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Fruit Pesticide Handbook For Commercial Fruit Growers
Michigan State University Extension Service
A.L. Jones, Botany and Plant Pathology; J. Hull, Horticulture; John Wise, T. Mike
Thomas , Entomology
Revised November 1996
132 pages

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FOR COMMERCIAL FRUIT GROWERS

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Fruit Spraying Calendar **1997**



Extension Bulletin E-154, Information Current as of November 1, 1996, revised annually. **DESTROY PREVIOUS EDITIONS**

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EXTENSION

Fruit Extension Agents in Michigan

The following contacts can provide fruit management assistance. The Code-A-Phone Numbers listed provide taped messages for a specific cropping system and region of Michigan. Addresses of the agents are provided for further contacts.

Region and District Agent	Code-A-Phone Numbers	
SOUTHWEST		
Mark Longstroth, District Horticultural and Marketing Agent Van Buren Extension Office 801 Hazen Street, Suite A Paw Paw, MI 49079 (616) 657-7745, (888) SWF-RUIT (793-7848), FAX (616) 657-6678	Paw Paw	(616) 657-6380
Bill Shane, District Fruit Agent SW Michigan Research and Extension Center 1791 Hillandale Road Benton Harbor, MI 49022 (616) 944-1477, FAX (616) 944-3106		
Trevor Nichols Research Complex 6237 124th Fennville, MI 49408 (616) 561-5040		
FRUIT RIDGE (Grand Rapids)		
Phil Schwallier, District Horticultural and Marketing Agent Clarksville Expt. Station 9302 Portland Rd. Clarksville, MI 48815 (800) 767-1345, FAX (616) 693-2317	Grand Rapids AgWeather Fruit	(616) 364-5463 (616) 451-8065
Amy Irish-Brown, Horticultural Agent Muskegon County 635 Ottawa Harris Building Muskegon, MI 49442-1016 (616) 724-6361, FAX (616) 724-6675		
WEST CENTRAL (Oceana)		
Mira Danilovich, District Horticultural and Marketing Agent Oceana Co. Extension Office 210 Johnson St. Hart, MI 49420 (616) 873-2129, FAX (616) 873-3710	Hart Mason Manistee	(616) 873-5433 (616) 757-3611 (616) 889-4012
NORTHWEST		
Jim Nugent, District Horticultural and Marketing Agent Northwest Michigan Horticulture Research Station 6686 Center Highway Traverse City, MI 49684 (616) 946-1510, FAX (616) 946-1404	Traverse City Pome Fruit Stone Fruit	(616) 947-3063 (616) 947-3064
Jim Bardenhagen, County Director Leelanau County Extension 116 E. Philip Street Lake Leelanau, MI 49653-9700 (616) 256-9888, FAX: (616) 256-9431		
Duke Elsner, Agriculture and Natural Resources Agent Grand Traverse County 220 Dendrinos Drive S7 Traverse City, MI 49686 (616) 922-4620, FAX (616) 922-4636		
Andy Norman, Agriculture and Natural Resources Agent Government Center Beulah, MI 49617-0307 (616) 882-0025 or (800) 689-6857	Benzie	(616) 882-0036
Gary Thornton, District Fruit IPM Agent NW Michigan Horticulture Research Station 6686 Center Highway Traverse City, MI 49684 (616) 946-1510, FAX: (616) 946-1404		
SOUTHEAST		
Bob Tritten, District Horticultural and Marketing Agent Genesee Co. Extension Office G-4215 W. Pasadena Flint, MI 48504 (810) 732-2177, FAX (810) 732-1400	Flint	(810) 732-1005

For Commercial Fruit Growers

Fruit Spraying Calendar 1997

This publication contains pesticide recommendations based on research and pesticide regulations. However, changes in pesticide regulations occur constantly. Some pesticides mentioned may no longer be available, and some uses may no longer be legal. If you have questions about the legality and/or registration status for using pesticides, contact your county Extension Service office.

**To protect yourself and others and the environment,
always read the label before applying any pesticide.**

Extension Bulletin E-154, Information Current as of November 1, 1996, Revised Annually—

Destroy Previous Editions

Michigan State University Extension

1997 Fruit Spraying Calendar

Edited by:

J. Hull, Department of Horticulture,
A. L. Jones, Department of Botany and Plant Pathology and the Pesticide Research Center,
and John Wise and T. Mike Thomas, Department of Entomology

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Introduction

Much effort goes into the planning of an effective, economical, and environmentally sound fruit pest management program. A successful pest management schedule must be based on a basic knowledge and understanding of:

- (1) The biology of the crop and its annual growth habits during the growing season;
- (2) The biology of the insects, diseases, nematodes and weeds that will be encountered, and their life cycle during the growing season;
- (3) The susceptibility of the different kinds and varieties of fruit to pests and pesticides;
- (4) The environmental conditions that will favor the pest(s) injuring the fruit crops; and
- (5) The cultural, biological, and chemical control strategies that need to be used to optimize the economical production of the fruit.

This publication is only intended to guide and assist the fruit grower in the selection of pesticides as he or she plans the best possible pest control program for the growing season. The insects and diseases listed in the following spray calendars are not always present or economically important in all fruit plantings each year. Thus, during any single growing season, each grower has to adjust the pest control program to fit the specific conditions observed during the past growing seasons and the conditions encountered during the present growing season.

To provide a more complete understanding of the complexities of fruit culture, the editors of this publication recommend the following publications that deal with fruit culture and fruit pests. These references are:

<i>Apple Grader's Manual (Commercial)</i>	E-0747
<i>Highbush Blueberry Varieties for Michigan</i>	E-1456
<i>Propagating Highbush Blueberries</i>	E-1680
<i>Blueberry Diseases in Michigan</i>	E-1731
<i>Grape Grader's Manual (Commercial)</i>	E-0897
<i>Peach Culture in Michigan</i>	E-0509
<i>Growing Raspberries in Michigan</i>	E-2197
<i>Tractor-mounted Air Blast Sprayers</i>	E-0840
<i>Increasing Storage and Market Life of Jonathan Apples</i>	E-0627
<i>Controlling Apple Storage Scald</i>	E-1015
<i>Commercial Strawberry Culture in Michigan</i>	E-0682
<i>Strawberry Diseases in Michigan</i>	E-1728
<i>Diseases of Tree Fruits in the East</i>	NCR-45
<i>Vineyard Preparation for Nematode and Virus Diseases Control</i>	E-0806
<i>Common Tree Fruit Pests</i>	NC-63
<i>Fertilizing Fruit Crops</i>	E-852
<i>10 Tips for Laundering Pesticide Soiled Clothing</i>	E-2149
<i>Choosing Clothing for Pesticide Safety</i>	E-2150
<i>Commercial and Private Application Core Manual: Initial Certification</i>	E-2195
<i>Manual Basico Para Aplicadores de pesticidas Comerciales y Privados</i>	E-2195-SP

<i>Using Chemigation Safely and Effectively</i>	E-2099
<i>SARA Title III: The Farmer's Responsibilities Under the Emergency Planning and Community Right-to-Know Law</i>	E-2173
<i>SARA Title III: Agricultural Businesses' Responsibilities Under the Emergency Planning and Community Right-to-Know Law</i>	E-2174
<i>SARA Title III Farm Response Planning: Information Needed to Prepare Offsite Response Plans for Farms in Michigan</i>	E-2334
<i>Using Pesticides Safely: A Guide for the Applicator</i>	E-2215
<i>On-Farm Agrichemical Storage and Handling</i>	E-2335
<i>Recordkeeping System for Crop Production</i>	E-2340
<i>Recordkeeping System for Crop Production, Annual Record Book (Pocket Size)</i>	E-2341
<i>Recordkeeping System for Crop Production, Annual Record Book (Full Size)</i>	E-2342
<i>Field File</i>	E-2343
<i>Farm Pesticide Safety Fact Sheet Grapes</i>	E-2358
<i>Farm Pesticide Safety Fact Sheet Sweet Cherries</i>	E-2360
<i>Farm Pesticide Safety Fact Sheet Peaches, Prunes and Plums</i>	E-2361
<i>Farm Pesticide Safety Fact Sheet Apples and Pears</i>	E-2362
<i>Farm Pesticide Safety Fact Sheet Tart Cherries</i>	E-2539
<i>Farm Pesticide Safety Fact Sheet Strawberries</i>	E-2543
<i>Farm Pesticide Safety Fact Sheet Blueberries</i>	E-2544
<i>Read Before Washing Pesticide-Soiled Clothing-Magnet in English</i>	E-2413
<i>Lea Esto Antes de Lavar la Ropa Manchada o Sucia con Pesticidas, Magnets in Spanish</i>	E-2413-SP
<i>Designing Facilities for Pesticide and Fertilizer Containment</i>	MWPS-37

The reference materials listed above are available at any county Extension office and at the Michigan State University Bulletin Office, 10B Agriculture Hall, East Lansing, MI 48824-1039.

Also, compendia on diseases of fruit crops are available from APS Press, 3340 Pilot Knob Road, St. Paul, MN 55121-2097 or by telephoning 1-800-328-7560. Each compendium contains color photographs to help and descriptions of symptoms, causes cycles, and control practices. Topics of currently available compendia include: Apple and Pear Diseases; Blueberry and Cranberry Diseases; Grape Diseases; Raspberry and Blackberry Diseases and Insects; Stone Fruit Diseases; and Strawberry Diseases.

An "Apple Insect Scouting Manual" by J. W. Johnson and M. Herr is available from Great Lakes Publishing, 343 S. Union St., Sparta, MI 49345.

Guidelines for Safe Use of Pesticides

Larry Olsen, Lynnae Jess and Karen Renner

Selecting Pesticides

Always thoroughly read the label and the supplemental labeling material for any pesticide that you may consider using. Understand the label instructions and limitations. Use the pesticide only for the purposes listed and in the manner directed on the label. Select only pesticides labeled for the crop you wish to use it on and the pest(s) you wish to control. To do otherwise will cost you in terms of effective and economical product performance and may lead to an unacceptable risk to humans, the crop, the surrounding environment, and later disposal problems of illegal material.

Pesticides and the Environment

Many people who live in rural areas get their drinking water from wells. Since well water is groundwater, it is easy to see why you should be concerned about keeping pesticides out of groundwater. **Groundwater** is the water beneath the earth's surface occupying the saturated zone (the area where all the pores in the rock or soil are filled with water). It is stored in geological formations known as **aquifers**. Groundwater moves through aquifers and can be obtained at points of natural discharge such as springs or streams, or by drilling a well into the aquifer.

The upper level of the saturated zone in the ground is called the **water table**. The water table depth below the soil surface fluctuates throughout the year, depending on the amount of water removed from the ground and the amount of water added by recharge and connected surface waters. **Recharge** is water that seeps through the soil from rain, melting snow, or irrigation. **Surface waters** are visible bodies of water such as lakes, rivers, and oceans.

Both surface water and groundwater are subject to contamination by **point source and nonpoint source pollution**. The key to preventing pesticides in groundwater and surface waters is identification of the source and route to the water. Point source contamination refers to situations where movement of a pesticide into water can be traced to a specific site. Nonpoint sources occur over a wide area. Nonpoint source contamination generally results from land runoff, precipitation, acid rain, or percolation rather than from a discharge at a specific, single location (such as a single pipe or well head).

After pesticides reach groundwater, they may continue to break down, but at a much slower rate, because of less available light, heat and oxygen. The movement of groundwater is often slow and difficult to predict. Substances that enter the groundwater in one location can turn up years later in other locations.

There are several processes that determine the fate of pesticides and whether they will end up in your drinking supply.

Adsorption is the binding of chemicals to soil particles. The amount and persistence of pesticide adsorption vary with pesticide properties, soil moisture content, soil pH, and soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils are much less adsorptive. A soil-adsorbed pesticide is less likely to volatilize, leach or be degraded by microorganisms, but it is also less available for uptake by plants.

Volatilization occurs when a solid or liquid turns into a gas. Pesticide volatilization increases with higher air temperature and air movement, higher temperature at the treated surface (soil, plant, etc.), low relative humidity, and when spray droplets are small. Pesticides also volatilize more readily from coarse-textured soils and from medium- to fine-textured soils with high moisture content. A pesticide in a gaseous state is invisible and carried away from a treated area by air currents. The movement of pesticide vapors in the atmosphere is called **vapor drift**. Unlike the drift of sprays and dusts that can sometimes be seen during an application, vapor drift is invisible.

Runoff is the movement of pesticides in water across the soil surface. It occurs as water moves over a sloping surface, carrying pesticides either mixed in the water or bound to eroding soil. The amount of pesticide runoff depends on the grade or slope of an area, the erodibility and texture of the soil, the soil moisture content, the amount and timing of irrigation or rainfall, and properties of the pesticide. Pesticide losses from runoff are greatest when heavy rainfall occurs shortly after a pesticide application. If heavy rainfall is expected, delay applying pesticides. Surface grading, drainage ditches and dikes, and the use of border vegetation can help reduce the amount and control the movement of runoff waters.

Surface water contamination is a major concern associated with the runoff of pesticides from treated fields, mixing and rinsing sites, waste disposal areas, and manufacturing facilities. In the 1988 inventory of water quality, pesticides were ranked sixth as river and stream pollutants, behind siltation, nutrients, pathogens, organic enrichment, and metals.

Leaching also moves pesticides in water. In contrast to runoff, leaching occurs as water moves downward through the soil. Factors that influence leaching include whether the pesticide dissolves easily in water, soil structure and texture, and the amount and persistence of pesticide adsorption to soil particles.

Groundwater contamination is a major concern associated with the leaching of pesticides from treated fields, mixing and rinsing sites, waste disposal areas and manufacturing facilities.

Absorption is the process by which chemicals are taken up by plants. Once absorbed, most pesticides are degraded within plants. Residues may persist inside the plant, however, and be released back into the environment as the plant tissues decay.

Crop removal can transfer pesticides. When treated crops are harvested, the pesticide residues are removed with them and transferred to a new location. After harvest, many agricultural commodities are washed or processed, which can remove or degrade much of the remaining residue. However, the wash water may now be contaminated and should be disposed of as a potential contaminant.

Microbial degradation occurs when microorganisms such as fungi and bacteria use a pesticide as a food source. Conditions that favor microbial growth include warm temperatures, favorable pH levels, adequate soil moisture, aeration (oxygen), and fertility. Adsorbed pesticides are more slowly degraded because they are less available to some microorganisms.

Chemical degradation is the breakdown of a pesticide by processes not involving a living organism. The adsorption of pesticides to the soil, soil pH levels, soil temperature and moisture all influence the rate and type of chemical reactions that occur. Many pesticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis in high pH (alkaline) soils or spray mixes.

Photodegradation is the breakdown of pesticides by sunlight.

Keeping Pesticides Out of Groundwater and Surface Water

It is very difficult to clean contaminated groundwater or surface water. Treatment is complicated, time consuming, expensive and often not feasible. The best solution is to prevent contamination in the first place. Management practices can be implemented to effectively reduce pesticide runoff and leaching and protect groundwater and surface water.

Use integrated pest management programs—Minimize pesticide use by combining chemical control with other pest management practices such as tillage, cultivation, crop rotation, and pest scouting.

Reduce compaction—Surface water runoff increases when soils are compacted.

Utilize conservation practices that reduce erosion and surface runoff—These practices include but are not limited to planting grass waterways to retard soil and water runoff and keeping buffer strips to protect surface water boundaries.

Plant vegetative filter strips and grassed waterways—These reduce pesticide runoff by trapping sediment and slowing water runoff, so that pesticides can interact with the vegetation and soil.

Consider the geology of your area—Be aware of the water table depth and the permeability of the geological layers between the surface soil and groundwater. Sinkholes can be especially troublesome because they allow surface water to quickly reach groundwater.

Consider soil and field characteristics—Determine the susceptibility of the soil or field site to leaching or runoff. Soil texture and organic matter content, in particular, influence chemical movement into groundwater while slope of the field influences surface runoff.

Select pesticides carefully—Pesticides that are highly soluble, relatively stable, and not readily adsorbed to soil tend to be the most likely to leach. Read labels carefully and consult a specialist from the Extension office, or your chemical dealer if necessary. The tables in this bulletin will also help you choose the best pesticide for your use.

Transport pesticides safely—Have pesticides delivered directly to your pesticide storage facility to avoid liability and potential accidents and spills in transit whenever possible. DOT shipping rules must be followed for transporting large quantities of pesticides, including proper placarding of the vehicle, liability insurance, special handling requirements, etc.

Follow label directions—The label carries crucial information about the proper rate, timing, and placement of the pesticide.

Calibrate accurately—Equipment should be calibrated carefully and often to avoid over and under application. During calibration, check the equipment for leaks and malfunctions.

Measure accurately—Concentrates need to be carefully measured before they are placed into the spray tank. Do not “add a little extra” to ensure that the pesticide will do a better job. Such practices only increase the likelihood of injury to the treated crop, the cost of pest control, and the chance of groundwater or surface water contamination. Pesticides that for some reason cannot be used on a crop must be disposed of as hazardous waste. To avoid the difficulty and expense of hazardous waste disposal, use your pesticides on labeled crops.

Avoid back-siphoning—The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemical into the water supply. Use an anti-backflow device when siphoning water directly from a well, pond, or stream.

Consider weather and irrigation—If you suspect heavy rain will occur, delay applying pesticides. Control the quantity of irrigation to minimize potential pesticide leaching and runoff.

Avoid spills—When they do occur, contain and clean them up quickly with an absorbent material like cat litter. Chemicals spilled near wells and sinkholes can move directly and rapidly into groundwater. Chemicals spilled near ditches, streams or lakes can move rapidly into surface water.

Change the location of mixing areas—Mix and load pesticides on an impervious pad if possible. If

mixing is done in the field, change the location of the mixing area regularly. Do not mix pesticides adjacent to the water source, and do not let the water run inadvertently on the soil near the mixing area. This will increase pesticide leaching and/or runoff.

Dispose of wastes and containers properly—Obey laws regulating the disposal of pesticide wastes. Pesticide containers are considered hazardous waste until they are cleaned or disposed of properly. Triple rinse or pressure rinse containers. Pour the rinsewater into the spray tank and use for treating the site or the crop. Do not pour rinsate on the soil, particularly repeatedly in the same location. This will saturate the soil and increase the potential for herbicide leaching. After triple rinsing, perforate both ends so the container cannot be reused.

Store pesticides away from water sources such as wells, ponds, and springs. Pesticides must be stored in a facility that will protect them from temperature extremes, high humidity, and direct sunlight. The storage facility should be heated, dry and well ventilated. It should be designed for easy containment and cleanup of pesticide spills and made of materials that will not absorb any pesticide material that leaks out of a container. Store only pesticides in such a facility and always store them in their original containers.

Do not store any protective clothing or equipment in the pesticide storage facility. Store herbicide separately from insecticides and fungicides to avoid contamination of one material by another and accidental misuse.

Keep the facility locked at all times when not in use to prevent animals, children, and irresponsible adults from entering and becoming poisoned. Post the facility as a *Pesticide Storage Facility* to warn others that the area is off limits. Maintain an accurate inventory of the pesticides stored in the facility at all times in case of emergency.

Always read and follow the *Storage and Disposal* section of pesticide labels for specific storage and handling instructions.

Pesticide Emergency Preparedness

When purchasing a pesticide, obtain a specimen label from the dealer and keep it on file on the farm. This label will be available immediately if an emergency involving a pesticide occurs. Take the label along to a medical treatment center if an individual has suffered pesticide poisoning.

Read and observe closely the *Precautionary Statements* section of the label. Make sure that several people are aware of and can administer treatments for pesticide poisoning contained in the *Statement of Practical Treatment* on the label. (See also the section on SARA Title III.)

Cleaning Pesticide Application Equipment

Follow all specific label directions for cleaning application equipment. If such instructions are not given on the pesticide label, then triple rinse the entire inside

of the application equipment, spraying the rinsate on a labeled site and do not exceed labeled rates.

Wash off the outside of the equipment in the target area. Only after rinsing the equipment out with fresh water should you clean the spray system with an appropriate cleaning solution. Do not spray any cleaning solution onto any crop; dispose of the cleaning solution as you would any municipal waste. Follow the equipment manufacturer's guidelines for routine and year-end cleaning and maintenance.

Protect Nontarget Organisms

The transfer of pollen from one flower to another by **bees** is a basic requirement for the production of practically all fruit. Because many insecticides are highly toxic to pollinating bees, it is to the fruit grower's benefit to use sprays so that the least possible number of bees are killed. Be aware of how bee poisonings can occur from pesticide applications and take the following precautions to reduce the chance of bee poisoning:

- Do not apply pesticides toxic to bees during bloom. This applies not only to the fruit bloom but also to dandelions and clovers that may be reached by the spray. Mow dandelions, yellow rocket and clovers in the fruit area to remove the blooms prior to spraying.
- Select pesticides that are least harmful to bees and select the safest formulation. Dusts are more hazardous to bees than sprays. Wettable powders are more hazardous than emulsifiable concentrates or water soluble formulations. Granular insecticide formulations are generally the least hazardous to bees. Microencapsulated insecticides are extremely hazardous as the minute capsules can be carried to the hive. The table on page 37 rates the toxicity of most common insecticides for bees and can serve as a guide to choosing the least hazardous material.
- Reduce drift during application.
- Time pesticide applications carefully. Evening applications are less hazardous than early morning; both are safer than midday applications.
- Do not let puddles of spray accumulate on the ground where bees might drink it. Supplying fresh water near bee hives can reduce this hazard.
- Do not treat near hives. Bees may need to be moved or covered before using insecticides near colonies.

The best way to avoid injury of **beneficial insects and microorganisms** is to minimize pesticide usage. Use selective pesticides whenever possible and apply only when necessary as part of a total pest management program.

Pesticides can be harmful to all kinds of vertebrates such as **fish and wildlife**. Most recognizable are the direct effects from acute poisoning. Fish kills can result from water polluted by a pesticide (usually insecticides). Pesticides can enter water via drift, surface runoff, soil erosion, and leaching.

Bird kills from pesticides can occur when birds ingest the toxicant in granules, baits, or treated seed; are exposed directly to the spray; consume a treated

crop; drink and use contaminated water; or feed on pesticide-contaminated prey.

Worker Protection Standard

New federal rules for farm worker protection, issued during 1992, require farmers to provide additional training and notification to farm workers to prevent accidental or occupational exposure to pesticides. Farmers should contact Extension agents to learn the details of this standard and availability of training materials for education of workers and handlers.

Read and follow the label instructions on **Restricted Entry Intervals (REI)** for every pesticide used. Some pesticide labels require both oral warning and posted signs to notify workers of pesticide applications. If the label doesn't require *both* forms of notification, notify workers *either* orally *or* by posting warning signs at entrances to treated areas. (Greenhouses *must* post warning signs for every application.) When using posted signs, post 24 hours or less before the pesticide application and remove signs within three days after the end of the restricted entry interval. Keep workers out during the entire time the signs are posted (except for early-entry workers wearing the proper personal protective equipment).

Record Keeping

The 1990 Farm Bill requires that all applicators who apply restricted use pesticides (RUP) keep records and maintain them for two years. Records to be kept include:

- brand name or product name and the EPA registration number,
- total amount of the product used,
- size of the area treated,
- crop, commodity, stored product or site to which the pesticide was applied,
- location of the application,
- month, day and year of the application,
- name and certification number of the applicator or applicator's supervisor.

The spray record sheet at the end of this publication, or E-2340 to E-2345 which includes directions and forms for a complete farm record keeping system, can be used for recording your sprays. Any record form is acceptable as long as the required data are included. Penalties are up to \$500 for the first violation and up to \$1000 for subsequent violations. Provisions for protecting the identity of the individual producers are included in the law. Commercial applicators must furnish a copy of the required records to the customer of the RUP application.

Endangered Species Act

To minimize the adverse impact of pesticides on endangered species, the EPA has initiated The Endan-

gered Species Act. The Michigan Department of Natural Resources (MDNR) administers the Michigan Endangered Species Act and maintains the federal and state endangered species lists in the state. Pesticide applications are a potential problem, particularly affecting birds, butterflies and moths. Alteration of the farm landscape can also negatively affect resident endangered species.

The Environmental Protection Agency (EPA) has determined threshold pesticide application rates that may affect listed species. This information is or will be included on pesticide labels. Counties with vulnerable endangered or threatened species will be identified on pesticide labels. Farmers must take the initiative and consult with the MDNR and the Fish and Wildlife Service (FWS) to be sure there are no endangered species in their area. The Nature Conservancy, a private land and habitat conservation organization, is working with the MDNR and the FWS and is conducting a landowner contact program to work with landowners who own property important for endangered species protection.

SARA Title III Emergency Planning and Community Right to Know Act

The Emergency Planning and Community Right to Know Law, under SARA Title III, requires farmers to notify their State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC), and local fire department if they store extremely hazardous materials, along with the name and telephone number of the facility representative. Check with your Extension agent to receive a list of EPA established "Extremely Hazardous Substances" and their threshold planning quantities.

The LEPC and fire chief may request maps of your storage facility and detailed lists of materials you store.

This law also requires that, in the event of a spill, the SERC, LEPC and National Response Commission be notified. The reportable quantities for spills is much less than for storage and can be obtained from the above sources. See Extension Bulletin E-2575 for more details on SARA Title III and a list of commonly used extremely hazardous substances.

Right to Farm

Farmers in Michigan are protected from nuisance lawsuits under the Right to Farm Act if they follow specific acceptable management practices. The Generally Accepted Agricultural and Management Practices for pesticide utilization and pest control, nutrient utilization, and manure management have been completed and are revised annually. Contact your Extension agent or regional office of the Michigan Department of Agriculture to obtain copies.

Fungicides

A. L. Jones and D. Ramsdell
Department of Botany and Plant Pathology

See descriptions of tree fruit fungicides on pages 30 and 59.

Small Fruit Crops

Aliette (Phosetyl-AL) is registered for use in strawberry, blueberry and raspberry for controlling phytophthora root rot and in strawberry to control leather rot. Up to four foliar applications may be used during the growing season with a 60 day interval between the last application and harvest.

Bayleton is a fungicide that has systemic activity with some "kick-back" action. It is registered for use on grapes. It controls black rot and powdery mildew. Although Bayleton is outstanding for the control of powdery mildew, it will not control downy mildew. NOTE: Manufacturer states that for tank mixing, Bayleton should be added and completely dispersed before adding other chemicals. Also, caution should be exercised when adding emulsifiable concentrates.

Bravo (Chlorothalonil) is registered for blueberry. It is effective against Phomopsis canker and aids in reducing mummyberry. Do not apply past bloom or fruit spotting may result.

Coppers—Various forms of cupric hydroxide are useful for control of downy mildew in grape as a preventative. Formulations are either in a dry flowable or a liquid flowable. The use of hydrated lime as a safener (4 lb/a) with cupric hydroxide prevents grape leaf injury.

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

Funginex is a systemic fungicide for the control of mummyberry disease. Apply Funginex with 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.

Mancozeb (*Dithane M-45 and Manzate 200*) is maneb (*manganese ethylenebisdithiocarbamate*) in combination with a zinc ion coordination product as a

safener. 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.

Nova gives excellent control of black rot and powdery mildew of grapes. Nova is a systemic fungicide with reasonably good residual activity.

Procure (triflumizole) provides excellent control of powdery mildew in grapes. It gives 48 to 72 hours of back action control.

Ridomil (metalaxyl) is a highly active fungicide against *Pythium* and *Phytophthora* (water mold) fungi. It is registered as a granular formulation for soil application to control *Phytophthora* root rot in bearing raspberry and as an EC for control of leather rot and red stele of strawberry and *Phytophthora* root rot of blueberry. Recently, mancozeb-Ridomil and copper-Ridomil combination products have been formulated for downy mildew control in grapes.

Rovral (*Iprodione*) is registered for use in grapes, strawberries and raspberries for excellent control of *Botrytis* fruit rot. The addition of a small amount of surfactant near harvest will increase coverage of the fruit.

Rubigan (fenarimol). This fungicide is registered for use in grape for controlling powdery mildew. This material, while very effective against powdery mildew, is not effective against black rot or *Botrytis* rot.

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

Ziram is registered for grapes. It is fairly effective against black rot, effective for downy mildew and very effective for control of Phomopsis and cane spot and fruit rot diseases.

Insecticides

J. W. Johnson
Department of Entomology

Agri-Mek (avermectin) is registered on strawberries and on pear under a Section 18 Emergency Exemption for pear psylla and pear rust mite control. The active material is a by-product of a soil fungus that has insecticidal activity. Agri-Mek is a translaminar (locally systemic) insecticide, and when applied before leaf tissue is mature and hard, has a long residual inside the foliage. Agri-Mek will also control spider mites on pear foliage when applied for pear psylla at first cover. This product **MUST** be applied with 1 gallon of paraffinic spray oil to be effective.

Apollo (Clofentezine) is a miticide for control of European red mite and spider mites on apples, pears, peaches, nectarines and cherries. Apollo, an active mite ovicide, provides control ranging from 10 weeks to full season depending on mite pressure, the extent of tree vegetative growth and predator mite populations. Control is achieved when eggs come into direct contact with the spray or contact with treated plant surfaces. On apples it may not be used after the tight-cluster stage, but is permitted post-bloom on most other fruit crops. In all cases, it may be applied **ONLY** once per year. Apollo is not toxic to predator mites.

Asana XL 0.66 EC is the active isomer of fenvalerate. This pyrethroid insecticide is compatible with oil and provides excellent pre-bloom to petal fall insect control. This material is highly toxic to mite predators and should be used carefully to prevent mite population buildup.

B.t.'s, *Bacillus thuringiensis*, bioinsecticides like Dipel, Javelin, Biobit and Crymax control lepidopteran larvae but must be ingested by susceptible larvae to be effective. Time applications for early egg hatch and generally repeat every 4-7 days to maintain control. Effectiveness varies depending on thoroughness of coverage, rate applied, weather conditions and tree vigor. B.t.'s can be used during bloom and do not impact most natural enemies.

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

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. Make repeat applications as needed or whenever mite infestations appear. No more than 4 lb/acre can be applied in any one crop season and no closer than 7 days before harvest.

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.

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.

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 some brambles. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer or oblique banded leafroller, which are common in Michigan.

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 or 4 EC emulsifiable concentrate or 25% wettable powder, its systemic properties have specific value in aphid control. When applied for aphids, it provides excellent control of tarnished plant bug. It also controls apple maggot. 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.

Furadan is a carbamate insecticide registered for control of root weevils on strawberry. This 4 pound flowable formulation may be used only post-harvest, as a banded treatment over the renovated rows. Furadan 4F is a highly toxic insecticide, and appropriate safety equipment should be used as specified on the label.

Guthion is the most widely used insecticide in Michigan orchards. Available as a 50% wettable powder, a 2 lb/gal emulsifiable insecticide, and a 3 flowable, it provides good broad-spectrum control of many primary fruit pests with a residual action of 10 to 14 days. There have been no phytotoxicity or residue problems

when the compound is used properly and in accordance with label directions.

While Guthion is similar to parathion in toxicity to humans, it is of low toxicity to predaceous orchard mites. Use the safety measures reserved for organophosphate insecticides when handling this material. It will not control organic phosphate resistant white apple leafhopper, spotted tentiform leafminer and oblique banded leafrollers, which are prevalent in Michigan.

Imidan is a phosphate chemical with a low toxicity to mammals comparable to Sevin. It is formulated as a 70% wettable powder for pre-bloom and post-bloom applications on apples, pears, peaches, cherries, plums, prunes, blueberries, grapes and apricots. It is phytotoxic on sweet cherries. It provides good broad-spectrum control of many fruit pests in Michigan. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer and oblique banded leafroller, which are common in Michigan.

Kelthane, a registered miticide for apples, pears, grapes, and strawberries, is available as a 50% wettable powder. It is a chlorinated hydrocarbon so it can be used in rotation with other miticides to prevent resistance buildup. Kelthane is moderately toxic to mite predators, and temperature does not affect its activity against pest mites. To avoid the possibility of resistance to Kelthane, use only 1 to 2 times during the season. If used twice, use against the same generation of mites to prevent resistance from occurring. Good spray coverage is necessary for good performance of Kelthane. Use of a spreader-sticker is advised.

Lannate (see Methomyl).

Lorsban is an organophosphorous insecticide that has great affinity for organic matter such as bark or soil. Applied as trunk sprays by handgun, it effectively controls peach tree borers. Applications in early June before newly hatched borers enter the trees and aimed at the lower scaffolds will also control lesser peach borer. It may be applied pre-bloom for scale and rosy aphid control, either alone or in combination with oil. Lorsban is registered as a broad-spectrum pesticide for seasonal use on apples. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer, or oblique banded leafroller, which are common in Michigan. It gives excellent control of scale insects. Lorsban is registered for control of insects attacking tart cherries, including the American plum borer. Do not use as a foliar spray on sweet cherries because of phytotoxicity.

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. Obtain-

able as emulsifiable concentrate, wettable powder or dust, Malathion is presently used in Michigan for certain insect pests attacking brambles, currants and blueberries. It is generally compatible with every insecticide and fungicide in common usage.

Methomyl (Lannate) is registered for use on apple and blueberry only as a 90% soluble powder and is primarily effective as a contact insecticide, though some systemic activity is also evident. Methomyl residues remain effective for about 3-5 days. Correct timing is a must.

Methomyl controls green fruitworm, certain leafroller and leafminer pests, which are difficult to control with other broad-spectrum compounds. It also controls indirect pests such as aphids. 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. This material is highly toxic to mite predators and should be used carefully to prevent mite population buildup. Methomyl may be somewhat phytotoxic to early McIntosh, Wealthy, and Duchess cultivars.

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 woolly apple aphid may result from a season-long (multiple applications) of Methomyl.

Mitac is a formamidin insecticide-acaricide available in 1.5EC and 25WP formulations. It effectively controls pear psylla. Mitac EC will control pear rust mite and pear blister mite and provides excellent control of summer populations of pear psylla that are resistant to other insecticides including pyrethroids. Apply Mitac when temperatures are 60°F or higher. Mitac will control codling moth on pears.

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. Do not apply 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. Do not use 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.

MPEDA is an insecticidal fatty acid (soap) concentrate that controls soft bodied adult insects such as aphids, leafhoppers, and mite adults and eggs. Good coverage is necessary for effective control. Use rates are based on a volume to volume basis, and growers must be careful to use the correct concentration to prevent phytotoxicity. This insecticide penetrates the insect cuticle, and kills it by allowing body fluids to evaporate

quickly. Once dried, the residual has no effect on insects or mites.

Penncap-M is a 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. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer or oblique banded leafroller, which are prevalent in Michigan.

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 to the hive where it is fed to the brood resulting in hive mortality. Do not use Penncap-M 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.

Permethrin (Ambush or Pounce) is a synthetic pyrethroid. These compounds exhibit low mammalian toxicity while having very high insecticidal activity. They act as stomach and contact poisons. Permethrin is cleared for seasonal use on peaches and cherries and may be used through petal fall on apples and pears. It will give control of insects that are resistant to organic phosphates. This material is highly toxic to mite predators and should be used carefully to prevent mite population buildup.

Pounce (see Permethrin).

Provado (imidacloprid) belongs to a class of insecticides called chloronicotinyls. Provado is registered on apple as a 1.6 F and on grape as a 75% WP in a Solu-Pak. This translaminar material has long residual in the foliage, and is effective on sucking insect pests such as leafhoppers and aphids. It will control organophosphate-resistant pests such as white apple leafhopper. Provado will provide adult control of leafhoppers near harvest. It also controls sap-feeding larvae of spotted tentiform leafminer, but must be applied at early petal fall to get excellent control. Provado is not toxic to natural enemies, and has no impact on pest or predator mites.

