a tank mix.
	*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 4F	1 qt	2 qt	Phomopsis will be partially controlled.
		OR			
		Captan 50W	2½ lb	5 lb	
THIRD COVER *(10-14 days after Second Cover)*	Fusicoccum canker, Anthracnose and Alternaria fruit rots	Difolatan 4F	1 qt	2 qt	Interval between last application and harvest for Difolatan is 21 days. Phomopsis canker will be partially controlled.
		OR			
		Captan 50W	2½ lb	5 lb	
FOURTH COVER *(Time to be announced by Dist. Hort. Agent)*	Fusicoccum canker	Difolatan 4F	1 qt	2 qt	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.
		OR			
		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 4F	1 qt	2 qt	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.

Insect Control

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	1 lb	2 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.
		8. Guthion 2 SC	½ qt	1 qt	
		9. Imidan 50 WP	1 lb	2 lb	
		13. Malathion 25 WP	4 lb	8 lb	
		17. Parathion 15 WP	2 lb	4 lb	
		23. Sevin 80 S	1¼ lb	2½ lb	
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, 5g, 13g**	4. Cythion ULV 95 Tech	—	10 oz	For control of aphid vectors of blueberry shoestring virus: Malathion should be applied with a ground sprayer (air blast or boom type).
		5. Diazinon 50 WP	1 lb	2 lb	
		8. Guthion 2 SC	½ qt	1 qt	
		13. Malathion 25 WP	4 lb	8 lb	
		23. Sevin 80 S	1¼ lb	2½ lb	
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, 31e** Blueberry borer, **17g**	4. Cythion ULV 95 Tech	—	10 oz	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.
		5. Diazinon 50 WP	1 lb	2 lb	
		8. Guthion 2 SC	½ qt	1 qt	
		9. Imidan 50 WP	1 lb	2 lb	
		13. Malathion 25 WP	4 lb	8 lb	
		17. Parathion 15 WP	1½ lb	3 lb	
		8 F	⅓ pt	⅔ pt	
		31. Mesurol 75 WP	2 lb	4 lb	
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.

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											
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			
Streptomycin	50	30									
Sulfurs	h		h	h	h						
Thiram (Thylate)	0		7				3e				
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 M22 Special						7					
Insecticides											
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					
Perthane	7	7			2						
Phosphamidon	30				f						
Plictran	14f	14f									
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.

SPRAY RECORD SHEET

GROWER	YEAR
CROP	**HARVEST DATE**

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

Tear out along this line

SPRAY RECORD SHEET

GROWER	YEAR
CROP	HARVEST DATE

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

SPRAY RECORD SHEET

GROWER	YEAR
CROP	HARVEST DATE

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

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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