Savey (Hexythiazox) is a miticide for control of European red mites and two-spotted spider mites on apple. It is an active mite ovicide and larvicide, pro-

viding control ranging from 10 weeks to full season depending on mite pressure, the extent of tree vegetative growth and predator mite populations. Control is achieved when eggs come into direct contact with the spray or contact with treated plant surfaces. Do not apply after the apple pink stage, and do not exceed one application per year to prevent resistance. It is not effective against rust mites and is not toxic to predator mites.

Sevin is formulated as a 50 WP, 80 S and 4 lb/gal flowable (XLR Plus). 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. This material is highly toxic to mite predators and should be used carefully to prevent mite population buildup. 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. Sevin is a fruit thinning agent if used within 30 days after full bloom.

Superior Oil—"Superior oil" has been recommended as one of the preventive European red mite control programs. The 70-sec. oil provides 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 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. The eradication programs are expensive and not very successful in controlling established mite populations. Oil applications have no value in controlling the two-spotted mite.

Thiodan effectively controls both lesser peach tree borer and true peach tree borer. Thiodan is suggested for growers who have borer problems on stone fruit trees. 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. Thiodan may also be used as a pre-plant dip for nursery stock. Unlike Lorsban, Thiodan may be used for all stone fruit species.

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. Thiodan is highly toxic and requires the same caution granted any chlorinated product similar to it. Thiodan is also labeled on many fruits for aphid, plant bug, and tentiform leafminer adult control. It has a restricted number of applications, making it most useful in the early season.

Vendex is formulated as a 50WP non-phosphate miticide with very good activity against a wide range of plant-feeding mites. Control is temperature dependent and is more effective in warm weather. 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. 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, insect and mite predators. **WARNING:** Do not apply within 30 days after bloom at a rate greater than 1/2 pt/100 gal or fruit thinning may occur. Outbreaks of woolly apple aphid may occur from a season-long program of Vydate.

Monitoring Insects

Biological monitoring refers to checking orchards for the presence of pest species and following their development through time so that control decisions can be made.

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

All insects are "cold blooded" organisms and their seasonal development is tied primarily to the fluctuations of temperature. 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 by 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.

Bait-Lure Trap

Two trapping techniques are used to monitor the presence and seasonal activity of fruit insect pests.

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

Pheromone Trap

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

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

IPM Product Suppliers: These two sources are distributors for Consep, Ecogen (formerly Scentry), Ladd, Phero-Tech, Trece, and other manufacturers.

Great Lakes IPM
10220 Church Road
Vestaburg, MI 48891
(517) 268-5643

Gempler's
P.O. Box 270
Mt. Horeb, WI 53572
1 (800) 272-7672

Tree-Row Volume

J. W. Johnson
Department of Entomology

With the introduction of dwarf and semi-dwarf trees, it is no longer feasible to spray all trees at the same gallonage and dosage. The need is for a method of determining rates per acre for different sized trees. As early as 1972, researchers Lyons and Byers of the Winchester Fruit Research Laboratory recognized the necessity of determining rates per acre for different sized trees. An average sized mature tree was considered to be 19.5 feet tall, 23.5 feet across and spaced 35 x 35 feet.

Trees of this size were sprayed with 400 gpa. The amount of pesticide required to treat an acre of large trees is considerably greater than the amount required on an acre of trees planted at a higher density. Proper application required that adjustments be made to compensate for these differences. Concentrate spraying must be considered in terms of reducing the gallons of water per acre for the row-spacing and tree-size combination being sprayed.

As the gallonage of water is reduced errors become more critical. Sprays applied 3 x or higher concentrate levels result in a 20 to 25% increase in deposit, thus allowing a similar reduction in rate of pesticide application without a reduction in pesticide deposit. From a practical viewpoint the acceptable concentrate level depends on several factors including the pest being controlled, density of foliage, weather conditions, and material being applied. Dilute sprays are preferred for applying growth regulators and control of pests such as scale and woody aphid. In most other cases concentrate sprays usually provide satisfactory results.

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

Example: Rows are 35 ft apart, with a tree width of 23.3 and a tree height of 20. The lineal feet in this orchard is $43,560 \div 35 = 1245$ lineal feet. The cubic feet = $1245 \times 23.2 \times 20 = 580,180$. $580,180 \div 400 = 1450$ cubic feet. As stated previously, it takes 1 gallon of spray material for every 1450 cubic feet. To simplify tree-row-volume, a graph is presented on page 15 in which all factors in the formula are included. To use the graph, begin by drawing a line from 0 to the number on the chart that corresponds to the specific row width in the orchard. This gives the base line for all orchards of that row spacing. Once this is done, the height and width of the trees for each planting are multiplied together to obtain a number for use on the vertical axis

of the graph. Follow this line horizontally across the graph from the calculated height x width figure to the intersection with the row spacing base line. Directly below this point on the horizontal axis is the required gallons per acre figure for dilute spraying. Two examples are shown on the graph. Example 1 illustrates 25 foot row spacing with trees that are 16 feet high and 16 feet wide. Draw a base line from 0 to 25, multiply 16×16 to get 256. Follow a horizontal line from 256 to the base line. Vertically below this is a base gallonage of 313 gpa dilute. Example 2 shows a need of 220 gpa dilute for 20 foot rows and trees that are 12 feet high and 12 feet wide.

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

As with any other production procedure, grower judgment must be used with this method. Where tree size is quite variable, calibration should be done for the average of the largest trees. Since two-thirds of the spray is directed to the top of the trees, excess material should be blown over to the smaller trees. A well-pruned orchard may require only 85% of the base rate early in the season while a full foliated processing orchard would need the full rate. There can be no substitute for grower experience and judgment in making additional adjustments related to leaf density, pest pressure, or desired results from thinners and growth regulators.

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

It is also important to note that tree-row-volume or any other concept for determining rate per acre will not make up for poor application techniques or improper timing. This method should allow growers to more precisely calibrate their equipment for the various blocks they must spray and thereby reduce problems that arise from too little or too much material per acre.

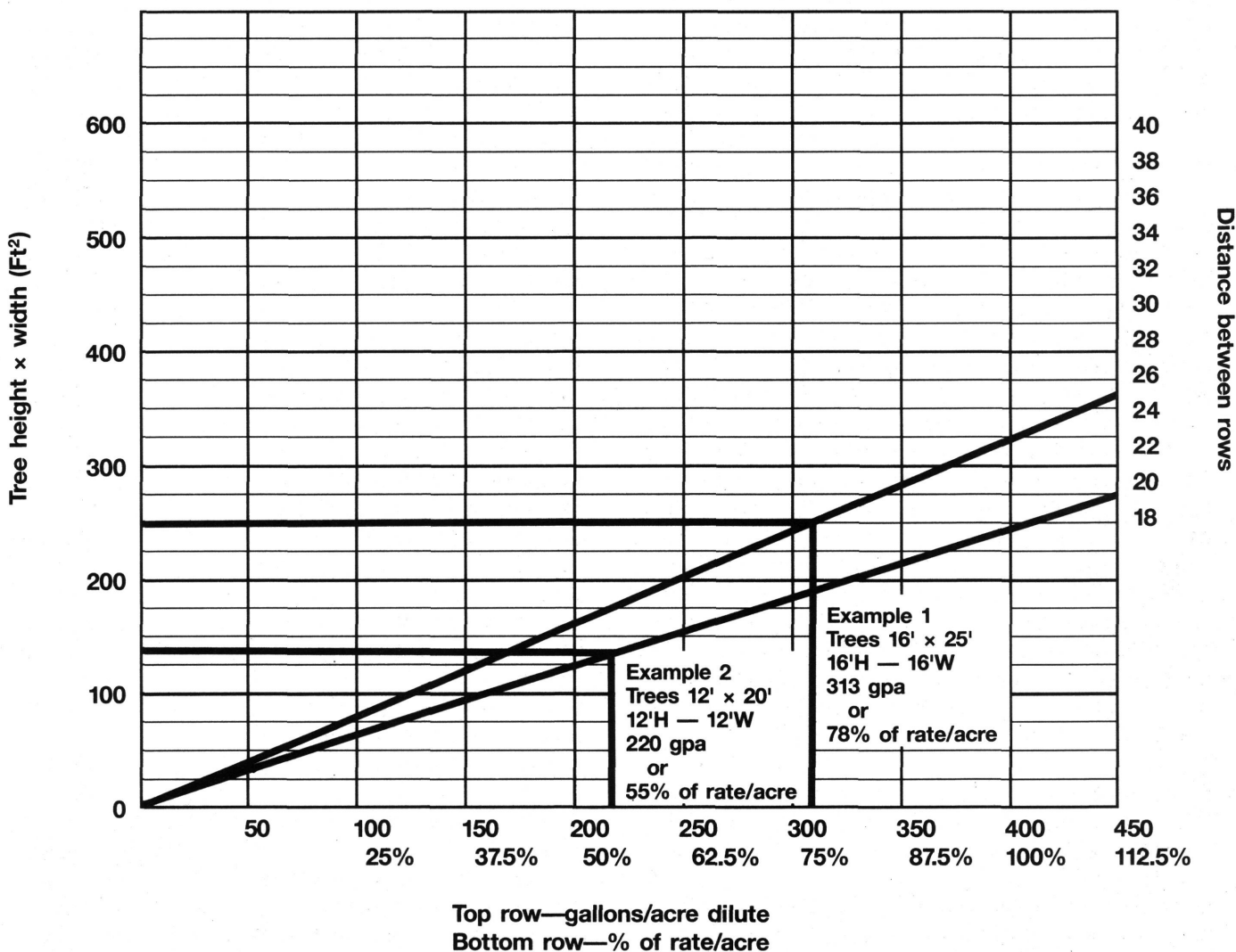
But it will only be effective if the necessary adjustments of equipment are made before spraying blocks of different sized trees.

Until a grower gains experience with this method, it is suggested that a grower experiment with one or two

blocks before committing the entire orchard to tree row volume. A tree-row volume spraying rate calculator has been developed for apples. This slide rule calculator is available at Virginia Tech University, 595 Laurel Grove Rd., Winchester, VA 22602. The cost is \$3.00 each.

Tree-Row Volume Graph

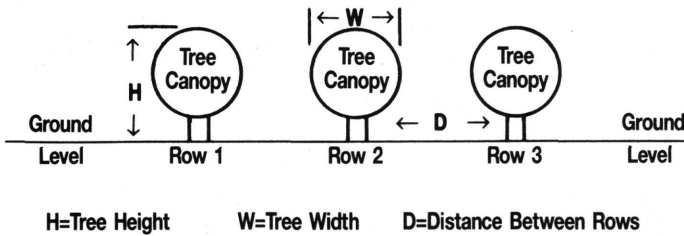
Courtesy of Lyons and Byers (V.P.I.)



Percent of Standard Chart

(Standard is 400 gal/A)

Calculating Percent of Standard



To determine your blocks PERCENT OF STANDARD, take the width & height line on the left and read across until you come to the correct width between rows. Example: Tree Height = 12 feet, Tree Width = 12 feet, Width Between Rows = 20 feet, then the Percent of Standard = 54%.

Height & Width	Square Feet	Distance Between Rows													
		14	16	18	20	22	24	26	28	30	32	34	36	38	40
6 8	48	26	23	20	18	16	15	.	.	.	.	.	.	.	.
6 10	60	32	28	25	23	20	19	.	.	.	.	.	.	.	.
6 12	72	39	34	30	27	25	23	.	.	.	.	.	.	.	.
6 14	84	45	39	35	32	29	26	.	.	.	.	.	.	.	.
8 10	80	43	38	33	30	27	25	23	.	.	.	.	.	.	.
8 12	96	51	45	40	36	33	30	28	.	.	.	.	.	.	.
8 14	112	60	53	47	42	38	35	32	.	.	.	.	.	.	.
8 16	128	69	60	53	48	44	40	37	.	.	.	.	.	.	.
10 12	120	64	56	50	45	41	38	35	32	.	.	.	.	.	.
10 14	140	75	66	58	53	48	44	40	38	.	.	.	.	.	.
10 16	160	86	75	67	60	55	50	46	43	.	.	.	.	.	.
10 18	180	97	84	75	68	61	56	52	48	.	.	.	.	.	.
12 12	144		68	60	54	49	45	42	39	36	.	.	.	.	.
12 14	168		79	70	63	57	53	49	45	42	.	.	.	.	.
12 16	192		90	80	72	66	60	55	51	48	.	.	.	.	.
12 18	216		101	90	81	74	68	62	58	54	.	.	.	.	.
14 14	196			82	74	67	61	57	53	49	46	.	.	.	.
14 16	224			93	84	76	70	65	60	56	53	.	.	.	.
14 18	252			105	95	86	79	73	68	63	59	.	.	.	.
14 20	280			117	105	96	88	81	75	70	66	.	.	.	.
16 16	256				96	87	80	74	69	64	60	57	.	.	.
16 18	288				108	98	90	83	77	72	68	64	.	.	.
16 20	320				120	109	100	92	86	80	75	71	.	.	.
16 22	352				132	120	110	102	94	88	83	78	.	.	.
18 18	324					111	101	94	87	81	76	72	68	.	.
18 20	360					123	113	104	97	90	84	79	75	.	.
18 22	396					135	124	114	106	99	93	87	83	.	.
18 24	432					147	135	125	116	108	101	95	90	.	.
20 20	400						125	116	107	100	94	88	83	79	.
20 22	440						138	127	118	110	103	97	92	87	.
20 24	480						150	139	129	120	113	106	100	95	.
20 26	520						163	150	139	130	122	115	108	103	.
22 22	484							140	130	121	114	107	101	96	91
22 24	528							152	142	132	124	117	110	104	99
22 26	572							165	153	143	134	126	119	113	107
22 28	616							178	165	154	145	136	128	122	116
24 24	576								154	144	135	127	120	114	108
24 26	624								167	156	146	138	130	123	117
24 28	672								180	168	158	148	140	133	126
24 30	720								193	180	169	159	150	142	135

Tree-Row Volume Insecticide Chart

This table provides the DILUTE spray rate that you should use on apple trees after you calculate the Percent of Standard from the previous page. A dilute rate is that amount of spray it takes to treat a tree to run-off, and would normally be applied with a handgun sprayer or airblast sprayer set to apply a large amount of water. The DILUTE rate for a "standard tree" is 400 gal/acre, but no one applies this much spray to an acre of apples in full leaf. If you have large standard trees that are not well pruned, you will need more water than this to get adequate coverage. The spray is usually concentrated by reducing the amount of water used as a carrier, resulting in a much lower spray volume. Concentrate sprays are designated by 1 × (dilute), 2 × (1/2 water), 3 × (1/3 water), etc. In a concentrate spray,

the amount of pesticide per acre does not change, just the water.

Example: To spray an orchard that is 60% of standard with Ambush 2EC:

Dilute Spray: Use 7.7 ounces of Ambush 2EC per acre in 240 gallons of water.

Concentrate Spray:

To spray a 2 × concentrate spray, use 7.7 ounces of Ambush 2EC in 120 gallons of water per acre;

To spray a 3 × concentrate spray, use 7.7 ounces of Ambush 2EC in 80 gallons of water per acre.

Percent of Standard		20	30	40	50	60	70	80	90	100	110	
Gallons of Water/Acre (Dilute)		80	120	160	200	240	280	320	360	400	440	
Material	Formulation											
Ambush	2 EC	2.6	3.8	5.1	6.4	7.7	9.0	10.2	11.5	12.8	14.1	ounce
	25 WP	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	ounce
Apollo	SC	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	ounce
Asana XL	0.66 EC	2.3	3.5	4.6	5.9	6.7	8.1	9.3	10.4	11.6	12.7	ounce
Carzol	92 SP	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4	pound
Cygon, Defend	25 WP	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	pound
	2.67 EC	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	pint
Diazinon	50 WP	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	pound
Dimethoate	See Cygon and Defend											
Guthion, Azinphos-Methyl	50 WP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	pound
Imidan	70 WP	0.6	1.0	1.2	1.5	1.8	2.1	2.4	2.7	3.0		pound
Lannate	90 SP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	pound
Lorsban	50 WP	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	pound
	4 EC	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	pint
Methomyl	See Lannate											
Morestan	25 WP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	pound
Superior Oil		1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	gallon
PennCap-M	2 FM	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	pint
Pounce	3.2 EC	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	ounce
Provado	1.6 F	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	ounce
Sevin	50 WP	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	pound
	80 S	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	pound
Thiodan	50 WP	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	pound
	3 EC	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	quart
Wydate	2L	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	pint

Equivalents 16 fluid oz = 1 pt, 4 oz = 0.25 lb, 2 pt = 1 qt, 8 oz = 0.5 lb, 4 qt = 1 gal, 16 oz = 1 lb

Insecticide-Miticide Rates for Apples

E-154 No.	Material	Formulation	Recommended	
			Per 100 Gallons	Full Rate Per Acre
41	Agri-Mek	0.15 EC	2.5-5 oz	10-20 oz
34	Ambush	2 EC 25 WP	3.2 oz 3.25 oz	12.8 oz 13 oz
17	Apollo	SC	1-2 oz	4-8 oz
40	Asana XL	0.66 EC	2.9 oz	11.6 oz
3	Carzol	92 SP	5 oz	1.25 lb
6	Cygon, Defend	25 WP 2.67 EC	2 lb 1.5 pt	8 lb 6 pt
5	Diazinon	50 WP	1 lb	4 lb
6	Dimethoate	See Cygon and Defend		
8	Guthion	3 F	8 oz	2 pt
8	Guthion	50 WP	0.5 lb	2 lb
9	Imidan	70 WP	0.75 lb	3 lb
10	Kelthane	35 WP		4-8 lb
10	Kelthane	50 WP	-	3-5 lb
11	Lannate	90 SP	0.5 lb	2 lb
32	Lorsban	50 WP 4 EC	12 oz 1 pt	3 lb 3-4 pt
14	Mpede		1 gal	
11	Methomyl	See Lannate		
15	Morestan	25 WP	0.5 lb	2 lb
24	Superior Oil		2 gal	8 gal
18	Penncap-M	2 FM	1 pt	4 pt
35	Pounce	3.2 EC	2 oz	8 oz
19	Provado	1.6 F	2 oz	8 oz
42	Savey	50 WP		3 oz
23	Sevin	50 WP 80 S	2 lb 1.25 lb	8 lb 5 lb
26	Thiodan	50 WP 3 EC	1 lb 2/3 qt	4 lb 2 2/3 qt
28	Vendex	4 L	4-8 fl oz	1-2 pt
30	Vydate	2 L	1 pt	4 pt

Equivalents 16 fluid oz = 1 pt 4 oz = 0.25 lb
 2 pt = 1 qt 8 oz = 0.5 lb
 4 qt = 1 gal 16 oz = 1 lb

How to Use the 1997 Fruit Spray Calendar

The evaluation of how well certain pesticides control specific pests listed in the Fruit Spraying Calendar was obtained from research data gathered over 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 pest susceptibility and pesticide activity or persistence.

To use the recommendations, determine the stage of fruit growth 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 (e.g.: you found green fruitworm larvae chewing leaves). Next, look under the columns titled "Efficiency" for that insect and read the numbers and letters there (e.g.: 11e, 26f). 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 and Thiodan is fair 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.

Information on fungicide effectiveness can be found in the Fungicide section on pages **8, 30, and 59**; and the Herbicide section starting on page **91**.

If you are trying to achieve "Integrated Mite Control" or are concerned about the beneficial insects present in the orchard, consult the table named "Effectiveness of Insecticides in Controlling Insect Pests Attacking Apples" (see page **37**). On the bottom of this table, these insecticides are rated as HT = highly toxic, MT = moderately toxic and NT = relatively non-toxic to the beneficial insects. If one material is rated toxic and another rated moderately toxic, use the least toxic one to preserve the beneficials.

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

Guide to Abbreviations Used in This Bulletin

B = bait

D = dust

DF = dry flowable

EC = emulsifiable concentrate or emulsion

F = flowable

G = granule

L or LC = liquid concentrate

LS = liquid solution

S = sprayable

SC = suspension concentrate

SP = soluble powder

W or WP = wettable powder

WDG = water-dispersible granules

Apple Pest Guide

Average Degree Days and Calendar Dates for Tree Growth Stages and Insect Development

The Apple Pest Guide (on the following page) was developed by Phil Schwallier, MSU Cooperative Extension Service, and Gil DeBruin, Reister's Grower Services and reviewed by James Johnson, former MSU fruit entomologist. This guide provides apple tree and apple insect growth stages, based on over 30 years of information compiled by the authors for the Peach Ridge area of Michigan. The growth stages are based on McIntosh apple, and degree days are based on starting accumulation on March 1st of each year

using a Baserville-Emin calculation method. If you use this chart for areas other than the Grand Rapids, MI area, or for other varieties of apples, you need to adjust values for your orchard.

The degree day and average calendar data are included in the apple section of the Fruit Spray Calendar. Look for the information in the dark bar with the name of the growth stage. This information should help you better understand growth condition in your orchard for better insect management decision-making.

APPLE PEST GUIDE

for the Peach Ridge Weather Station

APPROXIMATE DATE	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER														
	7	14	21	28	5	12	19	26	3	10	17	24	31	7	14	21	28	4	11	18	25	1	8	15	22	29	5	12	19	26
DD BASE 42°F	90	127	189	205	242	284	367	422	511	616	749	889	1061	1226	1405	1564	1750	1860	2167	2359	2552	2735	2916	3091	3261	3417	3545	3656		
DD BASE 50°F	96	51	82	90	109	129	174	190	205	254	318	401	498	607	719	842	954	1094	1239	1390	1526	1663	1791	1917	2037	2153	2256	2345	2396	
Overw. Stage	DOR-MANT	1ST GREEN	1/4" GREEN	1/2" GREEN	TIGHT GREEN CLUSTER	OPEN CLUSTER	PINK BLOOM	KING BLOOM	FULL BLOOM	PETAL FALL	1ST COVER	2ND COVER	3RD COVER	4TH COVER	5TH COVER	6TH COVER	7TH COVER	8TH COVER	9TH COVER											
Scale	Adult	Apply Oil to control Scales.						1st	Peak		Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	
EUROPEAN RED MITE	Adult	Apply Oil to control eggs.						1st	End			1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	1st	Peak	End	
OBLIQUE BANDED LEAFROLLER	Larvae				Larvae active.					Pupate					Peak	End														
APHIDS	Egg				1st		Peak			Give birth.																				
GREEN FRUITWORM	Egg & Pupa	1st			Peak					End																				
SPOTTED TENTIFORM LEAFMINER	Pupa		1st				Peak			End																				
TARN PLANTBUG	Adult						Peak			1st																				
RED BANDED LEAFROLLER	Pupa		1st				Peak			End																				
PUM CURCULIO	Adult						1st			Peak																				
WHITE APPLE LEAFHOPPER	Egg										Peak																			
CODLING MOTH	Larvae						1st			1st																				
APPLE MAGGOT	Pupa						1st			1st																				
ORIENTAL FRUITMOTH	Larvae						1st			Peak																				
DOGWOOD BORER	Larvae										1st																			
EUROPEAN CORN BORER	Adult																													
	Hatch									Earlier generations not a pest in apples.																				

This information was developed by Philip Schwallier, District Horticulture Agent, MSU Cooperative Extension Service and Gilbert DeBruine, Orchard Consultant, Reister's Grower Services Inc. Our thanks to Dr. James Johnson, Tree Fruit Entomologist, MSU for reviewing this publication. It is a guide of "NORMAL" pest development in a typical year. Your actual situation during any year may be different. The dark shaded areas indicate critical control periods if the pest is present and the light shaded areas indicate possible control periods. The dates, growth stages and pest development were all correlated with the Peach Ridge Weather Station. The degree days were determined using the Baskerville-Emin method since March 1st, and are averages for a 28 year recording period.

Information provided by the Kent Cooperative Extension Service, 836 Fuller NE, Grand Rapids, Michigan, Phone: 616-774-3265, Fax: 616-774-3636.

■ Critical control period.
 ■ Possible control period.

APPLES

The rate of material 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 letters stand for effectiveness of control against specific pests: e = excellent, g = good, f = fair, and p = poor.

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASE		
Phytophthora Collar Rot	See "Special Apple Disease Controls," page 35	
Fire Blight	Copper Silvertip— $\frac{1}{4}$ " green tip. See "Special Apple Disease Controls," page 33	

Apple Scab Control (see page 30 for details)

SILVER TIP DD BASE 50 = 51 AVG. CALENDAR DATE = APRIL 14

Fungicide	Rate/acre	Comments	Restrictions
Benlate 50% WP		Not recommended in Michigan because of resistant scab.	Do not exceed 5 lb per acre per season or apply within 14 days of harvest.
Captan 50% WP	6-8 lb	<i>Primary scab:</i> Begin applications at $\frac{1}{4}$ to $\frac{1}{2}$ inch green tip and continue on a 5 to 7 day schedule through first cover.	Do not exceed 64 lb per acre per season. Do not use with oil or near oil applications.
	4-8 lb	<i>Secondary scab:</i> Apply at 10 to 14 day intervals in second and later cover sprays.	Do not apply within 14 days of harvest.
EBDC Fungicides (other formulations may also be available)		Use either the "Pre-Bloom" or "Extended Application" schedule.	Do not combine or integrate the two treatment schedules.
Dithane M-45 75% DF OR Manzate 200 DF OR Penncozeb 75 DF OR Polyram 80 WP	6 lb	<i>Pre-Bloom Use:</i> Begin applications at $\frac{1}{4}$ to $\frac{1}{2}$ inch green tip and continue on a 7 to 10 schedule through bloom.	Do not apply after bloom or more than 24 lb per acre per year.
Dithane M-45 75% DF OR Manzate 200 DF OR Penncozeb 75 DF OR Polyram 80 WP	3 lb	<i>Extended Application Schedule or for Use in Tank Mixtures:</i> Begin applications at $\frac{1}{4}$ to $\frac{1}{2}$ inch green tip and continue applications on a 7 to 10 day schedule through the second cover spray. Tank mix with non-EBDC fungicide when needed for primary scab control.	Do not apply more than 3 lb per acre per application or 21 lb per acre per season. Do not apply within 77 days of harvest.
Nova 40W	5-8 oz	<i>Pre-Bloom:</i> Begin application at green tip or when conditions become favorable for primary scab development. Apply alone or tank mixed with Captan or EBDC fungicide.	Do not apply more than 5 lb per acre per season. Do not apply within 14 days of harvest.
	5-8 oz	<i>Bloom, Postbloom:</i> Tank mix with a protectant fungicide (generally Captan or an EBDC fungicide).	
	8 oz	<i>Postinfection:</i> Apply within 96 hr after the beginning of an infection period.	

(Continued on next page)

SILVER TIP (CONTINUED)

Fungicide	Rate/acre	Comments	Restrictions
Procure 50 WS	8-16 oz	<i>Standard Spray Schedule:</i> Begin applications at 1/2" green tip stage and continue on a 7 to 10 day interval through the second cover spray. Tank mix with Captan or EEDC fungicide for maximum fruit disease control.	Do not apply more than 64 oz/acre per season.
	12-16 oz	<i>Postinfection:</i> Apply within 48 to 72 hr after the beginning of an infection period. Use the high rate under heavy disease pressure or when applied after 48 hr.	Do not apply within 14 days of harvest.
Rubigan 1 EC	8-12 oz	<i>Regular:</i> Begin applications at green tip or when conditions become favorable for primary scab development and continue on a 7 day schedule through the second cover spray. <i>Extended:</i> Tankmix with recommended rates of a protectant fungicide. Begin applications at green tip or when conditions become favorable for primary scab and continue on a 7 to 10 day spray interval.	Do not apply more than 12 fl oz per acre per application or 84 fl oz per acre per season. Do not apply within 30 days of harvest.
	1st spray 12 oz 2nd spray 8-12 oz	<i>Postinfection:</i> Apply within 96 hr after the beginning of an infection period. Apply the 2nd spray within 7 days of the 1st spray.	
Syllit 65W		Not recommended in Michigan because of resistant apple scab.	Do not apply within 7 days of harvest.
Topsin M 70 WSB		Not recommended in Michigan because of resistant apple scab.	

TIGHT CLUSTER—PRE-PINK DD BASE 50 = 104 AVG. CAL. DATE = APRIL 23

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASE		Nova, Procure, and Rubigan control scab and powdery mildew. Tank mix a mildewicide with Captan or EBDC fungicide when control of mildew is desired.
Apple Scab (Primary)	See Silver Tip and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
INSECTS/MITES		INSECTICIDES 3. Carzol 92 SP (1 lb) 14. MPEDE (1%-2% v/v)*** 15. Morestan 25 WP (1-2 lb) 17. Apollo SC (4-8 fl oz)**** 24. Superior Oil (8 gal) 26. Thiodan 50 WP (4 lb) 26. Thiodan 3 EC (2 2/3 qt) 32. Lorsban 4 EC (2-4 pt) 34. Ambush 2 EC (12.8 fl oz) 34. Ambush 25 WP (12.8 oz) 35. Pounce 3.2 EC (8 fl oz) 35. Pounce 25 WP (12.8 oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
European Red Mite	*15e, 17e, 24e	
San Jose Scale	24e, 32e	
Spotted Tentiform Leaf Miner (adult and eggs)	3g, 26f, **34e, **35e, **40e	
Rosy Apple Aphid	14+24e***, 24e, 32e	
Comments: Tight cluster and pre-pink sprays are needed for control of spotted tentiform leaf miner adults and eggs.		Comments: *—Morestan is an ovicide and should be applied at tight cluster or pink to control mite eggs. **—Asana, Pounce, and Ambush are adulticides and ovicides and should be applied before the eggs hatch. ***—MPEDE should be used at 1%-2% v/v plus Superior Oil at 2% v/v. ****—Apollo may not be applied after tight cluster.

APPLES

PINK DD BASE 50 = 174 AVG. CALENDAR DATE = MAY 8

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Comments: <i>Mildew control is critical at this time. If a severe problem exists, start at green tip.</i>		
INSECTS/MITES		INSECTICIDES
European Red Mite	3g, 15e, 30f	3. Carzol 92 SP (1 lb)
Aphids	6e, 11g, 26e, 30g, 32g	5. Diazinon 50 WP (4 lb)
Tarnished Plantbug	3g, 6e, 11g, 26f, 34e, 35e, 40e	6. Dimethoate 2.67 EC (6 pt)
Green Fruitworm	11g, 26f, 32e, 34e, 35e, 40e	6. Dimethoate 25 WP (8 lb)
Resistant Oblique Banded Leafroller	11e, 34e, 35e, 40e	6. Dimethoate 400 (4 pt)
Non-Resistant Oblique Banded Leafroller	8e, 9e, 11e, 32e, 34e, 35e, 40e	8. Guthion 3 F (2 pt)
		8. Guthion 50 WP (2 lb)
		9. Imidan 70 WP (3 lb)
		11. Lannate 90 SP (1/2-1 lb)
		15. Morestan 25 WP (2 lb)
		26. Thiodan 50 WP (4 lb)
		26. Thiodan 3 EC (2 2/3 qt)
		30. Vydate 2 L (4-8 pt)
		32. Lorsban 50W (2-3 lb)
		34. Ambush 2 EC (12.8 fl oz)
		34. Ambush 25 WP (12.8 oz)
		35. Pounce 3.2 EC (8 fl oz)
		35. Pounce 25 WP (12.8 oz)
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		42. Savey 50 WP (3 oz)

BLOOM DD BASE 50 = 205 AVG. CALENDAR DATE = MAY 12

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17 WP (1.5 lb)*
Apple Scab (Primary)	See Silver Tip and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Fire Blight	1e, See Fire Blight, page 33	
		Comments: <i>*—In Van Buren County, in Ada Township Kent County, and Sherman Township Newaygo County use Mycoshield (17% oxytetracycline) at 1.5 lb/150 gallons of water per acre (200 ppm solution) as part of an anti-resistance strategy for streptomycin (Agrimycin). It can only be used on apples in 1997 if a special Section 18 emergency registration is granted by EPA.</i>

PETAL FALL DD BASE 50 = 254 AVG. CALENDAR DATE = MAY 18

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17 WP (1.5 lb)*
Apple Scab (Primary)	See Silver Tip and page 30	Comments: *—In Van Buren County, in Ada Township Kent County, and Sherman Township Newaygo County use Mycoshield (17% oxytetracycline) at 1.5 lb/150 gallons of water per acre (200 ppm solution) as part of an anti-resistance strategy for streptomycin. It can only be used on apples in 1997 if a special Section 18 emergency registration is granted by EPA (see Bloom comments).
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Fire Blight	1e, See Fire Blight, page 33	
INSECTS/MITES		INSECTICIDES
Aphids	11g, 19e***	3. Carzol 92 SP (1 lb)
White Apple Leafhopper	3e, 6f, 11e, 14g, 19e***	5. Diazinon 50 WP (4 lb)
Potato Leafhopper	See Comments	6. Dimethoate 2.67 EC (6 pt)
Tarnished Plantbug	6e, 26g, 34e,**** 35e,**** 40e	6. Dimethoate 25 WP (8 lb)
Green Fruitworm	11g, 18g,* 26f, 32e,** 35e,**** 40e	6. Dimethoate 400 (4 pt)
Plum Curculio	8e, 9e, 18e,* 32g,** 34e,**** 35e,**** 40e	8. Guthion 3 F (2 pt)
Leafrollers	8e, 9e, 11e, 18e,* 32e,** 34e,**** 35e,**** 40e, 43f/g	8. Guthion 50 WP (2 lb)
Spotted Tentiform Leaf Miner (Larvae)	11e, 19e***	9. Imidan 70 WP (3 lb)
Oblique Banded Leafroller	See Pink	11. Lannate 90 SP (1 lb)
European Red Mite	3g	14. MPEDE (1%-2% v/v)
		18. PennCap-M 2F (4 pt)*
		19. Provado 1.6 EC (4-8 fl oz)
		26. Thiodan 50 WP (4 lb)
		32. Lorsban 50 WP (2-3 lb)**
		34. Ambush 25 WP (12.8 oz)
		35. Pounce 25 WP (12.8 oz)
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		43. B.t.'s*****
		Comments: —Potato leafhoppers migrate to Michigan from Southern states, generally in storm fronts. They feed on all fruit crops, and cause leaf margins to turn brown (called "hopperburn"). Most organophosphates applied for other pests will control potato leafhoppers. *—WARNING: Do not apply PennCap-M if pollinators are working flowers (cover-crop) on the orchard floor. Vydate 2 L used within 30 days post bloom at rates greater than 1/2 pt/100 gal may cause fruit thinning. **For plum curculio use 3 lb/A. ***—Provado must be used at early petal fall to control Spotted Tentiform Leaf Miner larvae and Rosy Apple Aphids. For Leafhopper control, use 4 fl oz/A; use the 8 fl oz/A rate for Leaf Miner and Rosy Apple Aphids. ****—Ambush and Pounce may not be applied after petal fall. *****—B.t. bioinsecticides should be timed for early egg hatch and generally repeated every 4-7 days to maintain control.

APPLES

FIRST COVER DD BASE 50 = 401 AVG. CALENDAR DATE = MAY 31

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17% (1.5 lb)* Comments: *—The fewer streptomycin applications made in summer, the longer the product is likely to be effective.
Apple Scab (Primary)	See Silver Tip and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Fire Blight	1e Following (within 24 hours) a hailstorm. See Fire Blight, page 33	
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 33	
INSECTS/MITES		41. Agri-Mek 0.15 EC (10–20 oz) plus paraffinic spray oil (1 gal) (Sun Ultrafine or other summer oil).
Plum Curculio	See Petal Fall	
Leafrollers	See Petal Fall	
European Red Mite	See Petal Fall, 41e	
Comments: If white apple leafhopper, green fruitworm, tarnished plantbug or aphids were not controlled at petal fall, then these pests should be controlled now with the chemicals recommended at petal fall.		

SECOND COVER DD BASE 50 = 607 AVG. CALENDAR DATE = JUNE 14

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 50. Captan 50 WP (4-8 lb) 51. Ziram 76 DF (6-8 lb) 52. Nova 40W (5-8 oz), Rubigan 1EC (8-12 fl oz), or Procure 50 WS (8-16 oz) + Protectant scab fungicide
Apple Scab (Secondary)	See page 31 for ratings	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 33	
INSECTS/MITES		INSECTICIDES 5. Diazinon 50 WP (4 lb) 6. Dimethoate 400 (4 pt) 6. Dimethoate 2.67 EC (6 pt) 6. Dimethoate 25 WP (8 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (3 lb) 11. Lannate 90 SP (1 lb) 18. PennCap-M 2F (4 pt) 23. Sevin 50 WP (8 lb) 23. Sevin 80 S (5 lb) 23. Sevin XLR+ (2-3 qt) 32. Lorsban 50 WP* (2-3 lb) 40. Asana XL 0.66 EC (4.8-14.5 fl oz) Comments: *—For tufted apple budmoth use 3 lb/A.
Codling Moth	5f, 8e, 9e, 11e, 18e, 23e, 32e, 40e	
Rose Chafer	18e, 23g, 32g See "Special Apple Insect Controls," page 36	
San Jose Scale (crawlers)	5g, 18g, 32e	
Tufted Apple Budmoth	8g, 11g, 18g, 32e*	
Comments: Call the local pest management code-a-phone or determine from the Extension horticultural agent when sprays should be applied.		

THIRD COVER DD BASE 50 = 842 AVG. CALENDAR DATE = JUNE 28

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	

INSECTS/MITES		INSECTICIDES 3. Carzol 92 SP (1¼ lb) 6. Dimethoate 400 (4 pt) 6. Dimethoate 2.67 EC (6 pt) 6. Dimethoate 25 WP (8 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 10. Kelthane 35 WP (4-8 lb) 10. Kelthane 50 WP (3-5 lb) 11. Lannate 90 SP (1 lb) 14. MPEDE (1% v/v)*** 18. PennCap-M 2F (4 pt) 19. Provado 1.6 F (8 fl oz) 28. Vendex 50 WP (1-3 lb) 30. Vydate 2 L (4 pt) 32. Lorsban 50 WP* (2-3 lb) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Codling Moth	See Second Cover	
Mites (adults)	3g, 10g, 14g,*** 28g, 30g	
Mites (immature)	3g, 10g, 14g, 28g, 30g	
Red-banded Leafroller	See Petal Fall	
Green Apple Aphid	6f, 11g, 19e, 30g, 32f, 40f	
Tufted Apple Budmoth	8g, 11g, 18g, 32e*	
Oblique Banded Leafroller	See Petal Fall	
Spotted Tentiform Leaf Miner	See Petal Fall	
Potato Leafhopper	See Petal Fall	

Comments:
 See note under 2nd cover on tufted apple budmoth.
 For mites, see "Special Apple Insect Controls," page 36.

Comments:
 *—For tufted apple budmoth use 3 lb/A.
 ***—Adding MPEDE to miticides such as Kelthane or Vendex will improve mite control. See label for use precautions. Use only as a tank-mix, it will not control mites alone.

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FOURTH COVER DD BASE 50 = 1094 AVG. CALENDAR DATE = JULY 11

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 33	
INSECTS/MITES		INSECTICIDES
Apple Maggot	5g, 6e, 8e, 9e, 11g, 18e, 23f, 32f,* 40p	5. Diazinon 50 WP (4 lb)
Codling Moth	See Second Cover	6. Dimethoate 400 (4 pt)
Oriental Fruit Moth	5g, 8e, 18e, 23e, 32e,* 40e	6. Dimethoate 2.67 EC (6 pt)
Japanese Beetle	18e, 23g	6. Dimethoate 25 WP (8 lb)
Comments:		8. Guthion 3 F (2 pt)
Call the local pest management code-a-phone or determine from the Extension agent when sprays for apple maggots should be applied.		8. Guthion 50 WP (2 lb)
		9. Imidan 70 WP (3 lb)
		11. Lannate 90 SP (1 lb)
		18. PennCap-M 2 F (4-8 pt)
		23. Sevin 50 WP (8 lb)
		23. Sevin 80 S (5 lb)
		23. Sevin XLR+ (2 qt)
		32. Lorsban 50 WP (2-3 lb)
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments:
		*—Use 3 lb/A.

FIFTH COVER DD BASE 50 = 1390 AVG. CALENDAR DATE = JULY 25

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 30	
Powdery Mildew	See "Special Apple Disease Controls," page 32	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 33	
INSECTS/MITES		INSECTICIDES
Apple Maggot	See Fourth Cover	8. Guthion 3 F (2 pt)
Codling Moth	See Second Cover	8. Guthion 50 WP (2 lb)
Red-banded Leafroller	See Petal Fall	9. Imidan 70 WP (3 lb)
Resistant Oblique-Banded Leafroller	11e, 40e	11. Lannate 90 SP (1 lb)
Nonresistant Oblique-Banded Leafroller	8e, 9e, 11e, 40e	32. Lorsban 50 WP (3 lb/100 gal)
Dogwood Borer	32e, See "Special Apple Insect Problems," page 36	40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Oriental Fruit Moth	See Fourth Cover	

SIXTH, SEVENTH AND EIGHTH COVERS (IF NEEDED)

SIXTH COVER DD BASE 50 = 1663 AVG. CALENDAR DATE = AUGUST 8

SEVENTH COVER DD BASE 50 = 1917 AVG. CALENDAR DATE = AUGUST 22

EIGHTH COVER DD BASE 50 = 2153 AVG. CALENDAR DATE = SEPTEMBER 5

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 30	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 33	
INSECTS/MITES		
Aphids	See Third Cover	
Apple Maggot	See Fourth Cover	
Codling Moth	See Second Cover	
Red-banded Leafroller	See Petal Fall	
Spotted Tentiform Leaf Miner (larvae)	11e, 19e,*** 30e	
White Apple Leafhopper	3e, 11e, 19e,*** 23e	
Tufted Apple Budmoth	8g, 18g, 32e,* 40e	
San Jose Scale	5g, 18g, 32e	
Resistant Oblique Banded Leafroller	11e, 40e	
Nonresistant Oblique Banded Leafroller	8g, 9e, 11e, 18e, 32e, 40e	
Oriental Fruit Moth	See Fourth Cover	
		INSECTICIDES 3. Carzol 92 SP (1/2 lb) 5. Diazinon 50 WP (4 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (3 lb) 11. Lannate 90 SP (1 lb)** 18. Penncap-M 2F (4 pt) 19. Provado 1.6 F (4 oz/A) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2 1/2 lb) 23. Sevin XLR+ (1-2 qt) 30. Vydate 2 L (4 pt) 32. Lorsban 50 WP (2-3 lb) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments: *—For tufted apple budmoth use 3 lb/A. **—No more than 5 applications may be made per year. ***—No more than 2 applications may be made per year.

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Phytophthora Collar Rot	See "Special Disease Problems and Controls," page 35	

Special Apple Disease Problems and Controls

Apple Scab Control

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

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

During primary infection, protectants are usually applied on a 5 to 7 day schedule. The frequency of application depends on the ability of the compounds to resist weathering action of rainfall and the rate of new growth during this time. Generally, compounds such as ferbam and sulfur that only protect are applied more frequently than compounds that can act in other ways as well (Table 1).

Table 1.
Background information on apple scab fungicides
(Compiled by Bob Tritten and Alan Jones)*

Fungicide Categories

Inorganic

- | | |
|---------------|--|
| Sulfur | <ul style="list-style-type: none"> • 2-3 days of protectant activity (forward action) • no after-infection activity (some say 9 hours—Mills Table) • poor retention and fair redistribution |
|---------------|--|

- | | |
|---------------|--|
| Copper | <ul style="list-style-type: none"> • 3-4 days of protection activity • little to no back action • can be phytotoxic to foliage and fruit • do not apply after 1/4" green stage • also used for fireblight control |
|---------------|--|

Sterol Inhibitors

- | | |
|----------------------------|---|
| Rubigan (fenarimol) | <ul style="list-style-type: none"> • 2-3 days of protection activity • 96 hours (4 days) of after-infection activity (curative action) • back-to-back sprays give increased after-infection control • locally systemic in foliage |
|----------------------------|---|

- | | |
|----------------------------|---|
| Nova (myclobutanil) | <ul style="list-style-type: none"> • 3-4 days of protection activity • 96 hours (4 days) of after-infection activity (curative action) • back-to-back sprays give increased after-infection control • locally systemic in foliage |
|----------------------------|---|

- | | |
|-------------------------------|---|
| Procure (triflumizole) | <ul style="list-style-type: none"> • 2-3 days of protection activity • 48-72 hours (2-3 days) of after-infection activity (curative action) • back-to-back sprays give increased after-infection control |
|-------------------------------|---|

Table 1 (continued).
Background information on apple scab fungicides

Fungicide Categories

Benzimidazoles

- | | |
|--------------------------|--|
| Benlate (benomyl) | <ul style="list-style-type: none"> • scab resistance is a major problem in Michigan—it is not recommended for scab control • OK for powdery mildew control and summer diseases • locally systemic |
|--------------------------|--|

- | | |
|--------------------------------------|--|
| Topsin-M (thiophanate-methyl) | <ul style="list-style-type: none"> • like Benlate • scab resistance is a problem in Michigan—it is not recommended for scab control • OK for powdery mildew control and summer diseases • locally systemic |
|--------------------------------------|--|

EBDC's

- | | |
|--------------------------|---|
| Polyram (metiram) | <ul style="list-style-type: none"> • an example of an EBDC fungicide • 5-6 days of protection when used at full rate • 18-24 hours of after-infection activity • very good retention and redistribution |
|--------------------------|---|

- | | |
|--|---|
| Dithane M-45
Manzate 200
Penncozeb (mancozeb) | <ul style="list-style-type: none"> • examples of EBDC fungicides • 5-6 days of protection when used at full rate • 18-24 hours of after-infection activity • very good retention and redistribution |
|--|---|

- | | |
|---------------------|---|
| Other EBDC's | <ul style="list-style-type: none"> • Manex, Maneb (see label for registration status on apple) |
|---------------------|---|

Dimethyldithio carbamate

- | | |
|---------------------------|---|
| Carbamate (ferbam) | <ul style="list-style-type: none"> • a second cousin to EBDC's • weak as a protector—3-5 days • no after-infection activity • good retention and redistribution • unsightly residues on fruit if applied close to harvest • associated with enlargement of fruit lenticels and russetting of Golden Delicious |
|---------------------------|---|

- | | |
|----------------------|---|
| Ziram (ziram) | <ul style="list-style-type: none"> • Much like ferbam—a weak protector • 3-5 days of protection activity • no after-infection activity |
|----------------------|---|

Tetramethylthiuram disulphide

- | | |
|------------------------|---|
| Thiram (thiram) | <ul style="list-style-type: none"> • Much like ferbam—a weak protector • 3-4 days of protection activity • has 16-20 hours of after-infection activity |
|------------------------|---|

Guanidine

- | | |
|------------------------|--|
| Syllit (dodine) | <ul style="list-style-type: none"> • 24-36 hours of after-infection activity • will inactivate sporulating lesions—two applications at high rates one week apart are needed • scab resistance is a significant problem in Michigan—it is not recommended for scab control |
|------------------------|--|

Heterocyclic compound

- | | |
|------------------------|--|
| Captan (captan) | <ul style="list-style-type: none"> • 5-6 days of forward action (protectant activity) • generally one day (18-24 hours) of after-infection (back action or kick back) activity • very good retention and redistribution • incompatible with superior oil |
|------------------------|--|

Ratings for Apple Fungicides

Fungicide and rate per acre	Scab	Powdery mildew	Sooty blotch & flyspeck	Fruit finish
Captan 50 W 6-8 lb	5	1	4	6
Procure**				
50 WS 8-16 oz	5	5	1	6
Nova** 40 W 5-8 oz	5-6	6	1	6
Rubigan**				
1 EC 9-12 fl oz	5-6	5-6	1	6
Sulfur 95 W 20 lb	3	3-4	3	4
Carbamate				
76 W 6 lb	3	1	4	3
Thiram 65 W 6 lb	3	1	3	5
Ziram 76 DF 6-8 lb	3	1	3	4
EBDC's (full rate)	5	1	5	6
Benlate 50% WP 8 oz plus Captan 50% WP 6 lb or Ziram 76 DF 6 lb	4	5	5	4
Topsin M 70 WSB 8 oz plus Captan 50% WP 6 lb or Ziram 76 DF 6 lb	4	5	5	4

6 = excellent, 5 = very good, 4 = good, 3 = fair, 2 = poor, 1 = none

*Bob Tritten is a District Horticultural and Marketing Agent with Michigan State University-Extension in SE Michigan. Thanks also to T. Mike Thomas, Phil Schwallier, and Jim Nugent for their review and input.

**Normally tank mixed with a protectant fungicide (generally Captan or an EBDC fungicide).

2. After-infection spray program—After-infection fungicides are effective for a few days after the beginning of an infection period. Fungicides with after-infection activity should be used at their full recommended rate, because at lower rates their ability to stop infections is reduced or lost (Table 1).

Timing of after-infection schedules for primary apple scab is based on wetting and prevailing air temperatures (see Table 2). After-infection fungicides 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 after-infection activity 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 after-infection properties must be used.

3. Postsymptom control—Postsymptom control is the ability of a fungicide, when applied to sporulating scab lesions, to suppress lesion development and sporulation. To inactivate sporulating scab lesions, use Syllit (dodine) 65% WP at 3 lb/acre 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 beno-

Table 2. Approximate numbers of hours of wetting required for primary apple scab infection at different air temperatures¹

Temperature Average (°F)	Degree of Infection			Incubation Period (days)
	Light (hrs. ²)	Moderate (hrs.)	Heavy (hrs.)	
78	13	17	26	—
77	11	14	21	—
76	9½	12	19	—
63 to 75	9	12	18	9
62	9	12	19	10
61	9	13	20	10
60	9½	13	20	11
59	10	13	21	12
58	10	14	21	12
57	10	14	22	13
56	11	15	22	13
55	11	16	24	14
54	11½	16	24	14
53	12	17	25	15
52	12	18	26	15
51	13	18	27	16
50	14	19	29	16
49	14½	20	30	17
48	15	20	30	17
47	15	23	35	—
46	16	24	37	—
45	17	26	40	—
44	19	28	43	—
43	21	30	47	—
42	23	33	50	—
41	26	37	53	—
40	29	41	56	—
39	33	45	60	—
38	37	50	64	—
37	41	55	68	—
33-36	48	72	96	—

¹From W. D. Mills, Cornell University; modified by A. L. Jones.

²The infection period is considered to start at the beginning of the rain.

myl resistance are suspect, use Captan 50% WP at 6 lb/acre on a protectant program.

4. The Integrated, Reduced-Spray (IRS) Program for Apple Scab—Recent research in the Eastern United States indicates that the first spray for apple scab in orchards with little or no overwintering inoculum can be delayed for 1 to 3 weeks after Green Tip provided sterol-inhibitor (SI) fungicides are used as the scab control fungicide.

The IRS apple scab program outlined below was designed by Wayne F. Wilcox of the New York State Agricultural Experiment Station. It minimizes the number of sprays applied for the control of primary apple scab and permits growers to coordinate the timing of scab sprays with early season insecticide and miticide sprays. Powdery mildew is also controlled. The IRS program for apple scab was successfully tested in

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numerous orchards in western New York state from 1988-90, but failures have occurred where assessments of primary inoculum levels were inaccurate, intervals between "back-to-back" sprays were too long, or protectant fungicides were improperly substituted for SI fungicides. It is recommended on an experimental basis in Michigan orchards where inoculum levels are low or non-detectable.

Risks and Assumptions

This is a minimal spray program for apple scab control, and there is little room for error, particularly in terms of rates and spray coverage. The IRS program is specifically not recommended when sprays are applied at concentrations greater than 6X or on an alternate-middle basis.

Whether or not the start of a scab control program can be delayed after Green Tip depends on the level of primary inoculum in leaves that were infected with scab the previous year. In general, the IRS program is designed for orchards with less than 2% fruit scab the previous year, questionable in orchards with 2-5% scab, and NOT recommended in orchards with more than 5% fruit scab the previous year. Caution is also advised following wet years with a late season build-up of scab on the underside of leaves.

Applications of SI fungicides can be flexible because, as first demonstrated in Michigan, their activity is greatly enhanced when two "back-to-back" fungicide applications are made about 7 days apart. These "back-to-back" sprays prevent lesion development from the few infections initiated between bud break and initiation of the spray program or between the long interval between the pink and petal fall sprays.

The IRS-Apple Scab Program

Where apple scab was very well controlled the previous season, it is possible to control primary apple scab in most low inoculum orchards with four sprays of Rubigan or Nova timed as follows: (1) Tight Cluster; (2) Pink; (3) Petal Fall; and (4) First Cover. This program provides two "back-to-back" applications (Tight Cluster/Pink and Petal Fall/First Cover) and can be coordinated with most early and mid-season insect and mite sprays.

For improved control of fruit infections, always tank mix Rubigan and Nova with a protectant fungicide as often as possible in the IRS-apple scab program and especially during the petal fall and first cover sprays. The minimum rate of Rubigan should be 9 fl oz/A with 12 fl oz/A preferred in the tight cluster and petal fall sprays if they are preceded by severe unprotected "Mills" infection periods. The minimum rate of Nova should be 5 oz/A in all sprays. The minimum rate of Captan 50 WP is 4 lb/A and of EBDC fungicides (Dithane M-45 80% WP or Manzate 200 DF or Penncozeb 80% WP or Polyram 80% WP) is 3 lb/A. Using Ferbam, Thiram, Ziram,

or Wettable Sulfur instead of Captan or EBDC fungicide is not recommended.

The specific timing of these sprays should be influenced more by spraying conditions (wait for good conditions) and the necessary timing of insect and mite sprays than by the occurrence of particular apple scab infection periods. If intervals greater than 10 days occur (e.g., from Pink until Petal Fall) and significant scab pressure has developed during this period, it may be necessary to compensate by increasing the rate of the SI fungicide.

Apple Powdery Mildew

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 or Captan are applied too closely to the oil application.

If Morestan is used pre-bloom for mite control, no additional fungicides are needed for powdery mildew control during the pre-bloom period.

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

Fungicides	Rate/acre
Scab fungicide plus Bayleton 50% DF ¹	2-6 oz
OR	
Nova 40W plus protectant fungicide	5-10 oz
OR	
Rubigan 1 EC plus protectant fungicide	8-12 fl oz
OR	
Procure 50 WS plus protectant fungicide	8-16 oz
OR	
Scab fungicide plus Wettable Sulfur 95% WP ²	8 lb

¹Where mildew is a severe problem, use 4 to 6 oz/acre in two to three applications, then reduce to 2 to 3 oz/acre. Where mildew is a minor problem, use 2 oz/acre. Short spray intervals (5 to 7 days) are preferred to long (10 to 14 days) intervals. Also controls rust.

²Other formulations of sulfur such as flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.

Sooty Blotch, Fly Speck and Scab

TIMING: Cover sprays starting at third cover

Fungicides	Rate/acre
Captan 50% WP	6-8 lb
OR	
Ziram 76 DF	6-8 lb
OR	
Benlate 50% WP plus Captan 50% WP or Ziram 76 DF	8 oz 6-8 lb
OR	
Topsin M 70 WSB plus Captan 50% WP or Ziram 76 DF	8 oz 6-8 lb

Cedar-Apple Rust

TIMING: Pink to third cover

Fungicides	Rate/acre
Bayleton 50% WP plus Scab fungicide	2-4 oz
OR	
Nova 40W plus protectant fungicide	5-8 oz
OR	
Rubigan 1 EC plus protectant fungicide	8-12 fl oz
OR	
Procuire 50 WS plus protectant fungicide	8-16 oz

Blister Spot on Mutsu, Cortland, Fuji

Blister spot is a bacterial disease of apple caused by a bacterium in the genus *Pseudomonas*. It is a common and serious problem on the cultivar Mutsu. New outbreaks of blister spot have been identified on Cortland and Fuji. Additional information on this disease may be found in Bulletin NCR-45 "Diseases of Tree Fruits," or in the "Compendium of Apple and Pear Diseases" published by the American Phytopathological Society.

Use of streptomycin to control blister spot is not recommended. Streptomycin-resistant *P. syringae* pv. *papulans* has been detected in Michigan and in other areas of North America where streptomycin was used to control blister spot. Resistance was confirmed in several Mutsu orchards in Michigan. Because of the loss of streptomycin for control due to resistance and the lack of alternative control procedures, establishing new plantings of Mutsu is not recommended.

Fire Blight Management

With the probable future loss of streptomycin for fire blight control due to the development of resistance in the pathogen, nonchemical aspects of control take on increasing importance and must be considered as a top priority.

Sanitation. The first step in managing fire blight is to remove the overwintering cankers from dormant trees. Cut the branch 8 to 12 inches below the canker margin.

Pruning out infected shoots to limit the spread of shoot blight is recommended on young or small trees, particularly those on M.9 or M.26 rootstocks. Removing infected shoots resulting from the extension of dormant canker is recommended on large trees. If infection to spurs and shoots is severe, however, it is of doubtful benefit to remove blight from large trees. To be effective in limiting spread, prune out strikes as soon as they appear.

Orchard Risk Assessment. At the beginning of each growing season, make a risk assessment of each orchard, categorizing its risk of infection by fire blight as low, medium, or high. This judgement should be based on such factors as the previous occurrence of fire blight in the orchard, the susceptibility of the varieties grown and their rootstocks, the age and vigor of the trees, and the number of overwintering cankers. The orchard risk assessment rating is used in combination with a "daily risk assessment," described below, to determine whether to apply antibiotic sprays.

In making orchard risk assessments, consider the relative susceptibility of the varieties to fire blight. A table listing the susceptibility of many new and common apple varieties is provided for your convenience. Trees propagated on M.26 rootstock tend to be more susceptible than others, and the rootstock itself is very susceptible. Young, vigorously growing trees are generally more susceptible than mature ones. Most commercial pear varieties are susceptible.

Chart for Assessing Orchard Risk

Daily risk rating	Orchard risk rating		
	Low	Moderate	High
Low	None	None	Marginal
Moderate	None	Marginal	Worthwhile
High	Marginal	Worthwhile	Critical

Chemical Control. Two bactericides, Agrimycin (streptomycin) and Mycoshield (oxytetracycline), are effective against the blossom phase of fire blight. Until Mycoshield is registered for use on apples, it can only be used on apples in 1996 if a special Section 18 emergency registration is granted by EPA and then only where streptomycin-resistant strains of fire blight have been identified.

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Streptomycin has been the standard for control of fire blight on apples since it was introduced in the 1950s. It is a more effective product than Mycoshield where bacteria are not resistant.

Since being discovered in one orchard in Van Buren county in 1990, streptomycin-resistant strains of the fire blight bacterium (*Erwinia amylovora*) have been detected in several additional orchards in Van Buren county. Resistant strains also have been detected in Ada township in Kent county, and in Sherman township in Newaygo county.

Mycoshield is useful as a replacement for streptomycin in areas where streptomycin resistance has been a problem and as a part of an anti-resistance management program. Apply it as a protectant during bloom for blossom blight control. The product has no effect on fire blight unless applied to open flowers under weather conditions that are likely to lead to blight infection. It does not provide economic control of blight if applied even a few hours after infection has occurred, and it does not prevent infection of shoots or fruit during the summer. According to the label, it must be applied as a concentrate spray.

Timing Antibiotic Sprays. Time antibiotic sprays carefully. With Agrimycin and Mycoshield, timing is everything. The best timing can be achieved using Paul Steiner's MARYBLYT model.

In the absence of information from the MARYBLYT model, reasonable control of fire blight should be achieved if the antibiotics are applied using the "daily risk system." These daily assessments are determined after the onset of bloom. On days with rain and days following a rain, note the maximum temperature and the amount of rainfall, then refer to the following chart to determine the daily risk rating.

Chart for Assessing Daily Risks

Maximum temperature	Rainfall	
	Less than 0.1 inch	More than 0.1 inch
	Daily risk rating	
Under 65°F	None	Low
65°F to 69°F	Low	Moderate
70°F to 80°F	Moderate	High
Over 80°F	High	High

For example, on a day with a maximum temperature of 75° F and more than 0.1 inch of rain, the daily risk rating would be high. On a day following a rain with the same maximum temperature but no rainfall, the rating would be moderate.

When determining daily risk ratings, use the "Orchard Risk Chart" described earlier to determine whether it is worthwhile to apply an antibiotic spray to control fire

blight. For example, if the daily risk rating is moderate and the orchard risk rating is low, a spray is not needed. If both the daily and the overall orchard risk ratings are high, on the other hand, applying a spray would be critically important.

When using the "daily risk system," remember that a single day with rain occurring early in the bloom period is usually inconsequential; in low-risk orchards, a spray is probably not needed. During the early bloom stage after a spray has been applied, a second application is usually not needed until a significant number of new blooms have opened. After full bloom, an application is effective for about four days. If rainfall of 0.5 inch or more occurs, however, it will end the application's effective period.

Hailstorms. Fire blight outbreaks can be severe after a hailstorm. If hail occurs and fire blight is either present in the orchard or has been a problem in previous years, spray immediately regardless of the risk assessment ratings.

Severity of fire blight on 2- and 3-year-old apple trees on M.7a or M.7 EMLA rootstocks at the Southwest Michigan Research and Extension Center following a severe epidemic in 1991.

Variety	Severity scores for 84 cultivars ^{1,2}	
	July 17	Sept. 11
<i>Moderately Resistant</i>		
Red Chief (Campbell) Delicious	10.0	9.7
Nured Delicious	9.7	9.5
Starkrimson Delicious	9.5	9.5
Liberty	9.7	9.2
Keepsake	9.7	9.2
Nured Winesap	9.5	9.2
Early Red One Delicious	9.2	9.2
Top Spur Delicious	9.2	9.2
Cascade Spur Delicious	9.2	9.2
Lurared	9.2	8.7
Melrose	9.0	8.5
Starkspur Ultra Stripe Delicious	9.0	8.5
Starkspur Supreme Red Delicious	8.7	8.5
Starkspur Compact Red Delicious	8.7	8.5
<i>Intermediate Resistance</i>		
Red Max	9.2	8.2
Empire	8.7	8.2
Ace Delicious	8.7	8.0
Scarlet Spur Delicious	8.7	8.0
Jonamac	8.2	8.0
Marshall McIntosh	8.2	8.0
Sturdeespur Delicious	8.5	7.7
Freedom	8.0	7.7
Macspur	8.0	7.7
Lysgolden	9.2	7.5
Dixi Red Delicious	8.5	7.5
Regent	8.0	7.2
Prima	7.7	7.2
Classic Delicious	8.5	7.0
Dana Red Delicious	8.2	7.0
Lustre Elstar	8.0	7.0
Scarlet Gala	8.0	7.0
Swiss Gourmet (Arlet)	7.7	7.0
Stamared	7.7	7.0
Ozark Gold	7.7	7.0

Severity of fire blight on 2- and 3-year-old apple trees on M.7a or M.7 EMLA rootstocks at the Southwest Michigan Research and Extension Center following a severe epidemic in 1991. (continued)

Variety	Severity scores for 84 cultivars ^{1,2}	
	July 17	Sept. 11
<i>Intermediate Resistance</i>		
Pioneer Mac	7.5	7.0
Mor Spur Mac	7.7	7.0
Akane	8.0	6.7
Red Winesap	8.0	6.7
Golden Glory	8.0	6.7
Gold Spur	7.7	6.7
Perfect Spur Criterion	7.5	6.7
Red Chief (Mercier) Delicious	7.5	6.7
Granny Smith	7.0	6.7
<i>Moderately Susceptible</i>		
Summer Treat	8.2	6.5
Red Fuji	8.0	6.5
Smoothee	7.2	6.5
Stark Gala	7.2	6.5
Mutsu	7.0	6.2
Red Cort	6.7	6.2
Golden Delicious	6.7	6.2
Honeygold	7.2	6.0
Imperial Gala	7.2	6.0
Super Chief Red Delicious	6.7	6.0
Fulford Gala	7.2	5.7
Royal Gala	7.0	5.7
Virginigold	6.5	5.7
Staybrite Staman	7.5	5.5
Red Fuji #4	6.5	5.5
Jonagold	6.2	5.5
Blushing Golden	7.5	5.2
<i>Very Susceptible</i>		
Spur GalaGoRed	7.0	5.0
Red Fuji Nagano	6.7	5.0
Nicobel Jonagold	5.2	5.0
Spigold	5.2	4.7
EarliJon	6.5	4.5
Fuji	5.5	4.5
Northwest Greening	5.5	4.5
Ultra Red Jonathan	5.2	4.5
Berts Special	5.0	4.5
Prime Gold	5.0	4.5
Double Red Jonathan	6.7	4.2
Braeburn	5.7	4.0
Geneva Early	5.2	4.0
Super Jon	4.7	4.0
Earligold	5.5	3.7
Jonnee	4.7	3.5
Idared	5.7	3.5
Starkspur Law Rome	4.7	3.2
Jonafree	3.2	3.2
Red Yorking	3.7	3.0
Nittany	4.0	2.7
Early Spur Rome	4.2	2.5
Ginger Gold	5.0	2.2
Nured Jonathan	3.0	1.7

¹Data adapted from T. M. Thomas and A. L. Jones, 1992. Plant Dis. 76:1049-1052.

²Final USDA rating scores were based on the scale: 10 = 0%; 9 = 1-3%; 8 = 4-6%; 7 = 7-12%; 6 = 13-25%; 5 = 26-50%; 4 = 51-75%; 3 = 76-88%; 2 = 89-99%; and 1 = 100% of the tree blighted. Data are mean rating scores for four trees.

Phytophthora Collar Rot

Collar rot can be avoided by carefully selecting the type of soil and rootstocks for new apple orchards. Do not plant susceptible rootstocks in orchards (or areas of the orchard) with heavy, poorly drained soils. Tiling of wet areas in an otherwise well-drained location often improves internal soil drainage sufficiently to eliminate problems with this disease.

Two fungicides, Ridomil and Aliette, are registered for the control of phytophthora collar rot. Chemical control measures are not substitutes for good cultural practices. Rather, they are stop-gap measures for use in emergency situations.

Ridomil for Collar Rot

Bearing Apple Trees. Ridomil 2E is applied as a soil drench consisting of 1 qt of Ridomil 2E per 100 gal of water. Apply 1 to 4 qt of the diluted mixture around the trunk of each tree. The exact amount of diluted mixture per tree depends on trunk diameter as indicated in the table below. Make two applications per year. One application is made in spring before growth starts and another application in the fall after harvest. On new plantings delay the first application until 2 weeks after planting.

Trunk diameter (inches)	Diluted mixture/tree (quarts)
< 1	1
1-3	2
3-5	3
> 5	4

Nonbearing Apple Trees. In nurseries and field plantings of nonbearing trees, make the first application of Ridomil 2E at two weeks after planting with additional applications made at three-month intervals throughout the growing season. Do not apply to plantings (except apple as noted above) that will bear harvestable fruit within 12 months of application. Apply 2 to 4 gal per treated acre (6 to 12 fl oz per 1000 sq ft) in sufficient water to obtain thorough coverage of the soil under the canopy of the trees. Sufficient surface area should be treated in nurseries to cover the root zone of the plants.

Aliette for Collar Rot

Aliette 80 WSP is applied as a spray to the foliage at the rate of 2.5 to 5 lb/acre. Begin applications at the start of the growing season. Do not apply more than 100 gal/acre per application or 20 lb of Aliette WSP per acre per season. Repeat every 60 days; maximum of four applications per year. Aliette is particularly effective against *Phytophthora cactorum*.

APPLES

Special Apple Insect and Mite Problems and Controls

Mites

Superior oil applied at the correct time with good coverage at the full rate can provide mite control until mid-summer, but can cause phytotoxicity if applied within 48 hours of freezing temperatures. Morestan, a dithiocarbonate, has a different mode of action and will control mites resistant to other chemical groups. It kills by contact action, and good coverage is essential. This unique miticide provides control of mite eggs and nymphs and is registered for powdery mildew control. Morestan may be used only pre-bloom but not within 10 days of an oil application.

Apollo, Savey and Agri-Mek all provide extended control of European red mites, ranging from 10 weeks to full season depending on mite pressure, tree vegetative growth and predator mite populations. Apollo must be applied no later than tight cluster and Savey at pink on apple. Agri-Mek is most effective when applied between petal fall and first cover (14 days past petal fall) with the addition of 1 gallon of paraffinic spray oil per acre. These compounds can be used in lieu of early season oil spray, but oils should remain as an important resistance management tool to reduce the selection pressure from consecutive use of Apollo and Savey, which have similar ovicidal modes of action.

Currently labeled summer miticides are few. Carzol early in the season provides control of adult mites (along with some insect pests) but is toxic to predator mites and may need to be applied back-to-back (7-14 days later) to achieve the desired control. Vendex provides good control during warm weather. Kelthane gives good control in all temperature conditions, but should be used only once or as a back-to-back application on the same generation of mites to prevent resistance from building. Vydate will kill some mites, but is very toxic to predators, and may cause some fruit drop if applied within 30 days after petal fall.

Dogwood Borer

The dogwood borer is a problem in some apple orchards in Michigan, mostly 4 to 9 years of age. Initially the dogwood borer larvae feed inside burr knots (adventitious roots) which can develop on the exposed above ground portion of clonal rootstocks. Feeding in the burr knot does little damage to the tree but feeding can continue below the bark where it is much more destructive and may eventually girdle the tree. Burr knots are aggregations of partially developed root initials which usually occur in clusters at or below the graft union. Reddish frass on the surface of a burr knot is a visible sign of infestation. Burr knots are fibrous and permit entry of pesticides so that larvae are readily controlled within the burr knot. The larvae can best be controlled with

trunk applications of Lorsban 50 WP at the rate of 3 pounds per 100 gal. A single spray timed for the peak egg hatch in late June to mid-July will provide control.

Japanese Beetle

This insect has moved into Southern MI, and adults can cause considerable defoliation where it occurs. Japanese beetles prefer grapes and peaches but will readily feed on other tree fruit species if available. The insect overwinters as a white grub, a larval stage in the soil. Japanese beetle adults should be susceptible to many stomach poisons (organophosphates and carbamates), and Sevin is labeled for control. Controlling larvae is not effective in commercial orchards, and the natural insecticide, *Bacillus popilliae*, marketed as DOOM, Japademic, and other names, will provide persistent but low levels of larval control.

Dock Sawfly

Dock sawfly occurs in the Northern U.S., and has been found in increasing numbers in new dwarf orchards in MI. It is a pest in the larval stage, and primarily feeds on species of dock and lambsquarter. There are several (up to four) generations per year, and most of these occur without damaging apples. The larva of the last generation of the year will "wander," looking for a site to pupate. Apples that are on limbs hanging in the groundcover, or on dwarf trees are subject to attack. Larvae will often "probe" an apple, making several holes in the fruit before tunneling into fruit. New orchards with disturbed soil are often infested with dock plants and the dock sawfly. Late season varieties such as Rome seem to be more susceptible, but any apple can be attacked. Apples are just an accidental host, and the larvae will overwinter in the fruit.

Control is linked to weed control. Keeping the tree rows and row middles free from dock and lambsquarter is important. Controlling larvae after they are on the apple is difficult if not impossible.

Rose Chafer

This small beetle is primarily a pest of grape, but it can damage most fruit species, especially non-bearing orchards with little insecticide residue. Rose chafer larvae live in the soil, and sandy loam sites are preferred. Adults emerge in June for about 4-6 weeks, and can rapidly defoliate trees. Most stomach poisons are effective (such as Guthion, Imidan, Sevin), but Penncap-M provides superior control. It is unknown if larvae do any damage to trees, but larval control is not effective at reducing populations.

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	3	5	6	8	9	10	11	13	14	15	17	18	19	23	24	26	28	30	32	34	35	40	41	42		
		Carzol	Diazinon	Dimethoate	Guthion	Imidan	Kelthane	Lannate	Malathion	MPED	Morestan	Apollo	Pencap-M	Provado	Sevin	Superior Oil ²	Thiodan	Vendax	Wydate	Lorsban	Pounce	Ambush	Asana	Agri-Mek	Savey		
Pests	Apple Maggot		G	E	E	E	E	G	P				E		G					F	P	P	P				
	Codling Moth		F	F	E	E	E	E	P				E		E					P	E	E	E	E			
	Cutworms					P			F											E	E	E	E	E			
	European Red Mite		E	P				G			G	E	E					E	G						E	E	
	Fruit Tree Leafroller		G	E	E	E	E	E	E				E		F		F			P	E	E	E	E	E		
	Green Apple Aphid		P	F	P	P	P	P	G				P	E	P	P	F			G	F	F	F	F	F		
	Green Fruitworm		F		P	P	P	P	G				F		F		F			P	E	E	E	E	E		
	Oblique Banded Leafroller		G		E	E	E	E	E				E		E					P	E	E	E	E	E	E	
	Plum Curculio			P	E	E	E	E	F	P			E		F					P	G	E	E	E	E	E	
	Red Banded Leafroller		G	P	E	E	E	E	E	P			E		F					P	E	E	E	E	E	E	
	Rose Chafer														E	G				G				G			
	Rosy Apple Aphid		P	E	P	P	P	P	G				E	E	P	E				G	E	F	F	F	F		
	Rust Mite		E	P	P	P	P	G				G	P	P	G					E	G	F	P	P	P	E	P
	San Jose Scale														G								E	P	P	P	
	Spotted Tentiform Leafminer		G												G								E	P	P	P	
Tarnished Plantbug		G	P	E	P	P	P	G						P								P	E	E	E		
Two-spotted Spider Mite		E		P										F								F			E	E	
White Apple Leafhopper		E	P	F	P	P	P	E	P					P	E							P	E	E	E	E	
Woolly Apple Aphid		F	G						P					F								E	P	E	P		
Bees		MT	HT	HT	HT	HT	HT	NT	HT	HT	NT	NT	HT	MT	HT	NT	MT	NT	NT	HT	HT	HT	HT	HT	NT		
Mite Predators		HT	NT	MT	NT	NT	MT	HT	MT	HT	MT	NT	MT	NT	HT	NT	MT	NT	HT	NT	HT	HT	HT	HT	NT		
Insect Predators		MT	HT	HT	MT	MT	NT	HT	MT	MT	NT	NT	HT	MT	HT	NT	MT	NT	HT	NT	HT	HT	HT	HT	NT		

¹Second generation only.

²Use only before pre-pink stage.

PEARS

The rates of materials 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 controlling the pest.

LATE DORMANT OR DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		INSECTICIDES
Pear Psylla	34e, 35e, 40e	34. Ambush 2 EC (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Comments: <i>Pear psylla resistance to pyrethroids is imminent and has already appeared in some localized pear orchards. See page 41 for more information.</i>		

Pear Scab Control

GREEN TIP TO PRE-PINK

Fungicide	Rate/acre	Comments	Restrictions
Benlate 50% WP + an EBDC fungicide as listed under "Extended Application Schedule"	12-24 oz + 3 lb	Begin applications at 1/2 inch green tip and repeat at 7 to 14 day intervals.	Do not exceed 5 lb of Benlate per acre per season. Do not apply within 77 days of harvest (see EBDCs below).
Carbamate 76 WDG	3-4.5 lb	Use 4.5 lb per acre in pink, calyx, first and second cover sprays, and 3 lb per acre in summer.	Do not apply within 7 days of harvest.
EBDC Fungicides (other formulations may also be available)		Use either the "Pre-Bloom" (e.g. 6 lb) or "Extended Application" (e.g. 3 lb) schedule. <i>Pre-Bloom Use:</i> Begin applications at 1/4 to 1/2 inch green tip and continue on a 7 to 10 day schedule through bloom.	Do not combine or integrate the two treatment schedules. Do not apply after bloom or more than 24 lb per acre per year.
Dithane M-45 75% DF OR Manzate 200 DF OR Penncozeb 75 DF	6 lb 6 lb 6 lb		
Dithane M-45 75% DF OR Manzate 200 DF OR Penncozeb 75 DF	3 lb 3 lb 3 lb	<i>Extended Application Schedule or for Use in Tank Mixtures:</i> Begin applications at 1/4 to 1/2 inch green tip and continue applications on a 7 to 10 day schedule through the second cover spray. Tank mix with non-EBDC fungicide when needed for primary scab control.	Do not apply more than 3 lb per acre per application or 21 lb per acre per season. Do not apply within 77 days of harvest.
Procure 50 WS	8-16 oz 12-16 oz	<i>Standard Spray Schedule:</i> Begin applications at 1/2" green tip stage and continue on a 7 to 10 day interval through the second cover spray. Tank mix with an EBDC fungicide (see Extended Application Schedule above) for maximum fruit disease control. <i>Postinfection:</i> Apply within 48 to 72 hr after the beginning of an infection period. Use the high rate under heavy disease pressure or when applied after 48 hr.	Do not apply more than 64 oz/A per season. Do not apply within 14 days of harvest.

(Continued on next page)

GREEN TIP TO PRE-PINK (CONTINUED)

Fungicide	Rate/acre	Comments	Restrictions
Ziram 76 DF	6-8 lb	Begin applications at 1/4" to 1/2" green tip and continue through cover sprays as needed.	Do not apply within 14 days of harvest. Do not apply more than 56 lb/A per season.

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		INSECTICIDES
European Red Mite	24e	18. Penncap-M 2F (4 pt) 24. Superior Oil (6 gal) 32. Lorsban 4 EC (3 pt)
San Jose Scale	18g, 24e, 32e	Comments: Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.

WHITE BUD

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Pear Scab	Fungicides listed under Green Tip to Pre-Pink	
INSECTS/MITES		INSECTICIDES
European Red Mite	3g, 10g, 15g	2. Mitac 50 WP (1 1/2-3 lb)** 2. Mitac 1.5 EC (1 gal)** 3. Carzol 92 SP (1 1/2 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (2 1/4 lb) 10. Kelthane 35 WP (4-8 lb) 15. Morestan 25 WP (1 1/2 lb) 26. Thiodan 50 WP (3 lb) 30. Vydate 2 E (6 pt) 34. Ambush 2 E (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Leafrollers	8e, 9e, 34e, 35e, 40e	
Green Fruitworm	26f, 34e, 35e, 40e	
Tarnished Plantbug	3g, 34e, 35e, 40e	
Pear Psylla	2g, 34e, 35e, 40e	
Pear Rust Mite	2g, 3e, 10e, 30f	
Comments:		Comments:
European red mite control is not necessary if dormant oil was applied.		**—Mitac is most effective under warm weather conditions.
Pear rust mite control requires pre-bloom and petal fall applications and post bloom treatments as needed. Alternate row spraying and high concentrate sprays are ineffective. See note on Mitac under Special Pear Insect Problems and Controls.		
Spraying at flower bud separation (green cluster) is the most effective pre-bloom timing for rust mite control.		

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17 WP (1.5 lb)
Fire Blight	1e, See Fire Blight, page 33	
Pear Scab	See Green Tip	
INSECTS		
Pear Sawfly	See Special Pear Insect Problems and Controls, page 41	

PEARS

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17 WP (1.5 lb)
Fire Blight	1e, See Fire Blight, page 33	
Pear Scab	See Green Tip	
INSECTS/MITES		INSECTICIDES 3. Carzol 92 SP (1½ lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (2¼ lb) 10. Kelthane 35 WP (4-8 lb) 18. Penncap-M 2 F (6 pt) 26. Thiodan 50 WP (3 lb) 26. Thiodan 3 EC (3 qt) 34. Ambush 2 E (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Plum Curculio	8e, 9e, 18e, 34e, 35e, 40e	
Green Fruitworm	18f, 26f, 34e, 35e, 40e	
Tarnished Plantbug	26f, 34e, 35e, 40e	
Pear Rust Mite	3e, 10e	
Comments:		<i>WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor.</i>

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		1. Agrimycin 17 WP (1.5 lb)
Fire Blight	1e, Following (within 24 hours) a hailstorm, page 33	
Pear Scab	See Green Tip OR Rubigan 1 EC + 3 lb Dithane M-45 80 WP or Manzate 200 DF or Penncozeb 80 WP. Do not apply within 77 days of harvest.	
Comments:		
Where <i>Fabraea Leaf Spot</i> or <i>Septoria Leaf Spot</i> are problems, continue with applications of Ziram until late July.		
INSECTS/MITES		41. Agri-Mek (20 oz) plus Paraffinic Spray Oil (1 gal)
Plum Curculio	See Petal Fall	
Pear Psylla Pear Rust Mite	41e, See Comments	

SUMMER COVERS

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Pear Scab	53f, 54e, 55g	53. Carbamate 76 WDG (4 lb) 54. Procure 50 WP (8-16 oz) + protectant scab fungicide 55. Ziram 76 DF (6-8 lb)
Comments: Where <i>Fabraea</i> Leaf Spot or <i>Septoria</i> Leaf Spot are problems, continue with applications of Carbamate or Ziram until late July.		
INSECTS/MITES		INSECTICIDES
Codling Moth	2e, 5e, 8e, 9e, 18e, 23e	2. Mitac 50 WP (1½-3 lb) 2. Mitac 1.5 EC (1 gal) 3. Carzol 92 SP (1½ lb) 5. Diazinon 50 WP (3 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (2¼ lb) 10. Kelthane 35 WP (4-8 lb) 18. Penncap-M 2 F (6 pt) 23. Sevin 50 WP (6 lb) 23. Sevin 80 S (4 lb) 28. Vendex 50 W (1-3 lb)
San Jose Scale (crawlers)	5g, 18e	
Pear Psylla	2g	
Apple Maggot	5g, 8e, 9e, 18e	
Mites (adults)	3g, 10g, 28g	
Mites (immatures)	3g, 10g, 28g	
Pear Rust Mite	3e, 10e	
Comments: Codling moth control is not necessary for first generation as the pear is too hard for the larvae to enter successfully. Hence no insect sprays, other than for pear rust mite and pear psylla, are required from petal fall until second generation codling moth in August. Check with your local Extension agent for timing of this application.		

Special Pear Insect Problems and Controls

Pear Psylla

Pear psylla has become resistant to most of the insecticides used against it, and current effective insecticides are few. Pyrethroid sprays for psylla control are effective only against the overwintering generation, and should not be used in the summer psylla sprays. Dithane-M45 and other mancozeb products may not be used at rates effective against pear psylla early in the season, so growers will have to use a pyrethroid followed by Mitac in the summer (2nd and 4th covers). The summer treatment threshold for pear psylla is 1 psylla nymph/3 leaves. If this number is met or exceeded, a Mitac application should be made at 2nd cover, with a possible application 4 weeks later. The 1.5 EC formulation of Mitac will also control pear rust mite and codling moth, but growers are restricted to 2 applications per year by the label. Agri-Mek is registered for pears. One application at 1st cover (14 days post-petal fall) will provide season-long control of pear

psylla and pear rust mite. Agri-Mek users should be sure to use the 20 ounce rate of Agri-Mek + 1 gallon of a paraffinic spray oil (Sun Ultra Fine Oil or other summer oil) per acre. Provado is registered for pear psylla control, but does not control pear rust mite.

Pear Sawfly

This insect was reported in Michigan in 1992. Damaged fruit collected from Van Buren Co. in spring 1992 contained larvae of pear sawfly. This insect is related to and similar in appearance to European apple sawfly, a pest in the Hudson Valley of New York. Pear sawfly females fly during pear bloom, laying an egg directly into the developing flower pistil. The hatching larvae feeds in the developing pear, and exits the fruit to pupate in the soil. Control is difficult, but pear sawfly will not likely become a pest problem in commercial pear orchards. This insect is not the same as pear slug, which is an incidental defoliator.

PEACHES AND NECTARINES

The rates of materials 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 choos-

ing 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, p = poor for the pesticide in controlling the pest, and n = not labeled or no activity against this pest.

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Peach Leaf Curl	4e, 6e, 10e, 12e	4. Bravo 720 (3 $\frac{1}{8}$ -4 $\frac{1}{8}$ pt)
Bacterial Spot	4n, 6f, 10n, 12n	6. Bordeaux mixture (see page 47)
Valsa Canker	See page 47	10. Ziram 76 DF (3 $\frac{3}{4}$ -6 lb)
Crown Gall	See page 48	12. Carbamate 76 WDG (4 $\frac{1}{2}$ -6 lb)
		Comments: Apply leaf curl sprays in autumn after leaf drop or spring before bud swell. Kocide, Tennacop (Citcop), COCS can also be used against peach leaf curl (use before bud swell in the spring, or in the fall), and are less messy than Bordeaux. The coppers have some suppression of bacterial spot, which is a problem with some susceptible varieties (see page 47).
INSECTS		INSECTICIDES
Peach Tree Borer (Pre-plant dip only)	See page 48	26. Thiodan 3 EC
		32. Lorsban 4 E (3 qt)/100 gal
Comments: See Special Problems: Peach Tree Borer.		

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		INSECTICIDES
San Jose Scale	32e	32. Lorsban 4 E (3 pt)
Peach Twig Borer	32e	34. Ambush 2 EC (9.6 fl oz)*
Climbing Cutworms	32e, 34e, 35e, 40e	35. Pounce 3.2 EC (6 fl oz)*
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments: *—Peaches only.

PINK

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	See Bloom	
Valsa Canker	See page 47	
INSECTS/MITES		INSECTICIDES
Tarnished Plant Bug	34e, 35e, 40e	34. Ambush 2 EC (9.6 fl oz)*
Green Fruitworm	34e, 35e, 40e	35. Pounce 3.2 EC (6 fl oz)*
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments: *—Peaches only.

PEACHES AND NECTARINES

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	1e, 2e, 3e, 4g, 5e, 6e, 7e, 8e, 14f	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb)
Valsa Canker	See page 47	2. Indar 75 WSP (2 oz)
Comments:		3. Rovral 50 WP (1½-2 lb)
Where pink bud spray is omitted, or if weather is unusually favorable for brown rot, begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.		4. Bravo 720 (3⅛-5½ pt)
		5. Nova 40 W (2.5-6.0 oz)
		6. Ronilan 50 WP (1½-2 lb)
		7. Orbit 41.8% (4 fl oz)
		8. Elite 45 DF (6 oz)
		14. Wettable Sulfur 95 WP* (15 lb)
		Comments:
		Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used. Topsin-M will not control Benlate-resistant pathogens.
		*—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	1e, 2e, 3e, 4g, 5e, 6e, 7e, 8e, 14f	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb)
Powdery Mildew	1g, 2n, 3n, 4n, 5g, 6n, 7n, 14g	2. Indar 75 WSP (2 oz)
Comments:		3. Rovral 50 WP* (1½-2 lb)
Powdery mildew is sometimes an economic problem in southwest Michigan, particularly on Rio-Oso-Gem and Redskin.		4. Bravo 720 (3⅛-5½ pt)
		5. Nova 40 W (2.5-6.0 oz)
		6. Ronilan 50 WP* (1½-2 lb)
		7. Orbit 41.8% (4 fl oz)
		8. Elite 45 DF (6 oz)
		14. Wettable sulfur 95 WP* (15 lb)
		Comments:
		Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used. Topsin-M will not control Benlate-resistant pathogens.
		*—Rovral and Ronilan are used during the bloom period and at pre-harvest with a maximum of five sprays per season.
INSECTS		INSECTICIDES
Plum Curculio	8e, 9e, 18e, 34e, 35e, 40e	5. Diazinon 50 WP (3 lb)
Oriental Fruit Moth	5g, 8e, 9e, 18e, 23e, 34e, 35e, 40e	8. Guthion 2 S (3½-4½ pt)
Rose Chafer	18g, 23g	8. Guthion 50 WP (1¾-2¼ lb)
Tarnished Plant Bug	26f, 34e, 35e, 40e	9. Imidan 70 WP (2¼ lb)
Green Peach Aphid	26e	18. Penncap-M 2 F (6 pt)
		23. Sevin 50 WP (6 lb)
		23. Sevin 80 S (4 lb)
		23. Sevin XLR+ (2 qt)
		26. Thiodan 3 EC (3 qt)
		26. Thiodan 50 WP (3 lb)
		34. Ambush 2 EC* (9.6 fl oz)
		35. Pounce 3.2 EC* (6 fl oz)
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments:
		*—Ambush/Pounce—peaches only up to petal fall.

PEACHES AND NECTARINES

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 5g, 14f	2. Indar 75 WSP (2 oz) 5. Captan 50 WP (8 lb) 14. Wettable sulfur 95 WP (15 lb)
Powdery Mildew	2e, 5n, 14g	Comments: <i>Benlate is omitted on peaches and nectarines at shuck split through fourth cover in order to delay resistance problems. Topsin-M should not be used for the same reason.</i> <i>Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.</i>
Peach Scab	2f, 5e, 14g	
Bacterial Spot	See page 47	
INSECTS			INSECTICIDES
Plum Curculio	See Petal Fall	5. Diazinon 50 WP (3 lb) 18. PennCap-M 2F (4½ pt) 23. Sevin 80 S (4 lb) 23. Sevin 50 WP (6 lb) 26. Thiodan 50 WP (3 lb) 26. Thiodan 3 EC (3 qt) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Oriental Fruit Moth	See Petal Fall	
Rose Chafer	See Petal Fall	
Lecanium Scale	5g, 18e, 23g	
Tarnished Plant Bug	26f, 40e	

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under Shuck Split	
Peach Scab	Fungicides listed under Shuck Split	
Powdery Mildew	Fungicides listed under Shuck Split	
Bacterial Spot	See page 47	
X-Disease	See page 47	
Comments: <i>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.</i>		
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall	23. Sevin 50 WP (1-2 lb/100 gal)
Tarnished Plant Bug	See Shuck Split	
Earwigs	23	
Comments: <i>Earwigs are slim brown insects, 1 inch long with pincers on the rear. They will sometimes feed on foliage or in peaches with split pits. Apply Sevin to trunk and soil around trees.</i>		

PEACHES AND NECTARINES

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Peach Scab	Fungicides listed under Shuck Split	
Powdery Mildew	Fungicides listed under Shuck Split	
Bacterial Spot	See page 47	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall	26. Thiodan 3 EC (1 qt/100 gal)
Lesser Peach Tree Borer	26g, 32e	32. Lorsban 4 E* (3 qt/100 gal)
Comments: For lesser peach tree borer control: Apply sprays between June 3 to 10, and if using Thiodan, apply another 3 weeks later. Apply with a hydraulic gun as a coarse dilute spray, with concentration on scaffold limbs, crotches and trunk. Avoid contact with foliage and fruit.		*—Limited to 1 application/season.

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Peach Scab	Fungicides listed under Shuck Split	
Powdery Mildew	Fungicides listed under Shuck Split	
Bacterial Spot	See page 47	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Second Cover	3. Carzol 92 SP (1 lb)
Lecanium Scale	See Shuck Split	17. Apollo SC (4-8 oz)*
Peach Tree Borer	26g, 32e	26. Thiodan 3 EC (1 qt/100 gal)
Mites	3g,** 17e	32. Lorsban 4 E* (3 qt/100 gal)
Comments: For peach borer control apply sprays the first week in July. Apply to the base of the tree as a coarse dilute spray. Use a hydraulic gun. Avoid contact with foliage and fruit. See "Peach Tree Borer," p. 48. If Lorsban 4 E was used for Lesser Peach Tree Borer, no additional spray for Peach Tree Borer is necessary.		*—Limited to 1 application/season. **—Carzol controls adults only.

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Bacterial Spot	See page 47	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall Cover	18. PennCap-M 2 F (6 qt)
Japanese Beetle	18e, 23g	23. Sevin 80 S (4 lb)
		23. Sevin 50 WP (6 lb)
		23. Sevin XLR+ (2 qt)

PEACHES AND NECTARINES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	1e, 2e, 3e, 5g, 6e, 7e, 8e, 14f	<ol style="list-style-type: none"> 1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb) 2. Indar 75 WSP (2 oz) 3. Rovral 50 WP* (1½-2 lb) 5. Captan 50 WP (8 lb) 6. Ronilan 50 WP* (1½-2 lb) 7. Orbit 41.8% (4 fl oz)*** 8. Elite 45 DF (6 oz) 14. Wettable sulfur 95 WP** (15 lb)
<p>Comments: Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.</p>		<p>Comments: Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used. Topsin-M will not control Benlate-resistant pathogens.</p> <p>*—Do not apply more than 5 applications per season.</p> <p>**—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by product label.</p> <p>***—Apply a maximum of two pre-harvest sprays during the period beginning 10-14 days before harvest through the day of harvest.</p>
INSECTS		
Oriental Fruit Moth	See Petal Fall	

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
X-Disease	See page 47	

Special Peach Insect & Disease Problems and 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, Autumn glo, 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 inoculum 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/acre
Syllit (dodine) ¹ 65 WP, plus Captan 50 WP	1-1½ lb 4 lb
OR	
Mycoshield 17 WP ²	150 ppm

¹Caution: 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.

²Use 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.

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 (see Table labeled "Brush Killers for Removal of X-Disease Hosts"). 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.

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.

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

PEACHES AND NECTARINES

Brush Killers for Removal of X-Disease Hosts

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). Do not apply Bromacil, Garlon or Weedone near ditches or where surface water may carry the material to desirable plants.
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	
Any season	Weedone CB	1 to 5 gal CB/A	Spray basal bark or cut or frilled surface with knapsack sprayer	

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.

This 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). Norbac is another brand of *A. radiobacter* strain 84 sold as a concentrated liquid suspension. 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 to 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.

Peach Tree Borer

Pre-Plant Treatment to control peach tree borer: Do not plant if infected with crown gall. If plants are not infested, dip trees in bundles or individually in Thiodan (3 lb/gal EC) used at the rate of 2²/₃ qt/40 gal water or Lorsban 4 E at the rate of 3 qt/100 gal water. Dip trees up to 12 inches above the grafting bud scar and plant immediately or allow to dry before returning to storage.

Spray application of Thiodan as a preplant treatment is better than dip to avoid cross contamination with crown gall.

Summer peach tree borer sprays should be applied with a handgun sprayer and applied to the trunk and lower scaffold limbs. DO NOT apply materials to foliage and/or fruit. DO NOT apply more than one application of Lorsban 4E per year. **Lorsban 4E is not registered for borer control on prunes or plums.**

PRUNES AND PLUMS

The rates of materials 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 Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair, p = poor for the pesticide in controlling the pest, and n = not labeled or no activity against this pest.

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Knot	See Comments	
Comments: <i>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.</i>		
INSECTS/MITES		INSECTICIDES
European Red Mite	24e*	18. PennCap-M 2 F (6 pt)
Lecanium Scale, San Jose Scale, Aphids, Peach Twig Borer, Climbing Cutworms	18, 24e,* 32e**	24. Superior Oil* (6 gal)
		32. Lorsban 4 EC (3 pt)
		Comments: *—Unless applied dilute (300 gal/A) the use of oil is questionable. If unable to spray dilute, consider using organic miticides applied at petal fall against motile stages of mites and control scale at the crawler stage. **—Delayed Dormant use only.

GREEN TIP

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Knot	1g, 2g	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb)
		2. Topsin M 70 WP (1.5 lb)
		Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used.</i>

PRUNES AND PLUMS

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 1. Benlate 50 WP (12 oz) plus Captan 50 WP (4 lb) 2. Topsin M 70 WP (1.5 lb) 7. Orbit 41.8% (4 fl oz) 14. Wettable sulfur 95 WP* (15 lb) 15. Rovral 50 WP (1½-2 lb)
Brown Rot	1e, 2p, 7e, 14g, 15e	
Black Knot	1g, 2g, 7n, 14n, 15n	
Comments: 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.		Comments: Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used. *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb) 2. Topsin M 70 WP (1.5 lb) 7. Orbit 41.8% (4 fl oz) 14. Wettable sulfur 95 WP* (15 lb) 15. Rovral 50 WP (1½-2 lb)
Brown Rot	1e, 2p, 7e, 14g, 15e	
Leaf Spot	1e, 2p, 7n, 14p, 15g	
Black Knot	1g, 2g, 7n, 14n, 15n	Comments: Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used. *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.
Comments: The cherry leaf spot fungus <i>Blumeriella jaapii</i> sometimes is a problem on Stanley and related cultivars in wet years. This is not a bacterial disease.		

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		INSECTICIDES 8. Guthion 2 S (3½-4½ pt) 8. Guthion 50 WP (1¾-2½ lb) 9. Imidan 70 WP (2¼ lb) 18. PennCap-M 2 F (6 pt) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Plum Curculio	8e, 9e, 18e, 40e	

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 1. Benlate 50 WP (12 oz), plus Captan 50 WP* (4 lb) 2. Topsin M 70 WP (1.5 lb) 14. Wettable sulfur 95 WP (15 lb)
Brown Rot	1e, 2p, 14g	
Leaf Spot	1e, 2p, 14p	
Black Knot	1g, 2g, 14n	Comments: *—Captan applied from shuck split through early July can cause shot holing of leaves and spotting of fruit of Stanley and Japanese Plums.
INSECTS		
Plum Curculio	See Petal Fall	

PRUNES AND PLUMS

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	See Shuck Split	
Leaf Spot	See Shuck Split	
Black Knot	See Shuck Split	
INSECTS		INSECTICIDES
Scale	5g	5. Diazinon 50 WP (3 lb)
Peach Tree Borers	See page 48	26. Thiodan 3 EC (1 qt/100 gal)
Plum Curculio	See Petal Fall	
Comments: Sprays for scale should be timed when crawlers become active. *Lorsban 4 EC is not registered for borer control on plums or prunes.		

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See Shuck Split	
Black Knot	See Shuck Split	
INSECTS		INSECTICIDES
Apple Maggot	8e, 9e, 18e	8. Guthion 2 S (3½-4½ pt)
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for apple maggot should be applied.		8. Guthion 50 WP (1¾-2½ lb)
		9. Imidan 70 WP (2¼ lb)
		18. Penncap-M 2F (5 pt)

THIRD AND FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See Shuck Split	
INSECTS/MITES		INSECTICIDES
Apple Maggot	See Second Cover	18. Penncap-M 2 F (6 pt)
Mites	16g, 28g	23. Sevin 80 S (4 lb)
Japanese Beetle	18e, 23g	23. Sevin 50 WP (6 lb)
		23. Sevin XLR+ (2 qt)
		28. Vendex 50 WP (1-2 lb)

PRUNES AND PLUMS

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	1e, 5g, 7e, 14f, 15e	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb)
Leaf Spot	1e, 5g, 7n, 14f, 15g	5. Captan 50 WP (6 lb)
Comments:		7. Orbit 41.8% (4 fl oz)***
Make first preharvest application for brown rot 2 to 3 weeks before harvest and repeat in 5 to 10 days.		14. Wettable sulfur 95 WP** (15 lb)
		15. Rovral 50 WP* (1½-2 lb)
		Comments:
		Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used.
		*—Do not apply more than 5 applications per season.
		**—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.
		***—Apply a maximum of two pre-harvest sprays during the period beginning 10-14 days before harvest through the day of harvest.

TART CHERRIES

The rates of materials 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, p = poor for the pesticide in controlling the pest, and n = not labeled or no activity against this pest.

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Crown Gall	See page 48	
Phytophthora Root Rot	See "Special Tart Cherry Disease Problems and Controls," page 61	
INSECTS/MITES		INSECTICIDES
Mineola Moth	5g, 8e, 9e, 18e, 23g, 34e, 35e, 40e	5. Diazinon 50 WP (3 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (1½ lb) 9. Imidan 70 WP (2¼ lb) 17. Apollo SC (4-8 oz)*** 18. Penncap-M 2F (6 pt) 23. Sevin 50 WP (6 lb) 24. Superior Oil (6 gal)* 32. Lorsban 4E (3 pt) 34. Ambush 2 EC (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Eye-Spotted Bud Moth	5g, 8e, 9e, 18e, 23g, 34e, 35e, 40e	
Mites	17e,*** 24e*	Comments: *—Unless applied dilute (300 gal/A), the use of oil is questionable. Growers unable to spray dilute should consider using organic miticides applied at petal fall against motile stages of mites and to control scales at crawler stage. ***—Use is limited to 1 application per season.
Scales	18e, 24e*	

GREEN TIP

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 60	

TART CHERRIES

PRE-BLOOM (WHITE BUD STAGE)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 60	1. Benlate 50 WP (1.5 lb), plus Captan 50 WP (4 lb) 2. Indar 75 WSP (2 oz)
European Brown Rot on Cultivar Meteor*	1e, 2e	Comments: —European brown rot is primarily on Meteor but is occasionally found on Montmorency. To date, European Brown Rot has only been detected in west central and northwest Michigan. It is a problem during bloom when the fungus attacks the flower parts and moves into the spurs. Benlate and Captan gives significant control; Rubigan, Nova, Rovral and Bravo gave poor control in initial tests.
Brown Rot (American)**	See Bloom	
Comments: *—Two sprays, at white bud and again at bloom, are needed to control European brown rot. **—In most years spray programs initiated when 10-20% of the flowers are open will give economic control of American brown rot. Infection at "white bud" is rare, but may occur where a large number of brown rot infected fruit are present from the previous season and a prolonged period of warm (above 60°F) wet weather occurs. If these conditions occur in unprotected orchards, use the maximum rate of Rovral, Ronilan, or Nova 24-48 hr after the beginning of the wet weather.		
INSECTS		INSECTICIDES
Green Fruitworm	26f, 32e, 34e, 35e, 40e	26. Thiodan 50 WP (3 lb) 28. Vendex 50 WP (1½-3 lb) 32. Lorsban 50 W (2-3 lb) 34. Ambush 25 WP (9.6 oz) 35. Pounce 25 WP (9.6 oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Plum Nursery Mite	28g	

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 60	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4 lb) 2. Indar 75 WSP (2 oz) 3. Rovral 50 WP* (1½-2 lb) 4. Bravo 720* (3¼-5½ pt) 5. Nova 40 W (2.5-6.0 oz) 7. Orbit 41.8% (4 fl oz) 8. Elite 45 DF (6 oz) 14. Wettable sulfur 95 WP** (15 lb) 16. Ronilan 50 WP* (1½-2 lb)
European Brown Rot on Cultivar Meteor	1e, 2e	Comments: *—Rovral may be used from white bud to petal fall, Bravo may be used through shuck split, and Rovral and Ronilan may be used again at preharvest. NOTE: Although Ronilan is registered at 1 lb per acre, this rate is not recommended because higher rates have given significantly better control of brown rot. **—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. Because Benlate/Topsin-M-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.
Brown Rot (American)	1e, 2e, 3e, 4f-g, 5e, 7e, 8e, 14f, 16e	

TART CHERRIES

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 60	2. Indar 75 WSP (2 oz)
Brown Rot	2e, 3e, 4f-g, 5e, 6p/n, 7e, 8e, 16e	3. Rovral 50 WP (1½-2 lb)
Leaf Spot	2g, 3f, 4e, 5g, 6f-g, 7f/n, 8g, 16p/n	4. Bravo 720 (3¼-5½ pt)
Comments: The Elite/Captan tank mix may be applied as a resistance management strategy for sterol inhibitor fungicides. This use is permitted only in Michigan as a FIFRA Section 2(ee) recommendation.		5. Nova 40 W (2.5-6.0 oz)
		6. Rubigan 1 EC (6-12 fl oz)
		7. Orbit 41.8% (4 fl oz)
		8. Elite 45 DF (6 oz) or Elite 45 DF (4 oz) plus Captan 50 WP (3 lb)
		16. Ronilan 50 WP (1½-2 lb)
		Comments: Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries past bloom.
INSECTS		INSECTICIDES
Green Fruitworm	26f, 32e, 34e, 35e, 40e	8. Guthion 3 F (2 pt)
Leafrollers	8e, 9e, 32e, 40e	8. Guthion 50 WP (1½ lb)
Plum Curculio	8e, 9e, 32g***, 34e, 35e, 40e	9. Imidan 70 WP (2¼ lb)
Rose Chafer	23g, 32g***	23. Sevin 50 WP (6 lb)
American Plum Borer	32e**. See "Special Tart Cherry Insect Problems and Controls" on page 62	23. Sevin 80 S (4 lb)
		26. Thiodan 50 WP (3 lb)
		32. Lorsban 50 W (2-3 lb)
		32. Lorsban 4 E (3 qt/100 gal)
		34. Ambush 25 WP (9.6 oz)
		35. Pounce 25 WP (9.6 oz)
		40. Asana XL 0.66 EC (4.8-14.5 fl oz)
		Comments **—Lorsban 4E only ***—Use Lorsban 50 W only

SHUCK FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 60	2. Indar 75 WSP (2 oz)
Leaf Spot	2g, 4e, 5g, 6f-g, 8e, 14g	4. Bravo 720 (3¼-5½ pt)
Brown Rot	2e, 4f-g, 5p/n, 6p/n, 8e, 14p/n	5. Nova 40 W (5-6 oz)
		6. Rubigan 1 EC (6-12 fl oz)
		8. Elite 45 DF (6 oz) or Elite 45 DF (4 oz) plus Captan 50 WP (3 lb)
		14. Syllit (dodine) 65 WP (1-2 lb)
		Comments: Do not use Bravo after shuck split; may resume use after harvest.

TART CHERRIES

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 2. Indar 75 WSP (2 oz) 5. Nova 40 W (5-6 oz) 6. Rubigan 1 EC (6-12 fl oz) 8. Elite 45 DF (6 oz) or Elite 45 DF (4 oz) plus Captan 50 WP (3 lb) 14. Syllit (dodine) 65 WP (1-2 lb)
Leaf Spot	2g, 5g, 6f-g, 8e, 14g	
INSECTS		INSECTICIDES 26. Thiodan 3 EC (1 qt/100 gal) 32. Lorsban 4 E (3 qt/100 gal)
Plum Curculio	See Petal Fall	
Peach Tree Borer, Lesser Peach Tree Borer	26g, 32e. See "Special Tart Cherry Insect Problems and Controls" on page 62	
Comments: For lesser peach tree borer control, apply sprays between June 3 and 10. Apply with a hydraulic gun as a coarse dilute spray concentrating on scaffold limbs, crotches and trunk.		

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	Fungicides listed under First Cover	
INSECTS		INSECTICIDES 5. Diazinon 50 WP (3 lb) 18. Penncap-M 2F* (6 pt) 32. Lorsban 50W (2-3 lbs)
Scale	5g, 18e*, 32e	
Plum Curculio	See Petal Fall	
Comments: Apply spray for scales when crawlers become active.		
		Comments: *—WARNING: Do not apply Penncap-M if pollinators are working flowers (cover-crop) on the orchard floor (see page 6).

TART CHERRIES

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See First Cover	
INSECTS/MITES		
Cherry Fruit Fly	5g, 8e, 9e, 18e,* 23e, 34g, 35g, 40g	INSECTICIDES 5. Diazinon 50 WP (3 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (1½ lb) 9. Imidan 70 WP (2¼ lb) 17. Apollo SC (4-8 oz)** 18. Penncap-M 2F* (6 pt) 23. Sevin 50 WP (6 lb) 23. Sevin 80 S (4 lb) 28. Vendex 50 WP (1-3 lb) 34. Ambush 25 WP (9.6 oz) 35. Pounce 25 WP (9.6 oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Rose Chafer	See Petal Fall	
Scale	See Second Cover	
European Red Mite	17e,** 28g	
Two-spotted Spider Mite	17e,** 28g	
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.		
		Comments: *—WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6). **—Use is limited to 1 application per season. Do not use within 21 days of harvest. Apollo does not kill adult mites, and should be tank mixed with other miticides.

CHERRY FRUIT FLY AERIAL CONTROL

METHOD		
Flat Fan Nozzles	13e	13. Malathion LV Concentrate (12 oz)

TART CHERRIES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2g, 3f, 5g, 6f-g, 7f/n, 8e, 14g, 16p/n	2. Indar 75 WSP (2 oz) 3. Rovral 50 WP (1½-2 lb) 5. Nova 40 W (5-6 oz) 6. Rubigan 1 EC (6-12 fl oz) 7. Orbit 41.8% (4 fl oz) 8. Elite 45 DF (6 oz) or Elite 45 DF (4 oz) plus Captan 50 WP (3 lb)
Brown Rot	2e, 3e, 5p/n, 6p/n, 7e, 8e, 14f, 16e	14. Syllit (dodine) 65 WP (1-1½ lb), plus Wettable sulfur 95 WP* (9 lb) 16. Ronilan 50 WP** (1½-2 lb)
Comments: Make first preharvest application for brown rot 2 or 3 weeks before harvest and repeat in 5 to 10 days.		Comments: *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. **—Although Ronilan is registered at 1 lb, higher rates have given significantly better control of brown rot. A ring-russet has been observed on sweet cherries when Ronilan was applied with a wetting agent in the pre-harvest period. Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.
INSECTS		
Cherry Fruit Fly	See Third Cover	

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2g, 4e, 5g, 6f-g, 14g	2. Indar 75 WSP (2 oz) 4. Bravo 720 (4⅛ pt) 5. Nova 40 W (5-6 oz) 6. Rubigan 1EC (6-12 fl oz) 8. Elite 45 DF (6 oz) 14. Syllit (dodine) 65 W (2 lb)
INSECTS		INSECTICIDES
Peach Tree Borer	See page 62	12. Vendex 50 WP (1-3 lb)
Two-spotted Spider Mite	12e	

Special Tart Cherry Disease Problems and Controls

Brown Rot, Leaf Spot and Powdery Mildew Control in Tart and Sweet Cherries

Protectant sprays are the backbone of effective control of common cherry diseases. They are typically applied on a 7- to 10-day spray schedule. It is no longer possible without Difolitan to control these diseases on a 14-day spray schedule. A protectant program should be strictly adhered to when controlling brown rot, particularly in sweet cherries. Brown rot develops too quickly to rely on after-infection control. With cherry leaf spot, after-infection spray programs are not generally recommended because they do not reduce fungicide usage adequately for the risk that's taken. Growers have, however, been successful with after-infection sprays following unanticipated infection periods during droughty periods.

An alternate row spray program where the interval does not exceed 7 days is an effective IPM strategy for reducing the total amount of fungicide used between petal fall and 3-4 weeks before harvest. Brown rot sprays in the last few weeks prior to harvest should be applied on an every middle basis, especially in sweet cherries.

With the increased reliance on the sterol inhibitors in recent years, resistance is a great concern. Whenever possible, growers should use 2-3 full cover sprays per year to control brown rot or leaf spot from another fungicide category, other than "sterol inhibitors," to postpone or prevent resistance within this valuable category of fungicides.

The relative strengths and weaknesses of currently available fungicides for cherry diseases are outlined below.

Table 2.
Background information on cherry fungicides
(Compiled by Gary Thornton and Alan L. Jones)

Fungicide Categories

Sterol Inhibitors (SI fungicides)

These compounds are locally systemic in the foliage and blossoms. Once applied, they are absorbed within a few minutes into the leaves and blossoms; the absorbed fungicide cannot be washed off. Regular sprays will increase the overall effectiveness of the control program. Postsymptom control is not adequate to control infections after they are observed and some defoliation will occur. Wetting agent is required when using Indar, and may improve activity.

Table 2 (continued).
Background information on cherry fungicides

Nova 40 W (myclobutanil)	<i>Blossom Brown Rot—Excellent</i>
	<ul style="list-style-type: none"> • Protectant—3-5 days • Back action—24-36 hours, dependent on temperature
	<i>Leaf Spot—Good; commonly used at 5 oz/acre</i>
	<ul style="list-style-type: none"> • Protectant—3-5 days • Back action (no precise data available) • Maximum interval between sprays for effective control is 10 days when used in a regular program of SI sprays
	<i>Powdery Mildew—Good</i>
	<ul style="list-style-type: none"> • Best control when used on a regular schedule • Wetting agent should improve effectiveness
	<i>Fruit Brown Rot—Not labeled for this use; activity very poor</i>
Rubigan 1 EC (fenarimol)	<i>Blossom Brown Rot—Not labeled for this use; activity very poor</i>
	<i>Leaf Spot—6 oz/acre—Fair; 12 oz/acre—Good</i>
	<ul style="list-style-type: none"> • Protectant—3-5 days • Back action (no precise data available) • Maximum interval between sprays for effective control is 7-10 days when used in a regular program of SI sprays
	<i>Powdery Mildew—Good</i>
	<i>Fruit Brown Rot—Not labeled for this use; activity very weak</i>
Elite 45 DF (tebuconazole)	<i>Blossom Brown Rot—Excellent</i>
	<ul style="list-style-type: none"> • Protectant—4-5 days • Back action—24-36 hours
	<i>Leaf Spot—Good</i>
	<ul style="list-style-type: none"> • Protectant—3-5 days • Back action (no precise data available) • Maximum interval between sprays for effective control is 7-10 days when used in a regular program of SI sprays
	<i>Powdery Mildew—Good</i>
	<i>Fruit Brown Rot—Excellent</i>
Indar 75 WSP (fenbuconazole)	<i>Blossom Brown Rot—Excellent</i>
	<ul style="list-style-type: none"> • Protectant—4-5 days • Back action—24-36 hours
	<i>European Brown Rot—Excellent control on Meteor in 1994</i>
	<i>Leaf Spot—Good</i>
	<ul style="list-style-type: none"> • Protectant—3-5 days • Back action (no precise data available) • Maximum interval between sprays for effective control is 7-10 days when used in a regular program of SI sprays
	<i>Powdery Mildew—Not labeled for this use; no data available</i>
	<i>Fruit Brown Rot—Excellent</i>
	<ul style="list-style-type: none"> • Wetting agent recommended

TART CHERRIES

Table 2 (continued).
Background information on cherry fungicides

Fungicide Categories

Orbit 41.8% (propiconazole)	<p><i>Blossom Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—4-5 days • Back action—24-36 hours <hr/> <p><i>Leaf Spot—Not labeled for this use; activity fair</i></p> <hr/> <p><i>Fruit Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Maximum of two pre-harvest sprays
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Benzene Compounds

Bravo 720 (chlorothalonil)	<p><i>Blossom Brown Rot—Good</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days • Back action—None <hr/> <p><i>Leaf Spot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—7-10 days • Back action—None • Do not use after shuck split, except post-harvest <hr/> <p><i>Fruit Brown Rot—Not labeled after shuck split</i></p>
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Guanidines

Syllit 65 (dodine)	<p><i>Leaf Spot—Good (where dodine resistance does not occur)</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days • Back action—36 hours <hr/> <p><i>Fruit Brown Rot—Poor; Fair if tank mixed with sulfur or Captan</i></p> <ul style="list-style-type: none"> • Protectant—7-10 days • Back action—None
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Dimethyldithiocarbamates

Carbamate 76 W (ferbam) + sulfur 95 WP	<p><i>Leaf Spot—Fair—sweets; Poor—tarts</i></p> <ul style="list-style-type: none"> • Protectant—4-6 days • Back action—None <hr/> <p><i>Fruit Brown Rot—Fair—sweets; Fair—tarts</i></p> <ul style="list-style-type: none"> • Protectant—4-6 days • Back action—None
Ziram 76 W (ziram)	<p><i>Leaf Spot—Fair—sweets; Poor—tarts</i></p> <hr/> <p><i>Fruit Brown Rot—Fair; best tank mixed with Sulfur 95 W or Captan 50 WP</i></p>

Heterocyclic Compounds

Captan 50 WP (captan)	<p><i>Only use in combination with Benlate, Topsin-M, or Syllit due to the low maximum labeled rate of 4 lb/acre. IR-4 is attempting to increase the label rate.</i></p>
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Dicarboximides

Rovral 50 WP (iprodione)	<p><i>Blossom Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—4-5 days • Back action—24 hours <hr/> <p><i>Leaf Spot—Fair</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days • Back action (no data available) <hr/> <p><i>Fruit Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days heavy pressure, 7-10 days light pressure • Back action—less than 24 hours • Good against Alternaria fruit rot
Ronilan 50 WP (vinclozolin)	<p><i>Blossom Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—3-5 days • Back action—24 hours

Table 2 (continued).
Background information on cherry fungicides

Ronilan 50 WP (continued)	<p><i>Leaf Spot—Poor</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days • Back action (no data available) <hr/> <p><i>Fruit Brown Rot—Very Good</i></p> <ul style="list-style-type: none"> • Protectant—5-6 days • Back action—less than 24 hours • Do not apply more than 1 pre-harvest treatment or within 14 days of harvest
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Benzimidazoles

Benlate (benomyl) 50 WP + Captan 50 WP	<p><i>Blossom Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—3-4 days • Back action—24-36 hours, depending on temperature • Resistance to Benlate in Brown Rot exists, but not of economic importance where non-related fungicides are used after petal fall • Locally systemic in bloom <hr/> <p><i>European Brown Rot—Excellent control on Meteor in 1994. This disease is restricted to areas of Michigan from Hart-Shelby north.</i></p> <hr/> <p><i>Leaf Spot—Resistance to Benlate is widespread—not recommended for use</i></p> <hr/> <p><i>Fruit Brown Rot—Excellent</i></p> <ul style="list-style-type: none"> • Protectant—5-7 days • Back action—less than 12 hours • See resistance note above
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Topsin-M 70 WP (thiophanate-methyl) Weaker than Benlate. See Benlate.

Inorganic

Sulfur 95 WP	<p><i>Blossom Brown Rot—Fair when used at 15-20 lb/A, Poor at lower rates</i></p> <ul style="list-style-type: none"> • Protectant—2-3 days • Back action—None <hr/> <p><i>Leaf Spot—Poor</i></p> <hr/> <p><i>Fruit Brown Rot—Fair</i></p> <ul style="list-style-type: none"> • Protectant—2-3 days • Back action—None <hr/> <p><i>When used at 9 lb/acre in tank mixtures with Syllit, Benlate, Topsin-M, it does not give adequate control of fruit brown rot when conditions are highly favorable for disease development.</i></p>
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Bacterial Canker

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

To prevent blossom blight, leaf and fruit spot stages of bacterial canker, use 1 lb per 100 gallons of dilute spray or 3 lb per acre of Tennessee Brand Tri-Basic Copper Sulfate. Initiate sprays at bud burst stage and repeat applications at weekly intervals to late May. Later sprays may cause some leaf yellowing and defoliation.

Phytophthora Root Rot

Phytophthora root rot is a problem on heavy, poorly drained soils. It occurs in all areas of Michigan where tart cherries are grown on poor sites. Tiling of wet areas in otherwise well-drained locations often eliminates problems with this disease. Trees on mahaleb rootstock are more susceptible to Phytophthora root rot than trees on mazzard, MXM2, or MXM60 rootstock.

Ridomil for Root Rot

Nonbearing Cherry Trees: In nurseries and field plantings of nonbearing trees, make the first application of Ridomil 2E at 2 weeks after planting with additional applications made at three-month intervals throughout the growing season. **Do not apply to plantings that will bear harvestable fruit within 12 months of application.** Apply 2-4 gal per treated acre (6-12 fl oz per 1000 sq ft) in sufficient water to obtain thorough coverage of the soil under the canopy of the trees. Sufficient surface area should be treated in nurseries to cover the root zone of the plants. Use of Ridomil is not a substitute for good cultural practices.

Aliette for Root Rot

Apply Aliette as a spray to the foliage at the rate of 5 lb/100 gal of dilute spray. Begin applications at the start of the growing season. Up to 4 foliar sprays may be applied during the season at 60-day intervals. Do not apply more than 100 gal per acre. Aliette is only registered for nonbearing stone fruit trees. A nonbearing tree is a tree that will not produce marketable fruit for 12 months after the last application. Aliette is particularly effective against *Phytophthora cactorum*.

Cherry Leaf Spot

Approximate number of hours of wetting required for conidial infection by the leaf spot fungus at different air temperatures^a

Average temperature (°F) (°C)		Wetting Period (hr) ^b		
		Light infection	Moderate infection	Heavy infection
81	27.2	28	43	—
80	26.7	21	35	—
79	26.1	18	30	—
78	25.5	16	27	42
77	25.0	14	24	36
76	24.4	12	21	32
75	23.8	11	19	29
74	23.3	9	18	27
73	22.7	8	16	25
72	22.2	7	15	23
71	21.6	7	14	22
70	21.1	6	13	21
69	20.5	6	13	20
63-68	17.2-20.0	5	12	19
62	16.6	6	12	19
61	16.1	6	13	20
60	15.5	7	13	20
59	15.0	7	14	21
58	14.4	8	15	22
57	13.8	9	16	23
56	13.3	10	17	24
55	12.7	11	18	25
54	12.2	12	19	27
53	11.6	14	21	29
52	11.1	15	23	31
51	10.5	17	25	33
50	10.0	19	27	35
49	9.4	20	29	38
48	8.8	23	32	42
47	8.3	25	34	46
46	7.7	28	38	51

^aAdapted from Eisensmith and Jones, 1981. *Plant Dis.* 65:955-958 and *Phytopathology* 71:728-732.

^bThe infection period is considered to start when rain begins.

CHERRIES

Special Cherry Insect Problems and Controls

American Plum Borer

This is a serious problem on tart and sweet cherries especially in counties from Oceana to as far north as cherries are grown in Michigan. The female adults are attracted to injured bark tissue for egg laying. The larvae feed on inner bark at the cambium. There are two generations a year. The second generation adults begin to emerge at cherry harvest and continue to emerge until early September. Lorsban 4E at 3 qt/100 applied with a hydraulic gun to the trunk at the petal fall stage when the first generation adults are emerging on tart and sweet cherries will give seasonal control. In addition, if the spray is directed at the base of the trunk and scaffold limbs, lesser peach tree borer will be controlled for the season.

Peach Tree Borer

The Peach Tree Borer can be a serious problem on cherries because it attacks and feeds on the root system. No evidence of frass or feeding is seen unless the soil is dug around the base of the tree. Cherry trees infested with Peach Tree Borer show wilting and loss of vigor. Unlike the Lesser Peach Tree Borer, the Peach Tree Borer does attack young, healthy trees. While cherry trees can survive many Lesser Peach Tree Borers infesting the scaffold limbs, a single Peach Tree Borer can cause serious injury to the root and affect the vigor of the tree. Multiple infestations of Peach Tree Borer in the root kills the tree. Applying Lorsban at petal fall for American Plum Borer does not control the Peach Tree Borer. Applying Lorsban in late June for Lesser Peach Tree Borer, taking special care to spray the base of the trunk and the soil around the trunk, controls Peach Tree Borer. Lorsban 4E will cause foliar and fruit injury on sweet cherry.

SWEET CHERRIES

The rates of materials 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, p = poor for the pesticide in controlling the pest, and n = not labeled or no activity against this pest.

PRE-BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Crown Gall	See page 48	
INSECTS/MITES		
Black Cherry Aphid	5g, 18e, 26e	
Mites	17e,* 24e	
Scales	24e, 32e	
		INSECTICIDES 5. Diazinon 50 WP (4 lb) 17. Apollo SC (4-8 oz)* 18. Pennncap-M 2F (8 pt) 24. Superior Oil (8 gal)* 26. Thiodan 50 WP (4 lb) 32. Lorsban 4 E (3 pt)
		Comments: *—Use is limited to 1 application per season.

WHITE BUD OR POPCORN

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot (blossom blight)	1e, 2e, 3e, 4f-g, 5e, 6e, 9e, 10e, 14f	
		FUNGICIDES 1. Benlate 50 WP (16 oz), plus Captan 50 WP (4 lb) 2. Indar 75 WSP (2 oz) 3. Rovral 50 WP (2 lb) 4. Bravo 720 (3 1/8-5 1/2 pt) 5. Nova 40 W (2.5-6.0 oz) 6. Ronilan 50 WP** (2 lb) 9. Orbit 41.8% (4 fl oz) 10. Elite 45 DF (8 oz) 14. Wettable sulfur 95 WP* (20 lb)
		Comments: *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used as rates that will give the same amount of sulfur as the 95% wettable powder formulation, except where prohibited by the product label. **—Although Ronilan is registered at 1 lb/acre, this rate is not recommended because higher rates have given significantly better control of brown rot and fruit injury has resulted when combined with a wetting agent.
INSECTS		
Green Fruitworm	26f, 34e, 35e, 40e	
		INSECTICIDES 26. Thiodan 50 WP (4 lb) 34. Ambush 25 WP (9.6 oz) 35. Pounce 25 WP (9.6 oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)

SWEET CHERRIES

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot (blossom blight)	See fungicides listed under White Bud	
Comments: Where popcorn spray is omitted, or if weather is unusually favorable for brown rot, begin bloom spray earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.		

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	2e, 3e, 4f-g, 5e, 6e, 7p, 8p/n, 9e, 10e, 14f	FUNGICIDES 2. Indar 75 WSP (2 oz) 3. Rovral 50 WP (2 lb) 4. Bravo 720 (4 1/8-5 1/2 pt) 5. Nova 40 W (2.5-6.0 oz) 6. Ronilan 50 WP (2 lb) 7. Captan 50 WP (4 lb) 8. Rubigan 1 EC (6-12 fl oz) 9. Orbit 41.8% (4 fl oz) 10. Elite 45 DF (8 oz) 14. Carbamate 76 WDG (4 lb), plus Wettable sulfur 95 WP (12 lb)*
Leaf Spot	2g, 3f, 4e, 5g, 6p/n, 7p, 8f-g, 9f/n, 10g, 14f	
Comments: *—Flowable sulfur, liquid sulfur and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% WP formulation, except where prohibited by the product label. Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended in cherries past bloom.		
INSECTS		
Black Cherry Aphid	See Pre-Bloom	INSECTICIDES 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (1 1/2 lb) 32. Lorsban 4 E (3 qt/100 gal) 34. Ambush 25 WP (9.6 oz) 35. Pounce 25 WP (9.6 oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz)
Green Fruitworm	See White Bud	
Leafrollers	8e	
Plum Curculio	8e, 34e, 35e, 40e	
American Plum Borer	32e. See comments on page 62.	
Comments: Pennacap-M should not be used at petal fall or shuck split because of hazard to pollinating insects.		

SWEET CHERRIES

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 2. Indar 75 WSP (2 oz) 4. Bravo 720 (4 $\frac{1}{8}$ -5 $\frac{1}{2}$ pt) 5. Nova 40 W (5-6 oz) 7. Captan 50 WP (4 lb)* 8. Rubigan 1 EC (6-12 fl oz) 10. Elite 45 DF (8 oz) 14. Carbamate 76 WDG (4 lb), plus Wettable sulfur 95 WP (12 lb)
Brown Rot	2e, 4f-g, 5p/n, 7p, 8p/n, 10e, 14f	
Leaf Spot	2g, 4e, 5g, 7p, 8f-g, 10g, 14f	Comments: Do not apply Bravo after shuck split and before harvest. *—Captan can build up and cause a bacterial spot-like symptom on sweet cherries if multiple applications are used with no rain.
INSECTS		
Plum Curculio	See Petal Fall	
Black Cherry Aphid	See Pre-Bloom	

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 2. Indar 75 WSP (2 oz) 5. Nova 40 W (5-6 oz) 7. Captan 50 WP (4 lb) 8. Rubigan 1 EC (6-12 fl oz) 10. Elite 45 DF (8 oz) 14. Carbamate 76 WDG (4 lb), plus Wettable sulfur 95 WP* (12 lb)
Brown Rot	2e, 5p/n, 7p, 8p/n, 10e, 14f	
Leaf Spot	2g, 5g, 7p, 8f-g, 10g, 14f	Comments: *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.
INSECTS		
Black Cherry Aphid	See Pre-Bloom	
Leafrollers	See Petal Fall	
Plum Curculio	See Petal Fall	
Rose Chafer	See Third Cover	

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		Comments: Lorsban 4E for borer control will cause foliar and fruit injury on sweet cherry.
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS		
Black Cherry Aphid	See Pre-Bloom	
Leafrollers	See Petal Fall	
Rose Chafer	See Third Cover	
Peach Tree Borer	See "Special Tart Cherry Insect Problems and Controls" on page 62	

SWEET CHERRIES

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS/MITES		INSECTICIDES 5. Diazinon 50 WP (4 lb) 8. Guthion 3 F (2 pt) 8. Guthion 50 WP (1½ lb) 12. Vendex 50 WP (1-3 lb) 17. Apollo SC (4-8 oz)** 18. PennCap-M 2F* (6 pt) 23. Sevin 50 WP (8 lb) 23. Sevin 80 S (4 lb) 34. Ambush 25 WP (9.6 oz) 35. Pounce 25 WP (9.6 fl oz) 40. Asana XL 0.66 EC (4.8-14.5 fl oz) Comments: *—WARNING: Do not apply PennCap-M if pollinators are working flowers (cover-crop) on the orchard floor. 6 pt is the maximum legal rate of PennCap-M on sweet cherries. Do not apply Imidan. It causes leaf spotting and defoliation of sweet cherry. **—Use is limited to 1 application per season.
Cherry Fruit Fly	5g, 8e, 18e, 23e, 34g, 35g, 40g	
Rose Chafer	23g	
European Red Mite	12e, 17e**	
Two-spotted Spider Mite	12e, 17e**	
Plum Nursery Mite	12e	
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.		

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 2. Indar 75 WSP (2 oz) 3. Rovral 50 WP (2 lb) 5. Nova 40 W (5-6 oz) 6. Ronilan 50 WP** (2 lb) 7. Captan 50 WP (4 lb) 8. Rubigan 1 EC (6-12 fl oz) 9. Orbit 41.8% (4 fl oz) 10. Elite 45 DF (8 oz) 14. Carbamate 76 WDG (4 lb), plus Wettable sulfur 95 WP* (12 lb) Comments: *—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. **—Although Ronilan is registered at 1 lb/acre, this rate is not recommended because higher rates have given significantly better control of brown rot. Benlate and Topsin-M not recommended for cherries because Benlate-resistant brown rot and leaf spot are widespread in Michigan.
Brown Rot	2e, 3e, 5p/n, 6e, 7p, 8p/n, 9e, 10e, 14f	
Leaf Spot	2g, 3f, 5g, 6p/n, 7p, 8f-g, 9f/n, 10g, 14f	
INSECTS		
Cherry Fruit Fly	See Third Cover	
Comments: Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.		

SWEET CHERRIES

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2g, 4e, 5g, 8f-g, 10g, 11g	2. Indar 75 WSP (2 oz) 4. Bravo 720 (4 ¹ / ₈ pt) 5. Nova 40 W (5-6 oz) 8. Rubigan 1 EC (6-12 fl oz) 10. Elite 45 DF (8 oz) 11. Syllit (dodine) 65 WP (1 ¹ / ₂ -2 lb)
INSECTS		INSECTICIDES
Peach Tree Borers	See American Plum Borer under "Special Tart Cherry Insect Problems" on page 62	12. Vendex 50 WP (1-3 lb)
Two-spotted Spider Mites	12e	

GRAPES

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 figures, regardless of the amount of water you are spraying/acre.

BUD SWELL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Phomopsis Leaf and Cane Spot Disease	52, 59, 60	<ol style="list-style-type: none"> 1. Bayleton 50 WP (3-6 oz) 2. Nova 40 WP (3-5 oz) 3. Procure 50 WP (4-6 oz) 6. Rubigan 1 EC (4 oz) 52. Mancozeb* (Dithane DF or Penncozeb DF) or Manzate 200 DF (1½ lb) 59. Captan 50 WP* (4 lb), Captec 4 L (2 qt) 60. Benlate 50 WP (1 lb) & liquid copper (1⅓ qt), plus hydrated lime (4 lb)
Powdery Mildew	1, 2, 3, 6	
<p>Comments: <i>Bud swell stage to shoots that are 1 to 3 in. long is good timing for Phomopsis leaf and cane spot disease control. Begin control for powdery mildew at 1" shoot growth stage.</i></p>		<p>Comments: <i>*—Most processors will not accept grapes sprayed with Captan. Many processors will not accept grapes sprayed with Mancozeb after the onset of bloom.</i></p>
INSECTS		INSECTICIDES
Grape Flea Beetle	No effective pesticides registered	32. Lorsban 4 E** (1 qt)
Climbing Cutworms	32**	
<p>Comments: <i>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.</i></p>		<p>Comments: <i>**—This is a Special Local Needs (SLN) label, and growers must possess the SLN label at the time of application. Lorsban 4 E will not control flea beetles. DO NOT use in conjunction with Lorsban 4 E sprays for grape root borer.</i></p>

FIRST COVER (PRE-BLOOM—SHOOT LENGTH 6 TO 12 INCHES)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES**		FUNGICIDES
Black Rot	1, 3, 5, 53, 62	1. Bayleton 50 WP (3-6 oz)
Black Rot + Downy Mildew	52, 59, 62	3. Benlate 50 WP DF ¹ (1 lb)
Powdery Mildew	1, 2, 6, 60, 62	5. Nova 40 WP (3-5 oz)
Comments:		6. Rubigan 1 EC (4 oz)
First cover—shoots 4 to 6 in. long.		52. Mancozeb* (2 lb)
**—Captan applied here will give further control of phomopsis leaf and cane spot disease. Captan is excellent against this disease and downy mildew, but weak against black rot.		53. Ferbam 76 WP ² (3 lb)
		59. Captan 50* WP (4 lb), Captec 4 L (2 qt)
		60. Procure 50 WP (4-6 oz)
		62. Ziram 76 DG (3-4 lb)
		Comments:
		NOTE 1: 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.
		NOTE 2: Ferbam slightly controls downy mildew. Benlate gives no control of downy mildew.
		*—Most processors will not accept grapes sprayed with Captan. Many processors will not accept grapes sprayed with Mancozeb after the onset of bloom.

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SECOND COVER (BLOOM)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot	1, 5, 53, 54, 59, 60, 62	FUNGICIDES 1. Benlate 50 WP (1-1½ lb) 5. Nova 40 WP or DF (3-5 oz) 6. Rubigan 1 EC (4 oz) 15. Rovral 50 WP (1½-2 lb) 16. Ridomil MZ58** (1.5 lb) or Ridomil-Cu 70 W** (1.5 lb) 52. Mancozeb (4 lb) 53. Ferbam 76 WP (3 lb) 54. Bayleton 50 WP (3-6 oz) 59. Captan 50 WP* (4 lb), Captec 4 L (2 qt) 60. Benlate 50 WP (1 lb) or Nova 40 WP (3-5 oz) plus, liquid copper (1⅓ qt) and hydrated lime (4 lb) 62. Ziram 76 DG (3-4 lb)
Black Rot and Powdery Mildew	1, 5, 54, 59, 60	
Black Rot, Downy and Powdery Mildews	16, 52, 60	
Botrytis Rot (early-mid bloom)	1, 15 add a non-ionic surfactant, e.g. Triton B-1956 or Triton CS-7 at 0.05% or 6 fl oz/100 gal water.	
Phomopsis Leaf and Cane Disease (fruit rot stage)	1, 5, 52, 60, 62	
Powdery Mildew	5, 6, 54, 62	
Downy Mildew	16, 52, 53, 62	

Comments:

Second cover—blossom opening.

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. A strong effort directed toward better control is necessary.

Comments:

While Benlate is fair to good and Bayleton and Nova are excellent for control of black rot and powdery mildew, none control downy mildew. To insure control of downy mildew, add Mancozeb, Captan or liquid copper plus hydrated lime as a tank mix at the recommended rates.

NOTE: If black rot disease pressure is heavy, increase Bayleton rate to 6 oz/acre.

*—Most processors will not accept grapes sprayed with Captan; many processors will not accept grapes sprayed with Mancozeb after beginning of bloom. Sprays of Benlate, Captan, or Mancozeb during bloom are effective in controlling fruit rot at harvest caused by Phomopsis. 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. Fixed copper plus hydrated lime can be tank mixed with Nova. This will control downy mildew, black rot, phomopsis fruit rot and powdery mildew.

**—Both of these products have a 66-day preharvest interval (PHI). Ridomil MZ58 provides some black rot control but no powdery mildew control. Ridomil-Cu 70 W will not control black rot but provides some control of powdery mildew.

INSECTS

Grape Berry Moth	5g, 8e, 9e, 11e, 18e, 23e
Rose Chafer	18e
Grape Phylloxera	26e*

Comments:

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.

If the first two generations of grape berry moth are controlled, it generally is not necessary to apply controls for the third generation that appears near harvest time.

INSECTICIDES

5. Diazinon 50 WP (2 lb)
8. Guthion 2 S (3-4 pt)
8. Guthion 50 WP (1½-2 lb)
9. Imidan 70 WP (1.5 lb)
11. Lannate 90 SP (½-1 lb)
18. PennCap-M 2 F (6-8 pt)
23. Sevin 50 WP (4 lb)
23. Sevin 80 S (2½ lb)
23. Sevin XLR+ (2 qt)
26. Thiodan 50 WP (2 lb)*

Comments:

*—Do not use Thiodan 3 EC formulation on Concord Grapes to prevent severe injury.

THIRD COVER (BUCKSHOT SIZED BERRIES)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot, Downy and Powdery Mildews	See Second Cover	See Second Cover
		Comments: At this time 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.
INSECTS		INSECTICIDES
Grape Berry Moth	See Second Cover	5. Diazinon 50 WP (2 lb)
Grape Leaf Hopper	5g, 8f, 9f, 11e, 18e, 19e,* 23e	8. Guthion 2 S (3-4 pt)
Rose Chafer	18e, 23g	8. Guthion 50 WP (1½-2 lb)
		9. Imidan 70 WP (1.5 lb)
		11. Lannate 90 SP (½-1 lb)
		18. PennCap-M 2 F (6-8 pt)
		19. Provado SoluPak (¾-1 oz)
		23. Sevin 50 WP (4 lb)
		23. Sevin 80 S (2½ lb)
		23. Sevin XLR+ (2 qt)
Comments: Timing for second brood berry moth is announced by your county agricultural agent. Control mites as populations increase.		Comments: *—Do not apply more than 2.0 oz of Provado per acre per year.

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot, Downy and Powdery Mildews	See Second Cover	Comments: NOTE: Time interval between last spray and harvest for Mancozeb, Ridomil MZ58 and Ridomil-Cu 70 W is 66 days.
INSECTS		INSECTICIDES
Grape Berry Moth	See Second Cover	Comments: Guthion is restricted to three applications per year.
Grape Phylloxera	See Second Cover	
Grape Leaf Hopper	See Third Cover	
Rose Chafer	See Third Cover	

FIFTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot, Downy and Powdery Mildews	See Second Cover	15. Rovral 50 WP (1½-2 lb)
Botrytis Rot (Just before cluster tightening)	15	See note at second cover regarding use of surfactant.
INSECTS		INSECTICIDES
Grape Berry Moth	See Second Cover	10. Kelthane 35 WP (1½-3½ lb)
Grape Leaf Hopper	See Third Cover*	18. PennCapp M 2F (6-8 pt)
Mites	10g, 28g	23. Sevin 50 WP (4 lb)
Japanese Beetle	18e, 23g	23. Sevin 80 S (2½ lb)
		23. Sevin XLR+ (2 qt)
		28. Vendex 50 WP (1-2½ lb)
Comments: *—Do not apply more than 2.0 oz of Provado per acre per year.		

GRAPES

SIXTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		INSECTICIDES 10. Kelthane 35 WP (1½-3½ lb) 28. Vendex 50 WP (1-2½ lb)
Grape Berry Moth	See Second Cover	
Japanese Beetle	See Fifth Cover	
Mites	10g, 28g	

SEVENTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 1. Benlate 50 DF (1 lb) 5. Nova 40 WP or DF (3-5 oz) 6. Rubigan 1 EC (4 oz) 14. Wetttable sulfur 95 WP* (4lb) 54. Bayleton 50 WP** (3-6 oz) 63. Procure 50 W (4-6 oz) Comments: *—Refer to sulfur tolerance list for grapes. Sulfur can cause severe injury to certain grape varieties (p. 73). **—Bayleton gives superior control of powdery mildew on French hybrid grapes.
Powdery Mildew	1, 5, 6, 14, 52, 63	
INSECTS		
Grape Berry Moth	See Second Cover	

EARLY RIPENING

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 15. Rovral 50 WP (1½-2 lb)
Botrytis Rot	15	

EIGHTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		
Grape Berry Moth	See Second Cover	
Comments: Required only if third brood grape berry moth is present.		

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES 15. Rovral 50 WP (1½-2 lb)
Botrytis Rot	15	

Special Grape Disease Problems and Controls

Eutypa Dieback

Eutypa Dieback, formerly called “dead arm,” is caused by the fungus *Eutypa lata*. 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. Removal and burning of infected vines is necessary to reduce inoculum in the vineyard. Benlate 50 WP as a post-prune treatment is useful when applied within a week of pruning and before rain occurs.

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 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, again when shoots are 4 to 6 inches long, again during early to mid bloom and at pea-sized fruit stage. Captan, Mancozeb, Benlate plus liquid copper and hydrated lime, and Nova plus liquid copper and hydrated lime 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. NOTE: Most processors will **not** accept fruit sprayed with Captan or with Mancozeb after the beginning of bloom.

Disease susceptibility¹ and sulfur sensitivity² of American, French Hybrid, and Vinifera (European) grape varieties.

Variety	Black Rot	Downy Mildew	Powdery Mildew	Botrytis	Sulfur Sensitive? (i.e. does sulfur cause injury?)	Dinocap (Karathane Dikar sensitive)
Aurora (S5279)	+++	++	+++	+++	No	+++
Baco Noir (Baco #1)	+	+	++	+	No	++
Cascade (S13053)	+	+	++	?	No	+
Catawba	+++	+++	++	+	No	No
Cayuga White		++	+	+	No	++
Chancellor (S7053)	+	+++	+++	+++	No	+
Chardonnay	++	+++	+++	+++	No	+
Chelois (S10878)	+	+	+++	+	No	+
Concord	+++	+	++	+	Yes	+
DeChaunac (S9549)	+	++	+++	++	No	+
Delaware	++	+++ ³	++	++	No	+++
Dutchess	+++	++	++	+	?	?
Elvira	+	++	++	+++	No	No
Foch (Marechal Foch)	+	+	++	+	No	?
Himrod	?	+	++	?	No	?
Niagara	+++	+++	++	+	No	No
Riesling		+++	+++	+++	No	?
Rosette (S1000)	?	++	+++	+	No	++
Rougeon (S5898)	++	+++	+++	++	Yes	+
Seyval (SV5-276)	++	++	+++	++	No	+
Steuben	++	+	+	?	No	?
Verdelet (S9110)	+	?	?	+	No	?
Vidal (V256)	?	?	+++	+	No	+++
Vignoles (Ravat 51)	+	++	+++	+++	No	++

¹Question mark (?) means relative susceptibility not established; + = slightly susceptible, ++ = moderately susceptible, +++ = very susceptible.

²Sulfur injury can occur on tolerant varieties when temperatures of 85° F or higher occur during or immediately after spray application.

³Berries are not susceptible.

STRAWBERRIES

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 figures, regardless of the amount of water you are spraying/acre.

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Stem End Rot, Leaf Blight, Leaf Spot	1	1. Benlate 50 WP* (1 lb) or Topsin M 70 WSB (3/4 lb) plus Captan 50 WP (5-6 lb), or Captec 4 L (2-2 1/2 qt)
Angular Leaf Blight (bacterial)	2	2. Basic Copper Sulfate (6 lb), plus hydrated lime (6 lb) per 100 gal water
Red Stele	3e	3. Ridomil 2 E (2 qt)
INSECTS		INSECTICIDES
Spittlebug	8g, 23e, 26e	8. Guthion 2 S (2 pt)
Mites*	10g, 28g	8. Guthion 50 WP (1 lb)
Strawberry Clipper***	34e	10. Kelthane 35 WP (1-3 lb)
Slugs**	36g	10. Kelthane 50 WP (3/4-2 lb)
White Grubs	See page 78	23. Sevin 50 WP (4 lb)
Root Weevils	See page 78	23. Sevin 80 S (2 1/2 lb)
Comments:		26. Thiodan 50 WP (2 lb)
*—Apply as two-spotted spider mites begin to increase.		26. Thiodan 3 EC (1 1/3 qt)
***—Apply first spray when first buds become visible followed by a second spray 10 days later.		28. Vendex 50 WP (1 1/2-2 lb)
		34. Lorsban 4 E (1 qt)
		36. Deadline (Metaldehyde) (10-40 lb)**
		Comments:
		**—Various formulations of Metaldehyde and Metaldehyde-Sevin baits have a label for slugs on strawberries.

STRAWBERRIES

SECOND COVER (PRE-BLOOM)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Gray Mold, Stem and Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56, 60	<ol style="list-style-type: none"> 1. Benlate 50 WP (1 lb), plus Captan 50 WP (5-6 lb) or Captec 4 L (2-2½ qt) 1A. Ridomil 2 E (2 qt) 1B. Aliette 80 W (2½-5 lb) 16. Ronilan 50 W (1½ lb), plus Captan 50 WP (5-6 lb) 56. Topsin-M 70 WP (¾ lb), plus Captan 50 WP (5-6 lb) 60. Rovral 50 WP (1-2 lb), plus Captan 50 WP (5-6 lb)
Red Stele	1A, 1B	<p>Comments: Do not use Ronilan, Rovral Benlate or Topsin-M without captan. The spectrum of activity of Ronilan and Rovral is rather narrow and is primarily for control of Botrytis gray mold. Apply Ridomil 2 E in spring after ground thaws and before bloom. A second application can be made in autumn after harvest. Apply Aliette or foliar spray in spring when active foliage growth occurs. If disease persists make additional applications at 30 to 60-day intervals.</p>
INSECTS		INSECTICIDES
Tarnished Plant Bug	20, 26e, 44	<ol style="list-style-type: none"> 8. Guthion 50 WP (1 lb) 8. Guthion 2 S (2 pt) 20. Brigade 10 WP (2 lb) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2½ lb) 26. Thiodan 50 WP (2 lb) 26. Thiodan 3 EC (1⅓ qt) 41. Agri-Mek 0.15 EC (1 lb) 44. Danitol 2.4 EC (10-21.3 oz)
Spittlebug	See First Cover	<p>Comments: Do not add oil to Agri-Mek applied to strawberry. May need back-to-back applications for satisfactory mite control.</p>
Strawberry Leafroller	8e, 23e	
Strawberry Clipper	See First Cover	
Mites	20g, 41g, 44g See First Cover	
Comments: Tarnished plant bug control is critical at this time. Best results are obtained with a specific Thiodan application at or before 10% king bloom.		

STRAWBERRIES

THIRD COVER (50% BLOOM)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56, 60	FUNGICIDES 1. Benlate 50 WP* (1/2 lb), plus Captan 50 WP (5-6 lb) 1A. Ridomil 2 E** (2 qt) 1B. Aliette 80 W (2 1/2-5 lb) 16. Ronilan 50 WP (1 1/2 lb), plus Captan 50 WP (5-6 lb) or Captec 4 L (2-2 1/2 qt) 56. Topsin-M 70 WP (3/4 lb), plus Captan 50 WP (5-6 lb) 60. Rovral 50 WP (1-2 lb), plus Captan 50 WP (5-6 lb)
Leather Rot	1A, 1B	
Comments: *—As per label, after fruit formation, the maximum allowable rate of Benlate is 1/2 lb 50 WP/acre. Therefore, combine with Captan as a tank mix. The addition of captan will aid in the control of leather rot (<i>Phytophthora cactorum</i>). **—Note: Begin foliar application between 10% bloom and early fruit set and continue on a 7-14 day interval as long as conditions favor disease development. In addition to application of Ridomil for Red Stele, one additional Ridomil application may be made for leather rot control at fruit set. Do not apply more than 6 qt/yr. Do not apply insecticides during bloom.		

FOURTH COVER (BERRIES HALF GROWN)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	See Third Cover	INSECTICIDES Comments: A repeat application of Thiodan may be necessary when the tarnished plant bug continues as a problem. Do not reapply 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.
INSECTS		
Tarnished Plant Bug	See Second Cover	
Mites	See First Cover	

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56, 60	FUNGICIDES 1. Benlate 50 DF (1/2 lb), plus Captan 50 WP (5-6 lb) 16. Ronilan 50 WP (1 1/2 lb), plus Captan 50 WP (5-6 lb) 56. Topsin-M 70 WP (3/4 lb), plus Captan 50 WP (5-6 lb) 60. Rovral 50 WP (1-2 lb), plus Captan 50 WP (5-6 lb) 61. Ridomil 2 E (2 qt)
Leather Rot	61e	
INSECTS		
Strawberry Sap Beetle	20g	INSECTICIDES 20. Brigade 10 WP (2 lb)

STRAWBERRIES

HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Diseases	See Pre-Harvest	
INSECTS/MITES		
Cyclamen Mites	10g, 26g	
Comments: <i>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 the suggested chemical. The material should be applied with up to 400 gallons of water per acre, 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 (Thiodan 4 days).</i>		
INSECTICIDES		
10. Kelthane 35 WP (4-6 ³ / ₄ lb)		
10. Kelthane 50 WP (³ / ₄ -2 lb)		
26. Thiodan 3 EC (2 ² / ₃ qt)		
26. Thiodan 50 WP (4 lb)		

POST-HARVEST AND NEW PLANTING

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	1, 59	
Red Stele	60e	
FUNGICIDES		
1. Benlate 50 WP* (1 lb) or Topsin M WSB (³ / ₄ lb)		
59. Captan 50 WP* (4 lb)		
60. Ridomil 2 E (2 qt)		
Comments: <i>*—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.</i>		
INSECTS		
Strawberry Leafroller	5g, 8e, 20, 23e	
Leafhoppers	5g	
Root Weevils	7e, 20 See page 78	
Strawberry Aphids	26e	
Slugs***	36g See comments page 74	
INSECTICIDES		
5. Diazinon 50 WP (2 lb)		
7. Furadan 4 F (2-4 qt)		
8. Guthion 50 WP (1 lb)		
8. Guthion 2 S (2 pt)		
20. Brigade 10 WP (2 lb)		
23. Sevin 50 WP (4 lb)		
23. Sevin 80 S (2 ¹ / ₂ lb)		
26. Thiodan 3 EC** (1 ¹ / ₃ qt)		
36. Deadline (Metaldehyde bait)*** (10-40 lb)		
Comments: **—See label for restriction of Thiodan use. ***—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.		

STRAWBERRIES

Special Strawberry Insect Problems and Controls

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

Lorsban 4E is the only remaining insecticide that is labeled for pre-plant application on strawberries. Lorsban 4E may be applied ONLY prior to planting at 2 quarts of Lorsban 4E per acre, with sufficient water to ensure uniform coverage; this product must be immediately incorporated. This is a Special Local Needs 24(c) label, and a copy of the 24(c) label must be in the possession of the applicator. See the label for other precautions and use restrictions.

Post-Harvest Control of Root Weevils

A Special Local Needs 24(c) label for **Furadan 4F** was granted by the Michigan Dept. of Agriculture in 1992 for post-harvest control of root weevils, such as strawberry root weevil and black vine weevil. These pests can be controlled with applications made after bed renovation. Be sure that no fruit remain on the plants, and to follow the label carefully for application timings.

BRAMBLES

(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.

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose		Lime sulfur solution (20 gal)* Lime sulfur solution (10 gal)**
Phytophthora Root Rot*	58	See Post-Harvest
Comments:		Comments:
*—May be applied one additional time in the fall. Do not apply within 45 days prior to harvest.		CAUTION: If unable to apply the first mentioned eradicated spray for anthracnose, a lime-sulfur spray at 5 gal/100 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 new leaves are exposed 1/4 to 3/4 in.
		**—When a few leaves have unfolded.

PRE-BLOSSOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose	57	57. Bordeaux: Powdered bluestone (6 lb), plus Hydrated lime (6 lb)
Spur Blight	57	58. Ridomil 5G (see comment above left)
Phytophthora Root Rot	58, 60	60. Aliette 80 WP (5 lb)
INSECTS		INSECTICIDES
Leafrollers	5g, 8e	5. Diazinon 50 WP (2 lb)
Raspberry Sawfly	13g	8. Guthion 2 S (1 pt)
Raspberry Fruit Worm	13g	8. Guthion 50 WP (1/2 lb)
Raspberry Cane Borer*	See Comments	13. Malathion 50 WP (4 lb)
Red-necked Cane Borer**	See Comments	Comments:
Comments:		<i>Aliette may be applied a total of four times per season as a foliar spray beginning in the spring and repeated on a 45 to 60 day schedule, but not within 60 days of harvest. Do not combine with copper sprays and do not apply within several days of a copper application. Do not use surfactants. Apply spray until brambles are thoroughly wet.</i>
*—To control the raspberry cane borer, cut off and destroy injured canes below the two rings made by the beetles. Do this as soon as wilted tips are noticed, usually in July.		
**—To control the red-necked cane borer, cut and burn in the fall or early spring any wild raspberries in the vicinity since this insect develops on wild raspberries. At pruning time remove and burn all canes showing any swellings.		

EARLY BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose		1. Ronilan 50 W** (1 1/2 lb) or Ronilan FL (1 1/2 pt)
Botrytis Rot (Gray Mold),	1, 2, 3	2. Rovral 50 W** (1-2 lb) or Rovral 4 F** (1-2 pt)
Penicillium Rot, Powdery Mildew	2	3. Benlate 50 WP* (3/4 lb)
Comments:		Comments:
		*—Benlate provides 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.

BRAMBLES

FULL BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES See Early Bloom section
Botrytis Rot,	1, 2	
Penicillium Rot, Powdery Mildew	2	

POST BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES See Early Bloom section Comments: <i>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.</i> <i>Use Ronilan or Rovral on a 7 to 14 day spray interval. Ripening fruit is especially susceptible to gray mold. Adhere to the 9 day pre-harvest interval for Ronilan.</i>
Botrytis Rot,	1	
Penicillium Rot, Powdery Mildew	2	
Phytophthora Root Rot	58, 60	
Comments: See comments under "delayed dormant" for Ridomil and under "pre-blossom" for Aliette use.		

FIRST COVER (PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		
Leafrollers	See Pre-Blossom	
Cane Borers	See Pre-Blossom	
Aphids	See Pre-Harvest	

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		INSECTICIDES 5. Diazinon 50 WP (2 lb) 13. Aqua Malathion 8 E (1 pt) 13. Malathion 25 WP (8 lb) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2½ lb) 23. Sevin XLR+ (2 qt)
Aphids	5g, 13e	
Japanese Beetle	13, 23g	
Comments: <i>Japanese beetle on fall bearing varieties is partially controlled by materials applied for aphid. Addition of non-ionic surfactant improves knock-down of this pest. Insecticide application for beetle control when fall bearing varieties are in bloom risks mortality for pollinators.</i>		

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Phytophthora Root Rot	58	58. Ridomil 5 G**
<p>Comments: Phytophthora root rot symptoms appear in summer and spring. Whole canes appear to suddenly wilt. Associated with low wet areas of soil.</p> <p>NOTE: A repeat application can be made once in the spring. Do not apply within 45 days of harvest.</p>		<p>Comments: **—Apply 5 lb/1,000 row ft in a band 3 ft wide centered over the row. Or, broadcast 27.5 lb/A.</p>
INSECTS		INSECTICIDES
Aphids	5g	5. Diazinon 50 WP* (2 lb)
Raspberry Crown Borer	5e*	<p>Comments: *—Where raspberry crown borers are a major problem, apply a drenching crown spray using Diazinon at 100 to 200 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.</p>

Special Brambles Disease Problems and Controls

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, tomato ringspot virus, 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.), 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. 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. Plant the field 500 to 1,200 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 1,200 ft with herbicides.

4. Spray the new planting with 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.

BLUEBERRIES

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, "Tractor-Mounted Air Blast Sprayers in Small Fruit Crops," for calibration of sprayers.

GREEN TIP (1/16")

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker**	9, 10, 11	1. Ridomil 2 E (14.5 pints) 2. Funginex 18.2 EC* (24 fl oz) 9. Benlate 50 WP (1 lb), plus Captan 50 W (5 lb)** or Captec 4 L (2½ qt)
Mummyberry (Shoot blight phase)	2	10. Bravo Weatherstik (3-4¼ pt)
Phytophthora Root Rot	1	11. Aliette 80 WDG (5 lb)
Comments:		Comments:
For established plantings applying 1 pint/1,000 linear ft of row (14.5 pints/A-broadcast basis). The chemical should be banded 3 ft wide centered on the row, but applied to the soil. One additional application may be made to coincide with periods favorable for root rot development.		*—Apply in 20 gallons water/acre by ground sprayer or in 5 gallons water/acre by airplane.
For new plantings do not apply more than 3.6 gals/A (broadcast basis) during the 12 months prior to harvestable fruit or illegal residues may result.		**—Although Phomopsis canker is not on the label, Benlate plus Captan will give some control. Conidiospores of both Phomopsis and Fusicoccum fungi are spread from cankers on stems with each rain beginning at bud break and continuing into the fall.
		Do not apply fungicides other than Funginex by airplane. Coverage is too poor to get good results.

GREEN TIP (1/4"-1/2")

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummyberry (Shoot blight phase)	2	2. Funginex 18.2 EC (24 fl oz)

PINK BUD

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummyberry (blossom infection stage)	2, 9	2. Funginex 18.2 EC* (24 fl oz) 9. Benlate 50 WP (1 lb), plus Captan 50 WP (5 lb) or Captec 4 L (2½ qt)
Fusicoccum and Phomopsis Canker	9, 10, 11	10. Bravo Weatherstik (3-4¼ pt)
Anthracnose	9, 10, 11	11. Aliette 80 WDG (5 lb)
Alternaria Fruit Rots	9, 10, 11	Comments:
		Phomopsis canker will be partially controlled by Benlate plus Captan.
		*—Funginex controls mummyberry only. Captan plus Benlate needed for control of other diseases listed.
INSECTS		INSECTICIDES
Oblique Banded Leafroller	11e	11. Lannate 90 SP (1 lb)
Spring Canker Worm	11e	11. Lannate LV (3 pt)

BLUEBERRIES

25% BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummyberry (blossom infection stage)	2	1. Ridomil 2E (14.5 pt) 2. Funginex 18.2 EC* (16 fl oz)
Fusicoccum Canker	9, 10, 11	9. Benlate WP (1 lb), plus Captan 50 WP* (5 lb) or Captec 4 L (2½ qt)
Anthracnose	9, 10, 11	10. Bravo Weatherstik (3-4 pt)
Alternaria Fruit Rots	9, 10, 11	11. Aliette 80 WDG (5 lb)
Phytophthora Root Rot	1	
Comments: See comments under "green tip."		Comments: *—Funginex controls mummyberry only. Captan plus Benlate needed for control of other diseases listed. Phomopsis canker will be partially controlled by Benlate plus Captan. Note: Funginex 18.2 EC rate cannot exceed 16 fl oz/acre during bloom.

FULL BLOOM (EARLY PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummyberry (blossom infection stage)		See materials under "25% bloom." Do not apply Bravo Weatherstik after bloom or fruit spotting may occur.
Fusicoccum and Phomopsis Canker		
Anthracnose		
Alternaria Fruit Rots		
INSECTS		INSECTICIDES
Oblique Banded Leafroller	43f/g	43. B.t.'s*
Cranberry Fruitworm	43f/g	
Cherry Fruitworm	43f/g	Comments: *—Time B.t. insecticides for early egg hatch and reapply every 4-7 days to maintain control.

BLUEBERRIES

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker		See materials under "25% bloom."
Anthracnose		Do not apply Bravo Weatherstik after bloom.
Alternaria Fruit Rots		
INSECTS		INSECTICIDES
Plum Curculio	8e, 9e, 23g	8. Guthion 2 S (2-3 pt)
Blueberry Tip Borer	8e, 9e, 23g	8. Guthion 50 WP (1-1½ lb)
Oblique Banded Leafroller	8e, 9e, 11e, 23g, 43f-g	9. Imidan 70 WP (1⅓ lb)
Cranberry Fruitworm	8e, 9e, 23e, 43f-g	11. Lannate 90 SP (1 lb)
Cherry Fruitworm	8e, 9e, 23e, 43f-g	11. Lannate 2.4 LV (3 pt)
Aphids	11e	23. Sevin 80 S (1⅞ lb)
Comments:		23. Sevin 50 WP (3-4 lb)
For aphid control, sprays should be applied with a ground sprayer.		23. Sevin XLR+ (1½-2 qt)
		43. B.t.s*
		Comments:
		*—Time B.t. insecticides for early egg hatch and reapply every 4-7 days to maintain control.

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker	9, 11	9. Benlate 50 WP (1 lb), plus Captan 50 WP (5 lb) or Captec 4 L (2½ qt)
Anthracnose	9	11. Aliette 80 WDG (5 lb)
Alternaria Fruit Rots	9, 11	
INSECTS		Comments:
	See First Cover	Phomopsis will be partially controlled by Benlate plus Captan.

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker	9	9. Benlate 50 WP (1 lb), plus Captan 50 W (5 lb) or Captec 4 L (2½ qt)
Anthracnose	9	
Alternaria Fruit Rots	9	Comments:
INSECTS		Phomopsis canker will be partially controlled by Benlate plus Captan. NOTE: Do not apply Benlate within 21 days of harvest.
	See First Cover	

BLUEBERRIES

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker	9, 11	9. Benlate 50 WP (1 lb), plus Captan 50 W (5 lb) or Captec 4 L (2½ qt)
Anthracnose	9	11. Aliette 80 WDG (5 lb)
Alternaria Fruit Rots	9, 11	
INSECTS		INSECTICIDES
Blueberry Maggot	8e, 9e, 13g	8. Guthion 2 S (2-3 pt)
Aphids	13g	8. Guthion 50 WP (1-1½ lb)
		9. Imidan 70 WP (1⅓ lb)
		13. Malathion LV Concentrate* (10 fl oz)
		13. Aqua Malathion 8 EC (1½-2½ pt)
		13. Malathion 25 WP (8 lb)

FIFTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS	See Fourth Cover	

SIXTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS	See Fourth Cover	

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum and Phomopsis Canker	9, 11	9. Captan 50 WP* (5 lb)
Anthracnose	9	11. Aliette 80 WDG (5 lb)
Alternaria Fruit Rots	9, 11	Comments: *—If canker is a serious problem, and it has been 3 to 4 weeks since the last canker spray, apply a spray at this time.
INSECTS		INSECTICIDES
White Marked Tussock Moth	11e, 23e	11. Lannate 90 SP (½-1 lb)
Oblique Banded Leafroller	11e, 23e	11. Lannate LV (3 pt)
Canker Worms	11e, 23e	23. Sevin 80 S (1⅞ lb)
Japanese Beetle	23g*	23. Sevin XLR+ (1½-2 qt)
		Comments: *—Addition of non-ionic surfactant to ground sprays increases knockdown of Japanese beetle.

POST HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	9	9. Benlate 50 WP (1 lb), plus Captan 50 WP (5 lb)
		Comments: If canker is a serious problem, apply the spray if it has been 3 to 4 weeks since the previous canker spray. Continue spray applications at 3 to 4 week intervals through leaf drop in the fall.

Plant Growth Regulators

J. Hull

Department of Horticulture

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

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

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

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

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

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

4. Coverage: Responses are generally localized. All plant growth substances must be applied with precision. Ensure that the proper amount is applied in a correct manner. Uniform, thorough coverage is essential. Calibrate your sprayer accurately. For large

trees, direct $\frac{2}{3}$ of the spray volume into the upper $\frac{1}{3}$ of the tree. Whenever possible, apply growth substances as a dilute spray.

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

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

7. Evaluation: Always leave several non-treated trees so that you can evaluate the effectiveness of your treatment [application]. It is best not to have these trees on the edge of the orchard. Keep good records so that future adjustments can be based on your past experiences.

Apples

Chemical Thinning

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, naphthaleneacetamide (NAD), and benzyladenine (BA). 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 two groups. (1) easy to thin; and (2) hard to thin.

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

1. Varieties Easy to Thin: McIntosh, Delicious, Empire, Idared, Paulared, Jerseymac, Jonathan, Northern Spy, Gala, and Rhode Island Greening: 4 grams of *actual* NAA per 100 gallons (10 parts per million). Spur type Delicious are harder to thin than regular Delicious and require 2 to 3 more parts per million concentration. NAA applied to spur type Delicious after Promalin or Accel applications can result in formation of pygmy fruit.

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

If the first application of NAA (made 5 to 7 days after petal fall) does not give enough thinning, increase the

concentration 2 to 5 parts per million and follow with a second application 7 to 10 days later. Very late applications can cause very small sized fruit.

Thinning with NAD

Amid-Thin (NAD) is suggested for use on apples in Michigan at 50 parts per million at petal fall. Concentrations lower than this have not given adequate thinning. Applying Amid-Thin *after* petal fall has resulted in *poor* 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 this material did not thin Delicious, but instead, resulted in a crop with many undersized, distorted apples. **Do not apply** Amid-Thin *after* petal fall on the Delicious variety. Do not combine with Accel.

Carbaryl as a Thinning Agent

Carbaryl (Sevin) applied between petal fall and second cover can reduce yield. Applications at other times in the growing season have no adverse effect on crop yield.

Sevin is a mild fruit thinning agent, but it has not always produced consistent and adequate results. Thinning with Sevin does not appear to be concentration-dependent and rates of 1/2 to 2 lb Sevin 50 WP/100 gal will result in similar thinning responses. Apply Sevin at first cover for fruit thinning. Warm temperatures following application (> 70° F) are required for thinning. Sevin used at second cover following thinning applications of NAA can cause overthinning and increase mite problems. Sevin XLR at 1/4 to 1 qt/100 gal or Sevin 80S at 1/3 to 1 1/4 lb/100 gal can also be used for thinning apples. Sevin is toxic to bees.

Benzyladenine for Thinning

Benzyladenine (BA) is marketed as Accel for thinning. This product also contains GA₄₊₇. BA has not satisfactorily thinned most varieties but has exhibited some effectiveness on Empire, Jonathan and McIntosh. BA can thin over a two-week period of time but developing fruits appear most susceptible to BA applied at the 10mm stage of fruit development. Good uniform spray coverage is important. To achieve thinning, BA must come in direct contact with the spur leaves of the fruit cluster to be thinned. Warm temperatures at and following application are necessary for effective thinning. A concentration of at least 25ppm (dilute basis) is necessary for minimum thinning response and 50ppm more effective.

BA is not satisfactory for thinning spur type Delicious and if combined with or followed by NAA applications can result in pygmy fruit and seedless apples.

Thinning Combinations

Combinations of NAA and Carbaryl provide thinning with lower rates of NAA. Apply 1/3 to 1/2 rate of NAA in combination with 1/2 to 1 lb Carbaryl. Carbaryl can be combined with BA for thinning although these combinations have not been fully researched. Try the usual rate of Carbaryl with 1/2 to 2/3 rate of BA. This combination seems to be synergistic. Combination applications generally are most satisfactory when applied at king fruit diameter of 8-10 mm, but are dependent on temperatures greater than 70° F for effective thinning.

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 the early NAA application did not thin sufficiently.

Record the following information to aid in evaluating response: air temperature and relative humidity at time of applications, wind speed and direction, time of day, drying time, stage of tree growth, fruit development and orchard vigor, amount of formulated material added to sprayer tank and gallons of water applied per acre, previous year's production and tree response.

Guide for Chemical Thinning of Apples in Michigan¹

Variety	Chemical Method	
	NAA 5-15 days after petal fall (ppm)	NAD at petal fall (ppm)
Delicious ²	10	—
Jonathan, Gala	10	50
McIntosh	10	50
Empire*	10	50
Northern Spy	10	50
R. I. Greening	10	50
Idared	10	50
Winesap	10	50
Grimes Golden	15	50
Cortland	15	50
Rome Beauty	20	—
Wealthy	20	50
Golden Delicious ³	20	—
Paulared, Jersey mac	10-15	50
Other summer varieties ⁴	—	50

¹This 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.

²Some spur type Delicious usually require higher concentrations.

³Sevin may cause fruit russetting of Golden Delicious.

⁴Varieties which mature before McIntosh.

*NAA at 10ppm applied at full bloom-early petal fall provides modest thinning. Apply a follow-up thinning spray 2-3 weeks after petal fall, if necessary.

Cautions

- As a general rule, apply NAA under fast-drying conditions, when the temperature is between 70° and 75° F. On the other hand, Amid-Thin gives best results when applied under slow-drying conditions. Amid-Thin is often applied in the evening.
- Weak trees are thinned more easily than vigorous ones. Weak wood in lower portion of tree thins easier than vigorous wood in the top.
- Trees thinned annually have a more predictable response to NAA thinning sprays.
- Thinning with NAA and Amid-Thin is greater when weather conditions during bloom do not favor good pollination and fruit set. However, when fruit set is questionable, but chemical thinning is essential, 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. Light rain just before or after NAA application may increase uptake and thinning action. Cloudy weather and warm night temperatures (+70°F) 2 to 3 weeks after bloom may cause heavy fruit drop.
- When freezing temperatures (32° F and lower) occur after pink and before applying the thinning sprays, NAA may cause excessive thinning. Reduce the concentration by 2 or 3 parts per million if frost, wind, chemical or insect damage to foliage has occurred.
- Each grower must work out the concentrations of NAA best suited for individual orchard conditions. Sprays of NAA will remove all the fruit and severely damage the leaves if too high concentrations are used. When conditions exist which might result in injury, or loss of crop from overthinning with NAA, Amid-Thin applied at petal fall using 50 parts per million is safer for widespread use. However, these decisions must be made by the grower.
- Uniform coverage is important to avoid over-thinning or under-thinning different parts of the tree.
- Thinning is most effectively accomplished with NAA applied 5 to 15 days after petal fall. The earlier applications permit evaluation and a second application, if necessary.
- If daytime temperature does not rise above 70° F within 5 days after Sevin application, poor thinning and small seedless fruit may result.

Surfactants increase the effectiveness of NAA. Decrease NAA concentration 50% when including a surfactant such as Tween 20, X-77 or Regulaid in the thinning spray.

Thinning with Concentrated Mixtures

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

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

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 50 WP 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 lb of Sevin 50 WP/100 gal. Higher concentrations may cause some leaf damage, and should not be used.

Promalin on Apples

Promalin (N-[phenylmethyl]-1H-purine-6-amine plus Gibberellins A₄ + A₇) is a compound applied to Red Delicious apples to promote fruit elongation and improve shape. Apply 1 to 1.5 pts/acre in 50 to 200 gallons of spray. Time of application is critical for satisfactory results. Apply from when king flower is in full bloom to early stages of petal fall of side blossoms. Promalin may cause excessive thinning on young trees.

Promalin can be applied to non-bearing apple trees to improve lateral branching. Apply one-quarter to one pint per 5 gallons using a pressurized hand sprayer and treat the new terminal growth of the leader when it is 1 to 3 inches (generally 1 to 2 weeks after full bloom). Thoroughly wet bark and foliage surfaces. Include a good non-ionic agricultural wetting agent. Do not spray trees under stress or after terminal growth ceases. NAA applied for thinning following promalin application can produce pygmy fruit.

Pro-vidé on Apples

Pro-vidé (Gibberellins A₄ + A₇) is for suppression of fruit russetting of Golden Delicious apples. Apply 15 ppm (10 ounces) in 100 gallons of water beginning at petal fall and continuing at 7 to 10 day intervals for a total of 4 applications. Do not exceed 100 gallons of spray per acre. The first two applications are most important and should be no more than 7 days apart. Apply under fast drying conditions. Do not utilize any wetting agent. Multiple applications may reduce flowering the next year.

Pre-Harvest Drop Control of Apples

NAA (naphthaleneacetic acid) may be used to control pre-harvest drop.

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

NAA may stimulate ripening. Harvest treated fruit before it becomes overmature.

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.

For early season varieties that mature before McIntosh, use 75 ppm (1/4 pt/100 gal) applied 7 to 10 days prior to normal harvest. On McIntosh and later season varieties use 150 to 300 ppm (1/2 to 1 pt/100 gal) 7 to 21 days before normal harvest. Tree response is influenced by temperature at time of, and the interval immediately after, application. Cool weather delays response, and warm weather accelerates it. Responses are usually noticeable within 7 days. The time and rate of application depend upon the apple variety and your market objectives. Treated fruit soften faster and have less shelf life.

Ethephon promotes fruit abscission. NAA must be used to counteract the abscission effect or excessive fruit drop will occur.

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 8 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. Glyphosate applied to root suckers when 6-10 inches high provides early season control.

Pears

Chemical Thinning

NAD thins Bartlett pears with the suggested time of application petal fall.

The following rates are given as guides: (1) 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 thinning varieties other than Bartlett.

Peaches

Chemical Thinning

No reliable chemicals are available for thinning peaches.

Cherries

Ethephon on Cherries

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

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

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

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

Temperature and tree vigor are associated with the degree of response achieved. At higher temperatures (greater than 85° F) the magnitude of response is in-

creased, 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 (1 $\frac{1}{3}$ pt/100 gal); for tart cherries, 200 ppm ($\frac{2}{3}$ pt/100 gal). Low volume applications seem to produce satisfactory fruit loosening with lower rates of ethephon per acre than required for dilute applications. Low volume applications (20 to 80 gal/acre) using $\frac{3}{4}$ to 1 pint ethephon per acre have been sufficient for tart cherry and 1 $\frac{1}{2}$ to 2 pts/acre are satisfactory for sweet cherry.
- 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 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.**
- 7. Do not apply within 7 days of harvest.**

Gibberellic Acid on Cherry

Gibberellic acid may be used to reduce flowering and fruiting of young tart and sweet cherry trees to maximize vegetative growth. Do not treat trees the first year they are planted in the orchard. Apply the second year to prevent flowering the third season and repeat the third year to prevent flowering the fourth year.

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

In the fourth year apply at 12 to 15 ppm. This will allow flowering in year five at a reasonable level rather than extremely heavy bloom and production which may significantly reduce growth in future years.

In mature tart cherry trees, gibberellin can help maintain and extend high fruiting capacity and reduce occurrence of blind nodes by stimulating lateral shoots and spurs. Apply about three weeks after full bloom. Concentrations of 10 to 20 ppm are used, with 15 ppm most common. Four ounces of Pro-Gibb per 100 gallons of water provides a 10 ppm solution. Use lower rates on more vigorous trees. Apply at temperatures above 70° F. Dilute applications are advised as it has not performed well in concentrate spray applications. Surfactants and wetting agents are not suggested until more research is completed.

Herbicides

J. Hull and E. Hanson
Department of Horticulture

Weed Control in Fruit Crops

Ground cover management affects both fruit tree vigor and yield. Use a ground cover system that facilitates management of the fruit planting for improved tree growth and productivity.

Maintaining young trees, especially those on less vigorous rootstocks, free of competition from weeds and sod results in larger trees. Trees maintained in weed-free conditions produce more fruit—a result of increased tree size, fruit set and increased fruit size. Thus, orchardists tend to maintain a weed-free area in the tree row and a sod or cover crop alleyway to support vehicle travel and control erosion.

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.

It is necessary to provide optimum growing conditions the first few seasons to produce a healthy tree with a strong trunk and scaffold branches. Control perennial weeds, such as quackgrass, nutsedge, or Canada thistle, with repeated tillage or herbicides prior to planting a new orchard or they may seriously reduce the growth of newly planted trees. 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 3 feet from the trunk is adequate in the first 2 years. As the tree becomes larger and its root system spreads over large areas, control weeds in the area 4 feet from the trunk or at least to the drip-line of the tree.

Commercial fruit growers can select from a number of herbicides which can provide weed control with economical 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 to 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, apply herbicides as accurately as possible.

Continuously using an herbicide for many years can result in weed problems through resistance to the particular herbicide or through infestations of weed

species resistant to a particular herbicide. It is important to know the weed species that have been a problem in the fruit planting. Select herbicides that are effective against such species. Combining two soil-active herbicides such as simazine plus oryzalin or terbacil plus diuron provides a wider spectrum of weed control. For example, where simazine-resistant lambs-quarters, rough pigweed, and yellow foxtail occur, adding terbacil, diuron, or oryzalin improves the degree of weed control. Terbacil does not control rough pigweed but can be combined with diuron if rough pigweed is a major orchard weed problem.

Early season applications of simazine, diuron, or terbacil may provide only fair to poor grass control in late season. Combining with oryzalin or napropamide provides control of late summer germinating grasses.

Selecting herbicides for orchard weed control is influenced by type of fruit trees involved, tree age, season of year when application is to be made and weed species to be controlled.

Oryzalin, Napropamide or Dichlobenil can be used in new orchard plantings to control grasses and some broadleaved weeds. Incorporation is important.

Applying herbicides in established fruit plantings is usually postemergent—after weeds have emerged—and should include Glyphosate, Paraquat or Sulfosate to control the emerged weeds. Most satisfactory orchard weed control is when at least two soil-active herbicides are combined with one of these chemicals.

Herbicides for Fruit Crops

2,4-D (Weedar 64, Hi Dep). 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. Primary herbicide for perennial weed control in sodded alleyways, 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 to 1.5 lbs 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. Two applications permitted per year with at least 75-day interval between applications. Several spot applications are often needed to completely eradicate these deep-rooted perennials. It may be combined with other herbicides. Never use in sprayers that will later be used for foliar applications on fruit and vegetable crops. **Applications after harvest and before frost preferred.** Do not apply during bloom.

Dichlobenil (Casoron, Norosac). This chemical effectively controls quackgrass in established fruit plantings. 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 with application in November prior to snowfall. Six pounds of chemical (150 lbs of 4 percent granules) per acre will control 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.

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

For established apple, pear, peach, cherry, plum, grape, blueberry and berries.

Diuron (Karmex). Diuron is particularly effective on annual grasses and broadleaved weeds. At higher rates of application, it may also suppress quackgrass. Applied at 2 to 3 lbs/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 or glyphosate to obtain season-long control of most weeds. It can also be tank-mixed with other soil-active herbicides for improved control of a wider range of weed species.

For established apple, pear, peach, grape, blueberry and raspberry.

Fluazifop-butyl (Fusilade DX) is a systemic herbicide only effective on grasses. Add 1 qt of crop oil or 1 pt of non-ionic surfactant for every 25 gal of dilute spray. Apply to actively growing grasses before they exceed growth stage specified on product label (annual grasses less than 8 inches tall and actively growing perennial grasses with 4 to 6 inches new growth). See label for rates to apply to different grass species. Avoid spray contact with fruit tree foliage.

For newly established apple, pear, peach, cherry, plum, grape and blueberry.

For established peach, cherry, plum, apricot and nectarine.

Glufosinate (Rely) is a foliar-active, nonselective herbicide that controls a broad spectrum of emerged annual and perennial grasses and broadleaf weeds. Best results obtained when applied to actively growing weeds. Apply 1 lb/acre when weeds less than 8 inches tall and 1.5 lb/acre when weeds 8 inches or taller. Does not provide residual weed control but can be tank mixed with residual herbicides for broad spectrum control. Avoid contact with green on uncallused bark on young trees and vines. Do not apply within 14 days of harvest.

For established apple and grape.

Glyphosate (Roundup Ultra). Glyphosate will control 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, apply after 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 does not cause problems. Carefully direct sprays toward the base of the tree. May be combined with other soil-active herbicides to provide season-long weed control. Most effective when applied in 20 gal of water per acre. Apply only near trees planted for 2 or more years.

Ammonium sulfate increases Roundup efficacy on a broad spectrum of weeds when spraying with hard water. Add 2% of ammonium sulfate (17 lb/100 gal) to the carrier solution prior to adding the Roundup.

For established apple, pear, cherry, plum, blueberry and grape.

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

Isoxaben (Gallery) is labeled for non-bearing tree fruit crops and grape. It controls broadleaf weeds when applied as preemergence treatment. Apply at $\frac{2}{3}$ to $1\frac{1}{3}$ lbs/acre depending upon weeds to be controlled. Combine with Surflan to also control grass species.

For non-bearing apple, cherry, peach, pear, plum, blueberry, bramble and grape.

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

For newly planted apple, pear, peach, cherry, plum, grape and blueberry.

For established apple, pear, peach, cherry, plum, grape and blueberry.

Norflurazon (Solicam). This chemical is labeled for apple, pear, peach, plum and blueberry, and can be applied to newly planted apple and peach trees after trees are established. Apply before weeds emerge or

combine with paraquat or glyphosate for control of existing vegetation. Apply 2 to 4 lbs/acre, using the lower rate on coarse soils (sandy loam). Rainfall is necessary to move Solicam into the weed root zone for the chemical to be effective. Solicam is more effective on grasses than broadleaf weeds and does not control established weeds. Combinations with diuron or simazine provide broad spectrum weed control. More effective when applied in the fall. Do not treat cherry on coarse soils.

For newly planted apple, pear, peach, cherry, plum, blueberry, raspberry, and grape.

For established apple, pear, peach, cherry, plum, blueberry, raspberry, and grape.

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

For newly planted apple, pear, peach, cherry, plum, grape and blueberry.

For established apple, pear, peach, cherry, plum, grape, brambles and blueberry.

Oryzalin/Isoxaben Combination (Snapshot)—Snapshot 80 DF is a commercial (premix) preparation that is 20% isoxaben and 60% oryzalin. Apply at 2-4 lb/acre in early spring or late summer to early fall.

For nonbearing apple, pear, peach, nectarine, plum, sweet cherry, and grape.

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

For newly planted apple, pear, peach, cherry and plum.

For established apple, pear, peach, cherry, plum and grape.

Paraquat (Gramoxone Extra). Paraquat provides very rapid knockdown of annual and perennial weeds and may be utilized in all fruit plantings. Apply when weeds and grasses are succulent and new growth is 1 to 6 inches high. It has no action through the soil to prevent further weed growth and usually new weeds will be evident 30 to 40 days after application. Do not allow paraquat to contact foliage or areas of the trunk where

bark has not formed. Painting trunks of young trees with latex paint before applying paraquat reduces possibility of injury. If weed growth is severe, apply at a rate of 1 lb of active ingredient per acre. On lighter infestations, 1/2 lb/acre is adequate.

Always add a nonionic surfactant (1 to 2 pts/100 gal of water) containing at least 50% surface active ingredient. To eliminate weed competition for the entire growing season, 2 to 3 applications are necessary. Paraquat is extremely toxic and should never be allowed to touch skin or eyes. Avoid inhaling mist of this chemical. Paraquat may be combined with other soil-active herbicides to provide season-long weed control.

For newly planted apple, pear, peach, cherry and plum.

For established apple, pear, peach, cherry, plum, grape and blueberry.

Pendimethalin (Prowl) is labeled for use on nonbearing fruit trees and grapes for preemergence weed control. Adequate rainfall (at least 1/2 inch) within 7 days after application is important for adequate weed control. Controls seeds as they germinate but not established weeds. Formulated as 4 lbs/gal of liquid. Can be utilized in same manner as oryzalin but has been much less effective in MSU trials. Does not control established weeds.

For newly planted apple, pear, peach, cherry, plum and grape. For nonbearing plantings only.

Pronamide (Kerb). 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. Apply in fall after fruit harvest but prior to leaf drop. On sandy loam soils, apply at rates of 1 to 2 lbs/acre of active ingredient. It is not effective on soils with a high organic matter content.

For established apple, pear, peach, cherry, plum, grape and blueberry.

Sethoxydim (Poast) is applied postemergence for grass control when grasses are actively growing. Rate varies with grass species and stage of growth. It does not control broadleaf weeds and is registered only for nonbearing plants. Add nonphytotoxic oil concentrate to the spray solution at 2 pts/acre.

For non-bearing peach, cherry and plum. Do not apply within 1 year of harvest.

For apple, pear, grape, blueberry and raspberry. May be applied up to 45 days of harvest in raspberry, 50 days in grape, 30 days in blueberry and 14 days in apple and pear.

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 spring in combination with paraquat or glyphosate. The use rate (2 to 4 lbs/acre) varies with soil type. Injury may occur on stone fruit on extremely sandy soils when the rate of appli-

cation exceeds 2 lbs/acre. Simazine does not build up in the soil from annual application of the above rates.

For established apple, pear, peach, cherry, grape and blueberry—all at least 1 year old.

Sulfosate (Touchdown) controls many annual and perennial weeds. It is a trimethylsulfoxonium salt of glyphosate that apparently moves into the plant and is translocated more rapidly than Glyphosate. It has the same mode of action and is similar to Roundup. Apply Touchdown to actively growing emerged weeds when they are small. Weeds 6 inches high are easiest to control. Rate to apply varies with weed species and size—higher rates required for larger weed size. Surfactant or wetting agent required for improved coverage of weed foliage. Perennial weed control may be improved by adding ammonium sulfate at 2% (17 lb/100 gal) in addition to nonionic surfactant.

For non-bearing apple, cherry, pear, peach, plum, blueberry, grape and raspberry.

Snapshot is a premix combination of isoxaben and oryzalin that provides control of a broader spectrum of weeds than either chemical by itself.

For nonbearing apple, pear, peach, nectarine, plum and sweet cherry.

Terbacil (Sinbar). This chemical is registered for use only on peaches, pears and apples which have been established at least 3 years and blueberries established at least 1 year. It controls most annual weeds and also will suppress the growth of some other perennial weeds.

In tree fruits, spring applications (April 15 to May 1) of Sinbar at 1 lb of active ingredient per acre control annual weeds. Two or 3 lbs/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, results 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.

For established apple and peach at least 3 years old and for Bramble and blueberry at least 1 year old.

Herbicide Combinations. The continuous use of a herbicide for many years can result in weed problems through the development of resistance to the particular herbicide or through heavy infestations of weed species resistant to a particular herbicide. Thus the combination of two soil-active herbicides such as simazine plus terbacil or terbacil plus diuron or 3 soil-active herbicides, provides for a wider spectrum of weed control. Where simazine-resistant lambs-quarter, pigweed and foxtail occur, the addition of terbacil or diuron improves the degree of weed control. Terbacil does not control redroot pigweed and should be combined with diuron if pigweed is a major orchard weed problem. Simazine does not control horseweed (marestail). Terbacil controls this weed. Combinations with terbacil require caution. Generally, about 1 lb/acre

of terbacil is necessary for an effective herbicide combination but this rate may be too high for light-textured sandy soils or soils with very little organic matter.

Early spring simazine applications tend to provide fair to poor grass control late in the season. Combination with oryzalin will provide control of later summer germinating grasses. Combination of oryzalin or napropamide with simazine, diuron or terbacil results in control of a broader spectrum of weeds and a longer period of control.

Oryzalin or napropamide can be utilized in new plantings to control grasses and some broadleaved annual weeds.

Integrated Management. Integrated pest management programs that utilize predator mites and insects as part of the pest control strategy often encourage some plant growth under the tree as habitat for predators. Broadleaf weeds appear to be favored by some predator mites.

Allelopathy is chemical interference that occurs when one plant interferes or influences the growth of other plants through release of chemicals into the environment. It involves introducing cover crop residue into crop management. Compounds in the decaying residue inhibit seeds from germinating.

Allelopathy weed control in orchards has involved seeding a cover crop in the fall of rye, wheat, barley or oats. In Michigan, Wheeler rye has produced the most biomass, although Yorkstar wheat has also been utilized. The cover crop is sprayed with glyphosate or paraquat when it is about two feet high or just beginning to bloom the following spring. The residue controls germinating weed seeds. Low gallonage glyphosate application (15 gal of solution/A at 3/4 lb a.i./A) effectively knocks down the cover crop.

Herbicides for Strawberries

The herbicides registered for strawberries are quite specific in the weed spectrum that they control. Rarely will 1 chemical handle all of the weed problems in a single planting.

DCPA (Dacthal). Dacthal provides good control of annual grasses such as crabgrass and foxtail when used at 8 lbs/acre on sandy soils. It has been much less effective on heavier soils and has not consistently controlled broadleaved weeds. Apply Dacthal for grass control in new and established plantings before emergence of the weeds.

2,4-D Amine (Formula 40, Weedar 64). 2,4-D (alkanol amine form only) has been effectively used in the renovation program for established strawberry plantings. Apply immediately after harvest, at 1 lb/acre, to control annual broadleaved weeds. It also provides control of some fleshy-rooted perennials not controlled with other chemical treatments. Do not apply 2,4-D at other times during the growth of the strawberry plant or injury and yield reduction may occur.

Fluazifop-butyl (Fusilade 2000) is for control of grasses only and is applied over the top of the plants when grasses are actively growing but less than 6 inches of new growth. The rate applied varies with stage of grass growth but should include 1 qt of crop oil concentrate per acre. Do not apply within 12 months of harvest.

Napropamide (Devrinol). Napropamide is extremely effective on annual grasses and some broadleaved weeds when applied preemergence in strawberries at 1 to 2 lbs/acre. It is sensitive to light and should be either incorporated into the soil about 2 inches deep prior to establishing new plantings, or irrigated in on established plantings. It may be applied in spring or fall or at other times of the year after cultivation. It is an amide herbicide like diphenamid and has the potential for inhibition of runner rooting on extremely light sandy soils. Do not apply from bloom through harvest.

Sethoxydim (Poast) is applied postemergence for grass control when grasses are actively growing. Higher rate required for quack grass than for annual grass control. Include 2 pts/A nonphytotoxic oil concentrate in spray solution. Do not apply within 7 days of harvest. Application of Poast plus oil concentrate up to 6 weeks after a Sinbar application may cause strawberry leaf injury.

Terbacil (Sinbar). Terbacil is used for pre- and post-emergence weed control in established strawberries. The safety margin on strawberries is extremely narrow. Use only on plants established in the field for at least 6 months. Apply 2 to 6 ozs product per acre per application. Do not apply more than 8 ozs of Sinbar 80WP per acre per growing season. Do not apply terbacil on newly planted berries. Avoid application during periods of the year when the plants are making active growth. The safest times to apply are after mowing the plants at renovation time or late fall after growth stops. (Or late winter-early spring on light sandy soils in areas with heavy snowfall.)

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 gal/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 pres-

sure. 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.

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 gal/acre, at a pressure of 20 to 60 lbs 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 gal/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 4-foot band in the row may be sufficient.

Names, Sources and Formulations of Herbicides for Fruit Crops¹

Common Name	Trade Name and Manufacturer	Concentration and Commercial Formulations ²
DCPA	DACTHAL (ISK Biosciences Corp.)	75 WP
dichlobenil	CASORON (Uniroyal)	4 G
diuron	KARMEX (DuPont)	80 WP; 80 DF
fluzifop-butyl	FUSILADE DX (Zeneca)	2 lb/gal L
glufosinate	RELY (AgrEvo)	1 lb/gal L
glyphosate	ROUNDUP ULTRA (Monsanto)	3 lb/gal L
hexazinone	VELPAR (DuPont)	2 lb/gal L; 90 SP
isoxaben	GALLERY (DowElanco)	75 DF
napropamide	DEVRIKOL (Zeneca)	50 WP; 50 DF
norflurazon	SOLICAM (Sandpøz)	80 DF
oryzalin	SURFLAN (DowElanco)	4 lb/gal L
oxyfluorfen	GOAL (Rohm & Haas)	1.6 lb/gal L
paraquat	GRAMOXONE EXTRA (Zeneca)	2.5 lb/gal L
pendimethalin	PROWL (Amer. Cyanamid)	4 lb/gal L
pronamide	KERB (Rohm & Haas)	50 WP
sethoxydim	POAST (BASF)	1.5 lb/gal L
simazine	PRINCEP (Ciba-Geigy)	80 WP; 90 WG, 4L
sulfosate	TOUCHDOWN (Zeneca)	6 lb/gal L
terbacil	SINBAR (DuPont)	80 WP
2,4-D	FORMULA 40 (Rhone-Poulenc)	3.8 lb/gal L
	WEEDAR 64 (Rhone-Poulenc)	3.8 lb/gal L
	HI DEP (PBI Gordon Corp)	3.8 lb/gal L

¹Trade names and formulations given for user convenience. Other formulations of the same herbicides, or other herbicides with the same active ingredients also may be labeled for use on certain crops.

²EC = emulsifiable concentrate; DF = dry flowable; G = granular; L = liquid; SP = soluble powder; WG = wettable granule; WP = wettable powder.

Interval from Herbicide Application to Harvest for Fruit Crops and Restricted Entry Interval for Worker Protection Standard

Herbicide	Days to Harvest ¹ (days)	REI ² (hours)
2,4-D	40	48
Casoron (dichlobenil)	30	12
Devrinol (napropamide)	35	12
Fusilade DX (fluazifop-p-butyl)	14	12
Gallery (isoxaben)		12
Goal (oxyfluorfen)		24
Gramoxone Extra (paraquat)		12
Karmex (diuron)	3 months	12
Kerb (pronamide)		24
Poast (sethoxydim)	14*	12
Princep (simazine)		12
Prowl (pendimethalin)		12
Rely (glufosinate-ammonium)	14	12
Roundup Ultra (glyphosate)	14	4-12
Sinbar (terbacil)		12
Solicam (norflurazon)		12
Surflan (oryzalin)		12
Touchdown (sulfosate)	365	12
Velpar (hexazinone)		24

*apple, pear (non-bearing stone fruits—1 year)

¹Days Between Herbicide Application and Fruit Harvest

²REI = Restricted Entry Interval

Herbicide Registration for Fruit Crops

Common Name	Trade Name	Method of application	Apple	Cherry	Peach	Pear	Plum	Grape	Blue-berry	Bram-bles	Straw-berry
Dichlobenil	Casoran	Pre	X	X	X	X	X	X	X	X	
Napropamide	Devrinol	Pre	X	X	X	X	X	X	X	X	X
Oryzalin	Surflan	Pre	X	X	X	X	X	X	X	X	
Oxyfluorfen	Goal	Pre	X	X	X	X	X	X			
Diuron	Karmex	Pre/ Early Post	X		X	X		X	X	X	
Isoxaben	Gallery	Pre/ Early Post	X	X	X	X	X	X	X	X	
Norflurazon	Solicam	Pre/ Early Post	X	X	X	X	X	X	X	X	
Simazine	Princep	Pre/ Early Post	X	X	X	X	X	X	X	X	
Terbacil	Sinbar	Pre/ Early Post	X		X				X	X	X
Glyphosate	Roundup Ultra	Post	X	X		X	X	X	X		
Sulfosate	Touchdown	Post	X	X	X	X	X	X		X	
Paraquat	Gramoxone Extra	Post	X	X	X	X	X	X	X	X	
Pronamide	Kerb	Post	X	X	X	X	X	X	X		
Fluazifop-butyl	Fusilade DX	Post	X	X	X	X	X	X	X	X	X
Sethoxydim	Poast	Post	X	X	X	X	X	X	X	X	X
2,4-D	Weedar 64TF Hi Dep	Post	X	X	X	X	X				X
Hexazinone	Velpar								X		
DCPA	Dacthal	Pre									X
Glufosinate	Rely	Post	X					X			

Herbicide rates are presented in pounds of active ingredient per acre. The table below indicates the amount of formulation required to obtain that amount of active ingredient. For example, to obtain 1 pound ai per acre of 80% wp requires 1.25 pounds of product.

Pounds of Formulation Needed When Rate in lb/A is:

% active ingredient	.25	.5	.75	1	1.5	2	3	4	5
100	.25	.5	.75	1	1.5	2	3	4	5
90	.28	.56	.83	1.1	1.7	2.2	3.3	4.4	5.6
85	.29	.59	.88	1.2	1.8	2.4	3.5	4.7	5.9
80	.31	.63	.94	1.25	1.9	2.5	3.8	5	6.3
75	.33	.67	1	1.3	2	2.7	4	5.3	6.7
65	.35	.77	1.2	1.5	2.3	3.1	4.6	6.2	7.7
50	.5	1	1.5	2	3	4	6	8	10
25	1	2	3	4	6	8	12	16	20

Weed Control Recommendations for Orchards, Vineyards and Small Fruit Plantings

J. Hull and E. Hanson
Department of Horticulture

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. See page 91 for detailed herbicide information.

TREE FRUITS

APPLES, PEARS

(Year of Planting)

Weed Problem	Chemical	lb/acre active ingredient*	Time of Application	Remarks and Limitations
Emerged annuals	paraquat (Gramoxone Extra)	1/2 to 1	Before or after planting trees and again during season as needed	Spray in band about 6 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.
	Sulfosate (Touchdown)	1/2 to 3	Apply to actively growing weeds, about 6 inches high.	Surfactant or wetting agent required.
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.
	pronamide (Kerb)	1 to 2	November	Apply after harvest and before soil freezes. Do not apply to trees transplanted less than 6 months.
	norflurazon (Solicam)	2 to 4	Apply to weed-free ground after soil settles.	Use only on apples; use lower rate on sandy soils. Most effective when applied in the fall.
	isoxaben (Gallery)	1/2 to 1	Fall or spring before weeds emerge.	Non-bearing only.
Annual broad leaf	oxyfluorfen (Goal)	1/2 to 2	Dormant	Do not apply after bud swell.
Grasses	Fluazifop-butyl (Fusilade DX)	0.25 to 0.375	To actively growing grass.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies.
	sethoxydim (Poast)	0.3 to 0.5		

See table on page 95 for assistance in calculating amount of formulated product to equal amount of active ingredient.

WEED CONTROL

APPLES, PEARS

(Established One Year or More*)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
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.	
	isoxaben (Gallery)	1/2 to 1	Fall or spring before weeds emerge.	Non-bearing only.
	norflurazon (Solicam)	2 to 4	Fall or spring before weeds emerge.	Use lower rates on sandy soils.
	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground.	Use lower rate on lighter soil. Apply in early spring.
	Napropamide (Devrinol)	4	Apply to weed-free ground.	Incorporation protects from rapid photo inactivation.
Quackgrass and emerged weeds	simazine (Princep) plus Paraquat (Gramoxone)	4 plus 1/2 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.
Quackgrass	glyphosate (Roundup Ultra)	1 1/2 to 2	Quackgrass should be 8 to 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.
	sulfosate (Touchdown)	1 1/2	Actively growing, 6 inches high.	Non-bearing only.
	pronamide (Kerb)	1 to 2	November	Apply before soil freezes.
Dandelions	2,4-D (Weedar 64)	1	After fruit harvest in fall and prior to bloom in spring.	Use only low volatile forms of 2,4-D. Spray at low pressure when there is no danger of drift onto trees. Do not apply when trees in bloom.
Field-bindweed and other problem perennials	glyphosate (Roundup Ultra)	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.
	sulfosate (Touchdown)	3	At or near flowering stage.	Non-bearing orchards only.
	2,4-D (Weedar 64)	1	When weeds are growing rapidly.	Use 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. Do not apply within 40 days prior to harvest.

*All chemicals listed previously for Year of Planting may be used as specified.

(Continued on next page)

WEED CONTROL

APPLES, PEARS (CONTINUED)

(Established One Year or More)*

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Emerged annuals and perennials	glyphosate (Roundup Ultra)	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.
	sulfosate (Touchdown)	1½	Actively growing weeds, 6 inches high	
	glufosinate (Rely)	1 to 1½	Actively growing weeds	1 lb/acre when weeds less than 8 inches tall and 1½ lb/acre if taller.

(Established Three Years or More)*

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Germinating annuals	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.

*All chemicals listed previously for Year of Planting may be used as specified.

CHERRIES (TART AND SWEET), PEACHES, PLUMS

(New Plantings and Established Orchards)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	paraquat (Gramoxone Extra)	½ to 1	Before or after planting trees and again during season as needed.	Spray in band about 4 feet wide to emerged weeds. Repeat applications are needed at 30 to 40 day intervals 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.
	norflurazon (Solicam)	2 to 4	Apply to weed-free ground after soil settles.	Do not use for cherry on coarse soils.
	isoxaben (Gallery)	½ to 1	Fall or spring before weeds emerge.	Non-bearing only.
Annual broadleaf	oxyflurofen (Goal)	½ to 2	Dormant	Do not apply after bud swell.
Perennial broadleaf weeds	2,4-D (Hi Dep, Weedar 64)	1 to 1½	When weeds are actively growing.	Do not apply within 40 days prior to harvest. Post-harvest treatment preferred.

(Continued on next page)

WEED CONTROL

CHERRIES (TART AND SWEET), PEACHES, PLUMS (CONTINUED)

(New Plantings and Established Orchards)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Emerged annuals and perennials	glyphosate (Roundup Ultra)	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. Not labeled for peach.
	sulfosate (Touchdown)	1 to 2	Apply to actively growing weeds, about 6 inches high.	Non-bearing only. Surfactant or wetting agent required.
Grasses	Fluazifop-butyl (Fusilade DX)	0.25 to 0.375	To actively growing grasses.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants.
	sethoxydim (Poast)	0.3 to 0.5		

(Established One Year or More)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals and quackgrass	simazine (Princep) plus paraquat (Gramoxone Extra)	2 to 4 plus 1/2 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 1/2 lb/acre in the spring.
	dichlobenil (Casoron)	6	November	Use granular formulation.
	norflurazon (Solicam)	2 to 4	Apply to weed-free ground after soil settles.	Fall applications generally more effective. Do not apply to cherry on coarse soils.
	glyphosate (Roundup Ultra)	1 1/2 to 2	Quackgrass should be 8 to 10 inches tall.	This chemical will not prevent annual weeds from coming up again from seed. Can be combined with simazine to control annual weeds.

PEACHES

(Established 3 Years or More*)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals and quackgrass	terbacil (Sinbar)	1/2 to 2	Late April or early May.	Use lowest rate on sandy soils. On sand pockets or knobs, do not apply any chemical.
Germinating annuals	diuron (Karmex)	2-3	In spring before weeds emerge.	
Perennial broadleaf weeds	2,4-D (Hi Dep, Weedar 64)	1 to 1 1/2	When weeds are actively growing.	Do not apply during bloom or within 40 days prior to harvest. Post-harvest treatment preferred.

*All chemicals listed previously for Year of Planting and Established Orchards may be used as specified.

WEED CONTROL

SMALL FRUITS

BLUEBERRIES, BRAMBLES

(First Year and Established Plantings)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting.	Use lower rate on lighter soil.
Grasses	Fluazifop-butyl (Fusilade DX)	0.25 to 0.375	To actively growing grasses.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants.
	sethoxydim (Poast)	0.2 to 0.46	To actively growing grasses.	Do not apply within 30 days of harvest in blueberry or 45 days in raspberry. Include crop oil concentrate.
Emerged weeds	glyphosate (Roundup Ultra)	1 to 2	Follow label instructions for best timing	Do not allow contact with green stems or leaves or injury will result.
	sulfosate (Touchdown)	1 to 2	When weeds are actively growing	Do not apply within 1 year of harvest. Do not allow spray to contact green stems or leaves or injury will result.

(Established One Year or More)*

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	diuron (Karmex)	1.6 to 3.2	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.
	Napropamide (Devrinol)	4	Apply before weeds emerge in spring.	
Quackgrass and annuals	dichlobenil (Casoron)	4 to 6	November	Granular formulation is most effective on quackgrass. Do not exceed 4 lb/acre on brambles.
	pronamide (Kerb)	1 to 2	November	Apply to dormant quackgrass or before emergence of annual weeds. Do not use on muck soils. Blueberry only.
	terbacil (Sinbar)	1.6 to 3.2 (blueberry) 0.8 to 1.6 (brambles)	In spring before weed growth starts.	Use only in 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.
	norflurazon (Solicam)	2 to 4	Fall to early spring before weeds emerge.	
Emerged weeds	paraquat (Gramoxone Extra)	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.
Woody perennials	hexazinone (Velpar)	1 to 2	Early spring before bud break.	Do not apply on light sandy soils or in successive years. Blueberry only.

*Chemicals listed for Year of Planting may be used as specified.

WEED CONTROL

GRAPES

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
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.
	Napropamide (Devrinol)	4	Apply to weed-free ground.	Apply in early spring.
	norflurazon (Solicam)	2 to 4	Fall to early spring before weeds emerge.	Use lower rate on sandy soil. Do not apply to vines less than 2 years old.
Annuals and perennials	paraquat (Gramoxone Extra) plus simazine (Princep)	1/2 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 Ultra)	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.
	glufosinate (Rely)	1 to 1 1/2	Actively growing weeds	1 lb/acre when weeds less than 8 inches tall and 1 1/2 lb/acre if taller.
	oxyfluorfen (Goal)	1/2 to 2	Dormant	Vines must be 3 years old and trellised.
Grasses	Fluazifop-butyl (Fusilade DX)	0.25 to 0.375	To actively growing grass.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants (Fusilade) or up to 50 days of harvest for Poast.
	sethoxydim (Poast)	0.3 to 0.5		
	pronamide (Kerb)	1 to 2	November	Apply before soil freezes to vines at least 1 year old.
Emerged weeds	Sulfosate (Touchdown)	1 to 2	When weeds are actively growing	Nonbearing vineyard only

WEED CONTROL

STRAWBERRIES

(New and Established Plantings)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Germinating grasses	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.
Annuals	Napropamide (Devrinol)	2 to 4	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.
Emerged grasses	sethoxydim (Poast)	0.2 to 0.46	To actively growing grasses.	Do not apply within 7 days of harvest. Do not apply within 6 weeks following terbacil application.
	fluazifop-butyl (Fusilade DX)	0.25 to 0.375	To actively growing grasses.	Do not apply within 12 months of harvest.

(Established Plantings)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Emerged broadleaved weeds	2,4-D (Weedar 64; 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)	0.1 to 0.3	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', 'Earliglow' and 'Kent' varieties. Do not exceed 1/2 lb Sinbar 80WP/season.

Post-Harvest Disorder Control

R. M. Beaudry and D. R. Dilley
Department of Horticulture, MSU

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 chemical) to retard spoilage." The lettering of this statement must be as large as the other lettering on the container. Furthermore, before treating fruit or shipping previously treated fruit, check to see if importing countries will allow entry for sale. This is especially important given the relatively lengthy storage period of apples. Information on the tolerance level of a number of pre- and postharvest chemicals on apples, pears and cherries for countries around the world is available. The Northwest Horticultural Council (P.O. Box 570, Yakima, WA 98907) sells a publication containing this information.

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, which results from reactions involving a volatile oxidizing substance produced naturally by the fruit. Antioxidant chemicals which are effective against scald are available for use on apple fruit. Treat susceptible varieties of McIntosh, Cortland, Delicious, Greening, Stayman Winesap, Turley Winesap and Rome 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 sometimes treated.

Control

Dip or drench the fruit shortly after harvest with a scald inhibitor. A delay of 2 weeks in storage considerably reduces scald control with chemicals. It should also be noted that there are some restrictions for the export of fruit treated with scald inhibitors, so knowledge of the destination of stored fruit may be an important consideration in the choice of which scald inhibitor to apply.

SUGGESTED CHEMICAL

Diphenylamine (DPA), from Atochem and Shield Brite, is a wettable powder or liquid at 1,000 or 2,000 ppm for warm fruit (50° F or higher) or 2,000 ppm for cold fruit. Apply at least 1,000 ppm to control scald on susceptible varieties including Cortland, Delicious, McIntosh, Mutsu, Rome Beauty, Stayman Winesap and Turley Winesap. An exception is that 2,000 ppm is required for

control on early-picked Delicious. Frequent renewal of DPA in the dip tank or drench and good agitation are essential to offset the DPA removed by the fruit, bins and debris or that which has settled out (DPA is a suspension, not a solution). Treatment with 2,000 ppm is frequently employed to assure an effective concentration of DPA. Test kits for quickly measuring the DPA solution concentration are available from several suppliers, and are useful in efficiently maintaining an adequate level of the scald inhibitor. Avoid levels above 2,000 ppm because of injury and residue hazards. Rome Beauty and Golden Delicious may be damaged at lower levels, i.e. 1,500 ppm. If scald control seems necessary for Jonathan, Idared or Golden Delicious, use 1,000 ppm. It is important to note that DPA tends to 'fix' the green color (chlorophyll) in the skin of apples.

DPA use is not permitted for fruit in Japan and West Germany and Canada is considering withdrawing its use. DPA formulations of differing levels of refinement are available, which may be a factor worth considering when choosing a product.

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.

Control

Dip or drench the harvested apples in a 2.5% solution of calcium chloride containing 20 pounds of actual calcium chloride per 100 gallons of water. The calcium chloride should be either Food Grade or Technical Grade that meets Food Chemical Codex specifications. It may be combined with DPA applied for scald control (see above). The treated fruit should be stored immediately or put under cover to avoid loss of the material (i.e., by rainfall) which must remain on the fruit during the storage period to be effective. The apples must be washed when prepared for use or marketing. Apples with enlarged, poorly corked lenticels, poor finish due to russetting, or mite injury in the calyx cavity may be damaged by calcium chloride. Include fungicide in the treatment solution to minimize the occurrence of fruit rots.

Nematode Management

G. W. Bird and F. W. Warner

Departments of Entomology, and Botany and Plant Pathology

Plant-parasitic nematodes cause significant economic losses in fruit systems as plant pathogens, virus vectors and predisposition agents. The purpose of this information is to provide fruit producers with nematocidal recommendations for nematode management.

All other aspects of nematode control in fruit production are covered in MSU Extension Bulletin E-2419, "Avoidance and Management of Nematode Problems in Tree Fruit Production in Michigan."

APPLE, CHERRY AND PEACH ORCHARDS

PREPLANT APPLICATION

Nematicide	Application rate/acre	Directions and/or Limitations
1,3-D (Telone II)	Broadcast: 30 gal	Apply as a preplant treatment at least 21 days prior to planting into well prepared soil. Soil temperatures should be between 50° and 80° F. Inject to an 8-inch soil depth with shanks spaced 12-24 inches apart. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F or if soil is very wet.
1,3-D and Chloropicrin (Telone C-17)	Broadcast: 35 gal	See information for 1,3-D.
Metham (Busan 1020 and Vapam)	Broadcast: 50-100 gal	Apply as a preplant treatment at least 21 days prior to planting into moist soil. Soil temperatures should be between 40° and 70° F. Inject to a soil depth of 4 inches with blades placed 5 inches apart. Follow immediately with a roller to smooth and compact surface. Light watering or a tarp after rolling helps prevent gas escape. Fumigant should be applied with equal parts water or in a 2 to 1, water to fumigant, ratio.
Fenamiphos (Nemacur 3)	Broadcast: 6 gal	Apply in 20-40 gallons of water to the soil as an emulsion spray. Incorporate immediately following the application.
Oxamyl (Vydate L)	Broadcast: 3-4 gal	Apply in a minimum of 20 gallons of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4-8 inches immediately after application. READ LABEL WARNINGS CAREFULLY.

POST-PLANT TREATMENT

Nematicide	Application rate/acre	Directions and/or Limitations
Fenamiphos (Nemacur 3)	Band: 1.67-3.33 gal	Apply in not less than 10 gallons of water per acre and incorporate immediately either mechanically or with sufficient irrigation. Center the treated band over the tree row with width of 4-6 feet. Do not apply within 72 days of harvest of apples or within 45 days of harvest of cherries or peaches. Do not apply more than 3.33 gallons per acre per site per year. Do not feed cover crops grown in treated orchards to livestock.
Oxamyl (Vydate L)	Foliar Spray: 2 qt	Mix in 100 gallons of water and apply as a dilute spray to foliage. Apply on a 2-3 week schedule for 4 applications. Do not apply to trees that will bear fruit within 12 months of the last application. For nonbearing orchards only.

NEMATODE MANAGEMENT

VINEYARDS AND SMALL FRUIT PLANTINGS

PREPLANT APPLICATION

Nematicide	Application rate/acre	Directions and/or Limitations
1,3-D (Telone II)	Broadcast: 30 gal	Apply as a preplant treatment at least 21 days prior to planting into well prepared soil. Soil temperatures should be between 50° and 80° F. Inject to an 8-inch depth with shanks spaced 12-24 inches apart. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F or if the soil is very wet.
1,3-D and Chloropicrin (Telone C-17)	Broadcast: 35 gal	See information for 1,3-D.
Metham (Busan 1020 and Vapam)	Broadcast: 50-100 gal	Apply as a preplant treatment at least 21 days prior to planting into moist soil. Soil temperatures should be between 40° and 70° F. Inject to a soil depth of 4 inches with blades spaced 5 inches apart. Follow immediately with a roller to smooth and compact surface. Light watering or a tarp after rolling helps prevent gas escape. Fumigant should be applied with equal parts water or in a 2 to 1, water to fumigant, ratio.
Fenamiphos (Nemacur 3)	Grapes —Band: 3 gal Brambles —Band: 2 gal	Apply in 20-40 gallons of water to the soil as an emulsion spray. Incorporate immediately following the application.
Fenamiphos (Nemacur 3)	Strawberries —Band: 0.5-1 gal on 40-in. rows	Apply in 20-40 gallons of water to the soil in a 12-18 inch band over the row and incorporate immediately by cultivation or by sprinkler irrigation prior to transplanting. Do not apply more than 1 application. Do not apply within 110 days of harvest.
Fenamiphos (Nemacur 15G)	Strawberries —Band: 12-18 lb on 40-in. rows	Apply in 12-18 inch band over the row and incorporate immediately by cultivation or by sprinkler irrigation prior to transplanting. Do not apply more than 1 application. Do not apply within 110 days of harvest.
Oxamyl (Vydate L)	Strawberries —Broadcast: 3-4 gal	Apply in a minimum of 20 gallons of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4-8 inches immediately after application. READ LABEL WARNINGS CAREFULLY. Many varieties of strawberries are sensitive to Vydate L.

POST-PLANT TREATMENT

Nematicide	Application rate/acre	Directions and/or Limitations
Fenamiphos (Nemacur 3)	Grapes —Band: 3 gal Brambles —Band: 2 gal	Apply in not less than 10 gallons of water per acre and incorporate immediately either mechanically or with sufficient irrigation. Band width should be 50% of the total area. Do not use more than 3 applications per site per year or exceed 3 gal/acre/site/year for grapes or 2 gal/acre/site/year for brambles. Do not use site for feed or grazing.
Oxamyl (Vydate L)	Strawberries —Band: 13.8 lb on 40-inch rows	Apply in 12 inch band over the row immediately after transplanting and incorporate with cultivation equipment. Apply a second application in a 12 inch band over the row 8 weeks after planting and incorporate. Use only on nursery stock that will not be harvested for fruit within 20 months after the final application.

Wildlife Damage Control in Orchards

Glenn Dudderar
Department of Fisheries and Wildlife

Mouse Damage Control

Habitat Reduction

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

Mouse Guards

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

Repellent Chemicals

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

Poison Baits

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

Diphacinone baits are most effective against pine mice, especially when applied to burrow openings.

Zinc phosphide baits are available from the USDA Animal Damage Control office in St. Johns, Michigan. Consult with your local county Cooperative Extension Service office for details.

Apply zinc phosphide baits at the rate of 6 to 8 lbs/acre treated and diphacinone baits at the rate of 10 lbs/acre treated. If satisfactory control is not achieved by the diphacinone treated baits on the first treatment, a subsequent treatment is advisable two or more weeks after the first treatment. Re-treatment with zinc phosphide treated baits within 90 days of the initial treatment is usually less successful unless the baits are **applied directly to mouse burrows and runways.**

Applications of poison baits should be made in late fall, after the harvest and just prior to the first snowfall. Where mouse populations are large, treatments earlier in the fall may be necessary. The weather should be dry and sunny during application and for at least 3 subsequent days. Where possible, treatment of border areas will reduce the rate of reinfestation by mice into the orchard. If border areas having mouse habitat cannot be treated directly, then bait stations (approximately 1 per 4 trees) should be placed on the edge of the orchard and baited shortly before or after the first permanent snowfall. PVC piping (1 to 1½ inches in diameter) arranged in an upside-down T makes an excellent bait station. The horizontal part of the T should be at least 16 inches long and the vertical section should be tall enough to reach above expected snow depths. Add bait as needed but no more than 1 cup at any one time. **In no case should any poison bait be applied to bare soil or placed in piles.** Such application is less likely to control mice and increases the hazard to non-target animals. Zinc phosphide poses more hazard to non-target birds than mammals and diphacinone poses more hazard to non-target mammals.

Rabbit Damage Control

Habitat Reduction

Thiram will reduce rabbit damage to trees for up to 90 days. Application rates are the same as for mice. A special formulation of ammonium hydroxide (Hinder) is also commercially available and is applied in a 5

*restricted use

percent solution. Durability is a problem. All chemicals should be applied to the point of runoff and to a height of 18 inches above the highest probable depth of snow accumulation. Hinder must be re-applied every 2 weeks or after every rain. Of the three chemical repellents, tests at MSU have shown thiram with a sticker to give the most reliable protection for up to 90 days. Since rabbit damage may begin to occur as early as late summer, begin application as soon as damage is first noticed. Re-treat prior to first snowfall. A third treatment is advisable in late winter where possible.

Population Reduction

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

Ground Squirrel Damage Control

Population Reduction

Ground squirrels, often called gophers, can be eliminated from orchards by trapping and gassing or poison baiting. In small orchards where ground squirrels are burrowing between and under only a few trees, the most economical method to eliminate them is to trap them with rat-sized wooden based snap traps baited with a mixture of peanut butter and oatmeal. Check the traps daily. Trapping can eliminate a few ground squirrels quickly. Another method for eliminating a few squirrels is to insert a 1 gal jug half filled with water onto a ground squirrel burrow immediately after seeing a ground squirrel enter it. In most cases, the squirrel will pop up into the jug.

In larger orchards or where ground squirrel populations are large, burrow gassing or poison baiting is necessary. Zinc phosphide* treated bait is commercially available for ground squirrel control. Tablespoon quantities of baits should be placed in or immediately around all burrows.

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

Porcupine Damage Control

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

Woodchuck Damage Control

Habitat Alteration

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

Population Reduction— Trapping, Gassing, Others

Woodchucks can be trapped by one of three methods. During the months of March and April woodchucks are easy to catch in the familiar wire box traps baited with whole kernel corn, carrots, celery or pieces of apples or potatoes. Once spring green-up occurs, however, woodchucks become more difficult to catch in box traps. Woodchucks can also be caught in a number 1 leg hold trap placed directly in front of the burrow entrance, staked down away from the entrance to prevent the woodchuck from gaining leverage on the edge of the burrow walls and pulling itself free. Old woodchucks may weigh 20 lbs or more and will require a larger trap. Woodchucks may also be trapped by placing a body gripping killer trap (Conibear 160 or 220) directly over the burrow entrance. Unfortunately, any animal attempting to go into the burrow will also be killed by this process.

Woodchucks may be gassed in their burrows with either commercial USDA gas cartridges or aluminum phosphide (Phostoxin)*. With these materials, it is vital that the woodchuck burrows be located early in the spring; and prior to placement of any of the materials, preparation be made to seal the burrow entrances with a piece of inverted sod or other appropriate device. Specific directions for the use of these materials in woodchuck control are found on the labels but the following information is essential. Use at least two commercial cartridges per burrow. When using gas cartridges, wait for approximately 15 minutes after sealing the burrow entrance and look for a plume of smoke emerging from a second burrow entrance. Seal the second entrance as well. Regardless of which material is used, check all burrow entrances within a week of treatment and re-treat any burrow that has been re-opened. Young woodchucks usually leave their mother's den in late June or July thus making springtime gassing far more effective than summer treatment.

*restricted use pesticide

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

Deer Damage Control

Exclusion

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

Specially designed seven wire, high-tensile strength, steel wire electric fences can be used to repel deer efficiently, but must be erected exactly as specified. Voltage must exceed 4,000 volts over the entire fence. Vegetation control along the fences to prevent shorting is also essential. Where deer are numerous, it is usually necessary to obtain a kill permit from the DNR to eliminate any deer which get inside the fence. Fences must be checked regularly and the lower wire disconnected when buried by snow. Sources of designs for deer fences can be obtained from county Extension offices.

Repellent Chemicals

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

- a. Feather meal
- b. Tankage or meat meal
- c. Soap bars
- d. Putrescent whole egg solids (Deer-Away)
- e. Ammonium hydroxide (Hinder)
- f. Capsicum (Miller's Hot Sauce)
- g. Thiram (Selco, Pratt's, Science)
- h. Denatonum benzoata (Tree Guard)
- i. Garlic (Plant Pro-Tec)

Feather meal, meat meal and putrescent whole egg solids are the most effective repellents in fruit areas, but each has certain limitations that must be accounted for if they are to be effective. Use feather meal and tankage during the warm months of the year. They provide protection for at least thirty days, but usually no more than 60 to 90 days. Place two to three teaspoons of feather meal or tankage in small cloth bags. Hang one bag or one small bar of soap on at least 2 sides on each tree in the orchard. Inspect the orchard every 30 days for damage and if damage resumes, reapply fresh materials. Do not hang soap bars near the trunk of the tree. Mice will be attracted to the fat in the dissolved soap as it runs down the trunk.

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

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

Population Reduction

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

Bird Damage Control

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

Repellent Devices and Chemicals

Propane exploding cannons, broadcast recordings of alarm and distress cries and electronic broadcasting devices (Av-Alarm), two-stage exploding 12 gauge

shotgun cartridges, and bird scare balloons can be used effectively to repel birds from fruit. To be effective, however, all these devices must be used in sufficient numbers and varied frequently in both location and rate operation. Maximum effectiveness will be achieved by using two or more of these devices in combination. Birds will become accustomed to and ignore a routine, unvaried application of any or all of these devices.

Mylar bird scare tape—shiny silver on one side and shiny red on the other—tends to control bird flocks, when placed over the top of trees or vineyards. It is more effective when used in conjunction with other scare tactics.

Methyl anthranilate (ReJeX-iT) can be sprayed on cherries, grapes,* and blueberries* to repel birds. The effectiveness of methyl anthranilate is enhanced by using it in conjunction with frightening devices (cannons, scare-shells, recording broadcasts, etc.) and trapping.

Population Reduction

Large decoy traps baited with a variety of moist foods such as apples, cherries, blueberries, lettuce and potatoes can be used to catch large numbers of birds efficiently. Decoy traps appear to be most effective if operated in the spring when birds first appear in the

orchard. If operation is begun during the ripening process the trap may not trap birds as efficiently as it attracts them and may result in increased damage, especially where birds are extremely numerous.

When protected species are trapped they can be released unharmed. If the protected species causing damage are released north of the orchard in early spring and south of the orchard in mid-summer, they usually do not return to cause damage. Where possible traps should be made portable so that they can be moved to the places where they are most needed and will be most effective.

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

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

USDA Animal Damage Control Office
2043 W. Maple Rapids
St. Johns, MI 48879 (517) 224-9517

The USDA ADC office will, in addition, provide technical assistance.

*registration expected in 1997

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. Consult product label.

FUNGICIDES

Chemical	Apples	Pears	Peaches	Plums and Prunes	Cherries	Grapes	Strawberries	Raspberries	Blueberries
Aliette							0	60	0
Bayleton	45					14			
Benomyl (Benlate)	14	14	3	3	3	70	1	3	21
Benomyl + Captan	14		3	3	3	70	1		21
Bravo			d	d	d				42f
Captan	0		0c	0	0c	0	0		0
Carbamate (Ferbam)	7	7	21		0	7			40
Copper (copper-lime mixtures)	b	b			b	b	b	b	
Dinocap (Karathane)	21					21	21	7	
Dithane FZ						7			
Dodine (Syllit)	7		15		0		14		
Elite			0		0				
Folpet (Phaltan)						0			0
Indar			0		0				
Mancozeb	77	77				66			
Nova (myclobutanil)	14		7		7	14			
Orbit			0	0	0				
Procure	14	14				7			
Ridomil (Mancozeb or copper mixtures)						66			
Ridomil (soil application only)							0e	45	0
Ronilan			10		10		0	9	
Rovral			7	7	7	0	0	0	
Rubigan	30	30			0	30			
Streptomycin	50	30							
Sulfurs	b		b	b	b				
Thiram (Thylate)	0		7				3a		
Topsin-M	0		1	1	1		0		
Ziram	14	14	14		14	21			

¹Application of Funginex after fruit formation has occurred may result in russetting of fruit.

Legend:	a	=	No residue if used according to recommendations.
	b	=	Sulfurs and copper plus lime mixtures are exempt if used as recommended.
	c	=	May be used as Post-harvest treatment—See label.
	d	=	Do not apply after shuck split and before harvest.
	e	=	Foliar application allowed on Strawberry.
	f	=	Do not apply after petal fall.

Days Between Final Spray and Harvest, continued

INSECTICIDES

Chemical	Apples	Pears	Peaches	Plums and Prunes	Cherries	Grapes	Straw- berries	Rasp- berries	Blue- berries
Agri-Mek	28	21							
Ambush	f	14	7		3				
Apollo	h		21	21	21				
Asana	21	28	14	14	14				
Biobit	0	0	0	0	0	0	0	0	0
Carzol	7c	7c							
Crymax	0	0	0	0	0	0	0	0	0
Cythion ULV					1	7			0
Diazinon	14	14	20	10	10	10	5	7	7
Dimethoate (Cygon)	28	28							
Dipel	0	0	0	0	0	0	0	0	0
Guthion WP	7	7	21	15	15	10	5	14	7
Guthion 3F	7	7			21				
Imidan	7c	7c	14c	7	7	7			3
Javelin	0	0	0	0	0	0	0	0	0
Kelthane	7	7				7	2		
Lannate	14c		4			14g			3
Lorsban	28		14		14				
Malathion	3	1	7	3	3	3	3	1	0-1c
Methoxychlor	7	7	21	7	7	14		3	14
Mitac		7							
Morestan	35c	35c	a, b	a, b	a, b				
Penncap-M	14	14	14	14	14	14			
Phosphamidon	30				c				
Pounce	f	14	7		3				
Provado	7					0			
Savey	i	28							
Sevin	1	1	1	1	1	7	1	7	0
Superior oil	b	b	b	b	b	b	b	b	b
Thiodan	21c	7e	30c	7c	21c	7	4c		
Vendex	14c	14c	14	14	14	28	1		
Vydate L	14	14							

Legend: a = Not after fruit begins to form.
 b = No residue if used according to recommendations.
 c = See label restrictions on use.
 d = Remove excess residues at harvest.
 e = 21 days if only 2 sprays are applied.
 f = Do not apply after petal fall.
 g = Lannate phi is 1 day for fresh grapes.
 h = Do not apply Apollo after tight cluster.
 i = Do not apply Savey after pink.

Toxicity of Pesticides Used on Fruits

FUNGICIDES

Chemical	LD50 mg/kg ¹		Runoff ² Potential	Leaching ² Potential	Restricted Entry Interval ³
	oral	dermal			
Aliette (fosetyl-AL)	>5000	>2000	3	3	12-24 hrs
Bayleton (triadimefon)	569	>2000	2	2	12 hrs
Benlate (benomyl)	>10,000	>10,000	1	3	24 hrs
Botran (dicloran)	>5000	—	2	3	12 hrs
Bravo (chlorothalonil)	>10,000	10,000	1	3	48 hrs
Captan (captan)	8400-15,000	—	2	3	1-4 days
Carbamate (ferbam)	>17,000	—	2	2	24 hrs
Champ (copper hydroxide)	1000	—	—	—	48 hrs
Copper Sulfate (copper sulfate) ...	472	—	—	—	24 hrs
Dithane M-45 (mancozeb)	4500-11,200	5,000-15,000	1	3	24 hrs
Funginex (triforine)	>2000	>2000	2	3	12 hrs
Indar (fenbuconazole)	>2000	>5000	—	—	12 hrs
Kocide 101 (copper hydroxide) ...	1000	—	—	—	48 hrs
Manzate 200 (mancozeb)	4500-11,200	5,000-15,000	1	3	24 hrs
Mertect (thiabendazole)	3100	—	1	3	12 hrs
Microthol Special	—	—	—	—	24 hrs
Nova (myclobutanil)	1600	>5000	1	2	24 hrs
Orbit (propiconazole)	1517	>4000	1	2	24 hrs
Penncozeb (mancozeb)	11,200	>15,000	1	3	24 hrs
Polyram (metiram)	2850-10,000	>2000	1	3	24 hrs
Procure (triflumizole)	1057-1780	>5000	2	2	24 hrs
Ridomil (metalaxyl)	669	>3100	2	1	12 hrs
Ronilan (vinclozolin)	>10,000	>2000	2	2	12 hrs
Rovral (iprodione)	3500	>2000	2	3	12 hrs
Rubigan (fenarimol)	2500	—	1	1	12 hrs
Streptomycin (streptomycin)	9000	—	—	—	12 hrs
Syllit (dodine)	1000	>1500	1	3	48 hrs
Thiram (thiram)	560-1000	>5000	2	3	SL
Topsin-M (thiophanate-methyl) ...	7500	—	2	3	12 hrs
Wettable Sulfur (sulfur)	—	—	—	—	24 hrs
Ziram (ziram)	1400	>6000	2	2	48 hrs

HERBICIDES

Chemical	LD50 mg/kg ¹		Runoff ² Potential	Leaching ² Potential	Restricted Entry Interval ³
	oral	dermal			
2,4-D	375-666	1400	2	2	12-48 hrs
Casoron (dichlobenil)	>3160	1350	1	2	12 hrs
Dacthal (DCPA)	3000-12,500	>10,000	1	3	24 hrs
Devinol (napropamide)	>500	>5000	1	2	12 hrs
Fusilade DX (fluazifop-butyl)	2451-3680	2450	1	3	12 hrs
Gallery (isoxaben)	>10,000	—	1	3	12 hrs
Goal (oxyfluorfen)	>5000	>10,000	1	3	24 hrs
Gramoxone Extra (paraquat)	20-150	236-325	1	3	12 hrs
Karmex (diuron)	1017-3750	>5000	1	2	12 hrs
Kerb (pronamide)	5620-8350	>3160	2	1	12 hrs
Poast (sethoxydim)	2676-3125	>5000	2	3	12 hrs
Princep (simazine)	3200-3500	>5000	2	1	12 hrs
Pentagon (pendimethalin)	2956	>2000	1	3	12 hrs
Rely	—	—	—	—	12 hrs
Roundup Ultra (glyphosate)	5000	>5000	1	3	12 hrs
Sinbar (terbacil)	5000-7500	>5000	2	1	12 hrs
Solicam (norflurazon)	>8000	>20,000	1	2	12 hrs
Surflan (oryzalin)	>5000	>2000	2	3	12 hrs
Touchdown (sulfosate)	750	>200	—	—	12 hrs
Velpar (hexazinone)	1690	5278	2	1	24 hrs

¹The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD₅₀ data have been obtained from the Farm Chemical Handbook and the EXTOKNET notebook. LD₅₀ values for the technical product were used when possible. Oral LD₅₀ values are for rats and dermal LD₅₀ values are for rabbits.

²The runoff/leaching potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the SCS "Soil-Pesticide Interaction Ratings." 1 = high, 2 = medium, 3 = low.

³Restricted Entry Interval for the Worker Protection Standard. SL = See Label. Some REIs vary by crop, always check the label.

INSECTICIDES

Chemical	LD50 mg/kg ¹		Runoff ² Potential	Leaching ² Potential	Restricted Entry Interval ³
	oral	dermal			
Agrimek (abamectin)	11	>330	1	3	12 hrs
Ambush (permethrin)	430-4000	>2000	1	3	24 hrs
Apollo (clofentezine)	>5000	>2400	1	3	12 hrs
Asana (esfenvalerate)	458	2000	1	3	12 hrs
Carzol (formetanate)	20	>10,200	1	3	48 hrs
Cythion ULV (malathion)	480-10,700	>2000	3	3	12 hrs
Diazinon (diazinon)	2.75-450	3600	1	3	24 hrs
Dimethoate (Cygon) (dimethoate) ...	60-387	400	3	2	2-4 days
Furadan (carbofuran)	5	885	3	1	48 hrs
Guthion (azinphos-methyl)	4.4-16	200	2	3	48 hrs
Imidan (phosmet)	113-369	1560-4640	2	3	24 hrs
Kelthane (dicofol)	575-960	2000-5000	1	3	12 hrs
Lannate (methomyl)	12-48	5880	2	1	2-7 days
Lorsban (chlorpyrifos)	82-270	1000-2000	1	3	24 hrs
Malathion (malathion)	480-10,700	>2000	3	3	12 hrs
Methoxychlor (methoxychlor)	5000-6000	—	1	3	12 hrs
Mitac (amitraz)	800	>200	2	3	24 hrs
Morestan (oxythioquinox)	1500	>5000	1	3	24 hrs
Pennacap-M (methyl parathion)	18-50	300	2	3	48 hrs
Pounce (permethrin)	430-4000	>2000	1	3	12 hrs
Provado	—	—	—	—	—
Sevin (carbaryl)	250-850	>2000	2	3	12 hrs
Sunspray (Superior Oil)	—	—	—	—	12 hrs
Thiodan (endosulfan)	18-220	200-359	1	3	24 hrs
Vendex (fenbutatin-oxide)	2631	>2000	1	3	48 hrs
Vydate L (oxamyl)	5.4	2960	3	3	48 hrs

PLANT GROWTH REGULATORS

Chemical	LD50 mg/kg ¹		Runoff ² Potential	Leaching ² Potential	Restricted Entry Interval ³
	oral	dermal			
Accel	—	—	—	—	12 hrs
Ethephon	4229	—	1	3	48 hrs
Gibberellic Acid	1500	—	—	—	12 hrs
Naphthalene Acetamide (NAD)	1690	2000	—	—	48 hrs
Naphthalene Acetic Acid (NAA)	2520	—	3	2	12-48 hrs
Promalin	1500	—	—	—	12 hrs

NEMATICIDES

Chemical	LD50 mg/kg ¹		Runoff ² Potential	Leaching ² Potential	Restricted Entry Interval ³
	oral	dermal			
Nemacur (fenamiphos)	2-19	200	2	1	48 hrs
Telone C-17 (dichloropropene and chloropicrin)	—	—	3	2	72 hrs
Telone II (dichloropropene)	224	333	3	2	72 hrs
Vapam	—	—	3	2	48 hrs
Vydate (oxamyl)	5.4	2960	3	3	48 hrs

¹The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD₅₀ data have been obtained from the Farm Chemical Handbook and the EXTTOXNET notebook. LD₅₀ values for the technical product were used when possible. Oral LD₅₀ values are for rats and dermal LD₅₀ values are for rabbits.

²The runoff/leaching potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the SCS "Soil-Pesticide Interaction Ratings." 1 = high, 2 = medium, 3 = low.

³Restricted Entry Interval for the Worker Protection Standard. SL = See Label. Some REIs vary by crop, always check the label.

Pesticide List for Recordkeeping Requirements

The following list contains trade name, common name, manufacturer, EPA registration number, restricted entry interval, runoff potential and leaching potential. The list was prepared to provide growers a convenient place to find information for pesticide recordkeeping requirements. This is a partial list of the commonly used pesticides on fruit crops in Michigan and is not intended to be a complete list. It will be the grower's responsibility to confirm the registration number and Restricted Entry Interval (REI) for the specific pesticide used by checking the label attached to the package.

FUNGICIDES

Trade Name	Common Name	Manufacturer	EPA Reg #	REI ¹	Runoff/Leaching Potential ²
Agri-Mycin 17 Ag	streptomycin	Merck	618-101	12 hrs	-/-
Aliette 80 WDG	fosetyl-AI	Rhone-Poulenc	264-516	12 hrs	3/3
Aliette Fungicide	fosetyl-AI	Rhone-Poulenc	264-467	24 hrs	3/3
AS-50 Ag Strep.	streptomycin	Merck	618-100	12 hrs	-/-
Bayleton 50 WP	triadimefon	Bayer	3125-320	12 hrs	2/2
Benlate 50 WP	benomyl	DuPont	352-354	24 hrs	1/3
Botran 75W	dicloran	Gowan	10163-189	12 hrs	2/3
Bravo 500	chlorothalonil	ISK Biotech	50534-8	48 hrs	1/3
Bravo 720	chlorothalonil	ISK Biotech	50534-188	48 hrs	1/3
Captan 50 WP	captan	Platte	34704-427	24 hrs-4 days	2/3
Captan 50 WP	captan	Micro-Flo	51036-166	24 hrs-4 days	2/3
Captan 80 WP	captan	Micro-Flo	51036-168	24 hrs-4 days	2/3
Captan 80 WP	captan	Micro-Flo	51036-181	24 hrs-4 days	2/3
Captan 80 WP	captan	Micro-Flo	51036-181	24 hrs-4 days	2/3
Captan 80 WP	captan	Micro-Flo	51036-181	24 hrs-4 days	2/3
Carbamate 76 WP	ferbam	UCB Chemical	45728-7	24 hrs	2/2
Champ Formula 2	copper hydroxide	Agtrol	55146-64	48 hrs	-/-
Champ Formula II	copper hydroxide	Agtrol	55146-57	48 hrs	-/-
Copper Sulfate	copper sulfate	Griffin	1812-314	24 hrs	-/-
Dithane M-45	mancozeb	Rohm & Haas	707-78	24 hrs	1/3
Elite 45 DF	tebuconazole	Bayer	3125-388	12 hrs	-/-
Funginex 18.2 EC	triforine	Ciba	100-721	12 hrs	2/3
Indar	fenbuconazole	Rohm & Haas	707-239	12 hrs	-/-
Kocide 101	copper hydroxide	Griffin	1812-288	48 hrs	-/-
Manzate 200 DF	mancozeb	DuPont	352-449	24 hrs	1/3
Mertect 340-F	thiabendazole	Merck	618-75	12 hrs	1/3
Microthiol Special 8 WPS	sulfur	Elf Atochem	4581-373	24 hrs	-/-
Mycoshield Ag Terramycin	oxytetracycline	Merck	618-104	12 hrs	-/-
Nova 40 W	myclobutanil	Rohm & Haas	707-221	24 hrs	1/2
Orbit 41.8%	propiconazole	Ciba	100-702	24 hrs	1/2
Penncozeb 80 WP	mancozeb	Elf Atochem	4581-358	24 hrs	1/3
Penncozeb 75 DF	mancozeb	Elf Atochem	4581-370	24 hrs	1/3
Polyram 80 W	metiram	BASF	7969-70	24 hrs	1/3
Procure 50 WS	triflumizole	Uniroyal	400-431	12 hrs	2/2
Ridomil 2 E	metalaxyl	Ciba	100-607	12 hrs	2/1
Ridomil 5 G	metalaxyl	Ciba	100-628	12 hrs	2/1
Ronilan 50 WP	vinclozolin	BASF	7969-53	12 hrs	2/2
Ronilan FL	vinclozolin	BASF	7969-62	12 hrs	2/2
Ronilan 50 DF	vinclozolin	BASF	7969-85	12 hrs	2/2
Rovral 50 WP	iprodione	Rhone-Poulenc	264-453	12 hrs	2/3
Rovral 4 F	iprodione	Rhone-Poulenc	264-482	12 hrs	2/3
Rubigan 1 EC	fenarimol	DowElanco	62719-134	12 hrs	1/1
Syllit 65 W	dodine	Platte	264-508-34704	48 hrs	1/3
Thiram 75 WP	thiram	Micro-Flo	51036-53	SL	2/3
Topsin-M 70 WSB	thiophanate-methyl	Elf Atochem	4581-322	12 hrs	2/3
Wettable Sulfur 90 WP	sulfur	Micro-Flo	51036-14	24 hrs	-/-
Ziram WP	ziram	Platte	34704-67	SL	2/2
Ziram 76 DF	ziram	Elf Atochem	4581-140	48 hrs	2/2

HERBICIDES

Casoron 4 G	dichlobenil	Uniroyal	400-168	12 hrs	1/2
Dacthal 75 WP	DCPA	ISK Biotech	50534-1	24 hrs	1/3
Devrinol 50 DF	napropamide	Zeneca	10182-258	12 hrs	1/2
Formula 40	2,4-D	Rhone Poulenc	62719-1-264	48 hrs	2/2
Fusilade DX	Fluazifop-butyl	Zeneca	10182-367	12 hrs	1/3
Gallery 75 DF	isoxaben	DowElanco	62719-145	12 hrs	1/3
Goal 1.6 E	oxyfluorfen	Rohm & Haas	707-174	24 hrs	1/3
Gramoxone Extra	paraquat	Zeneca	10182-280	12 hrs	1/3
Hi Dep	2,4-D	PBI-Gordon	2217-703	48 hrs	2/2
Karmex 80 DF	diuron	DuPont	352-508	12 hrs	1/2
Kerb 50 WP	pronamide	Rohm & Haas	707-159	12 hrs	2/1
Pentagon WG	pendimethalin	American Cyanamid	241-268	12 hrs	1/3
Poast	sethoxydim	BASF	7969-58	12 hrs	2/3
Princep 90 WG	simazine	Ciba	100-603	12 hrs	2/1
Princep 4 L	simazine	Ciba	100-526	12 hrs	2/1
Prowl 3.3 EC	pendimethalin	American Cyanamid	241-337	12 hrs	1/3
Rely	glufosinate	AgrEvo	45639-187	12 hrs	2/3
Roundup Ultra	glyphosate	Monsanto	524-475	4 hrs	1/3
Savey 50 WP	hexythiazox	Gowan	10163-208	12 hrs	1/3
Sinbar 80 WP	terbacil	DuPont	352-317	12 hrs	2/1
Snapshot 80 DF	isoxaben				
	+ oryzalin	DowElanco	62719-174	12 hrs	1/3
Solicam 80 DF	norflurazon	Sandoz Agro	55947-78	12 hrs	1/2
Surflan 75 W	oryzalin	DowElanco	62719-110	12 hrs	2/3
Surflan AS	oryzalin	DowElanco	62719-112	12 hrs	2/3
Touchdown 6 E	sulfosate	Zeneca	10182-324	12 hrs	-/-
Velpar 90 SP	hexazinone	DuPont	352-378	24 hrs	2/1
Weedar 64	2,4-D	Rhone-Poulenc	264-2	48 hrs	2/2

¹REI = Restricted Entry Interval, SL = See Label. Some REIs vary by crop, always check the label.

²The runoff/leaching potential ratings are from the ARS/NRCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the NRCS "Soil-Pesticide Interaction Ratings." 1 = high, 2 = medium, 3 = low.

(Continued)

Pesticide List for Recordkeeping Requirements (continued)

INSECTICIDES

Trade Name	Common Name	Manufacturer	EPA Reg #	REI ¹	Runoff/Leaching Potential ²
Agri-Mek 0.15 EC	avermectin B1 and abamectin	Merck	618-98	12 hrs	-/-
Ambush 2 EC	permethrin	Zeneca	10182-18	24 hrs	1/3
Ambush 25 WP	permethrin	Zeneca	10182-35	24 hrs	1/3
Apollo SC	clofentezine	AgrEvo	45639-135	12 hrs	1/3
Asana XL	esfenvalerate	DuPont	352-515	12 hrs	1/3
Azinphos-Methyl 50	azinphos-methyl	Micro-Flo	51036-164	48 hrs	2/3
Biobit WP	<i>Bt var. kurstaki</i>	Abbott	58998-1	4 hrs	-/-
Carbaryl 4 L	carbaryl	Platte	34704-447	12 hrs	2/3
Carbaryl 80 WP	carbaryl	Micro-Flo	51036-151	12 hrs	2/3
Carzol 92 SP	formetanate	AgrEvo	45639-163	48 hrs	1/3
Cygon 400	dimethoate	American Cyanamid	241-233	4 days	3/2
Cythion ULV	malathion	American Cyanamid	241-208	12 hrs	
Diazinon 50 WP	diazinon	Ciba	100-460	24 hrs	1/3
Diazinon AG 500	diazinon	Micro-Flo	51036-71	24 hrs	1/3
Diazinon 50 W	diazinon	Micro-Flo	51036-108	24 hrs	1/3
Dimethoate 400	dimethoate	Platte	34704-207	48 hrs	3/2
Dimethoate 2.67 EC	dimethoate	Platte	34704-489	48 hrs	3/2
Dipel	<i>Bt var. israelensis</i>	Abbott	275-18	12 hrs	-/-
Guthion 2 S	azinphos-methyl	Bayer	3125-123	48 hrs	2/3
Guthion Solupak 50 WP	azinphos-methyl	Bayer	3125-301	48 hrs	2/3
Guthion 50 WP	azinphos-methyl	Bayer	3125-193	48 hrs	2/3
Guthion 3 F	azinphos-methyl	Bayer	3125-338	48 hrs	2/3
Imidan 50 WP	phosmet	Gowan	10163-166	24 hrs	2/3
Imidan 70 WP	phosmet	Gowan	10163-169	24 hrs	2/3
Javelin WG	<i>Bt</i>	Sandoz	55947-136	12 hrs	-/-
Kelthane 35 WP	dicofol	Rohm & Haas	707-205	12 hrs	1/3
Kelthane MF	dicofol	Rohm & Haas	707-202	12 hrs	1/3
Lannate 90 SP	methomyl	DuPont	352-342	2-7 days	2/1
Lannate 2.4 LV	methomyl	DuPont	352-384	2-7 days	2/1
Lorsban 50 WP	chlorpyrifos	DowElanco	62719-39	24 hrs	1/3
Lorsban 4 EC	chlorpyrifos	DowElanco	62719-23	24 hrs	1/3
Malathion 25 WP	malathion	Micro-Flo	51036-33	12 hrs	3/3
Methoxychlor 2 EC	methoxychlor	Platte	34704-102	12 hrs	1/3
Mitac 1.5 EC	amitraz	AgrEvo	45639-49	24 hrs	2/3
Mitac 50 WP	amitraz	AgrEvo	45639-61	24 hrs	2/3
Morestan 25 WP	oxythioquinox	Bayer	3125-302	24 hrs	1/3
Pennacp-M	encapsulated methyl parathion	Elf Atochem	4581-292	48 hrs	2/3
Pounce 25 WP	permethrin	FMC	279-3051	12 hrs	1/3
Pounce 3.2 EC	permethrin	FMC	279-3014	12 hrs	1/3
Provado	imidacloprid	Bayer	3125-457	12 hrs	-/-
Sevin 80 S	carbaryl	Rhone-Poulenc	264-316	12 hrs	2/3
Sevin XLR	carbaryl	Rhone-Poulenc	264-333	12 hrs	2/3
Sevin 50 WP	carbaryl	Rhone-Poulenc	264-314	12 hrs	2/3
Sevin 4 F	carbaryl	Rhone-Poulenc	264-349	12 hrs	2/3
Sunspray 6 E	superior oil	Sun	862-11	12 hrs	-/-
Sunspray Ultra-fine Spray Oil	superior oil	Sun	862-23	4 hrs	-/-
Supracide 2 E	methidathion	Ciba	100-501	2-14 days	2/3
Thiodan 50 WP	endosulfan	FMC	279-1380	24 hrs	1/3
Vendex 50 WP	fenbutatin-oxide	DuPont	352-480	48 hrs	1/3
Vydate L	oxamyl	DuPont	352-372	48 hrs	3/1

PLANT GROWTH REGULATORS

Accel	GBA + GA	Abbott	275-92	12 hrs	-/-
Amid-thin-W	NAA	Amvac	5481-426	48 hrs	3/2
Ethrel	ethephon	Rhone-Poulenc	264-267	48 hrs	1/3
Fruitone N	NAA	Amvac	5481-427	48 hrs	3/2
K-Salt Fruit Fix 800	NAA	Amvac	5481-413	24 hrs	3/2
K-Salt Fruit Fix 200	NAA	Amvac	5481-414	24 hrs	3/2
Pro-Vide	gibberellic acid	Abbott	275-2	12 hrs	-/-
Promalin	gibberellins	Abbott	275-32	12 hrs	-/-
Tre-Hold	NAA	Amvac	5481-429	12 hrs	3/2

NEMATICIDES

Nemacur 3 S	fenamiphos	Bayer	3125-283	48 hrs	2/2
Nemacur 15G	fenamiphos	Bayer	3125-236	48 hrs	2/2
Telone II	dichloropropene	DowElanco	62719-32	72 hrs	3/1
Telone C-17	dichloropropene and chloropicrin	DowElanco	62719-12	72 hrs	3/1
Vapam	metam-sodium	Zeneca	19182-150	48 hrs	3/2
Vydate L	oxamyl	DuPont	352-372	48 hrs	3/1

¹REI = Restricted Entry Interval, SL = See Label. Some REIs vary by crop, always check the label.

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Notes:

Restricted Use Pesticide Recordkeeping Form

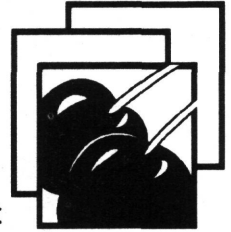
Month/ Day/ Year	Commodity, stored prod., or crop	Pesticide trade name, EPA registration number	Total amt. applied	Location of application	Applicator's name & certification number	Size of area treated
	Notes*					
Month/ Day/ Year	Commodity, stored prod., or crop	Pesticide trade name, EPA registration number	Total amt. applied	Location of application	Applicator's name & certification number	Size of area treated
	Notes*					
Month/ Day/ Year	Commodity, stored prod., or crop	Pesticide trade name, EPA registration number	Total amt. applied	Location of application	Applicator's name & certification number	Size of area treated
	Notes*					

*Notes are optional and could include information such as wind speed & direction, weather, crop status, pest development stage & population density, soil type, equipment used, etc.

Notes:

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New subscribers can use this form to subscribe for mail or FAX service. (Previous subscribers are sent a renewal mailing in February.) For FAX service, each issue is FAX-ed to our subscribers during the night following the day that the issue is written. For example, the *CAT Alert* team writes the fruit edition on Tuesday and it is FAX-ed to subscribers on Tuesday evening throughout the night. This means that you receive the issue two to three days faster than mail delivery. In addition, FAX subscribers will have access to a toll-free phone number to request that weather information and certain Extension Bulletins be FAX-ed to them.

Send your subscription in any time during the year, but please note that **the first issue will not arrive until April**. We'll send back issues from the current publishing year, if you subscribe after the start of the season.

Editions available on other crops

Editions of *the Alert* are also available for: field crops, vegetables, and landscape/Christmas trees.

1997 CAT Alert Subscription Form

Name _____ Address _____ _____ City, State _____ Zip code(9 digit) _____ County _____ Phone (_____) _____ FAX (if ordering FAX service) (_____) _____	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Fruit CAT Alert</td> <td style="width: 10%; text-align: right;">mail - \$30</td> <td style="width: 20%; text-align: right;">\$ _____</td> </tr> <tr> <td>(must have 9600 baud or faster)</td> <td style="text-align: right;">FAX - \$70</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>Field Crop CAT Alert</td> <td style="text-align: right;">mail - \$30</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>(must have 9600 baud or faster)</td> <td style="text-align: right;">FAX - \$70</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>Vegetable CAT Alert</td> <td style="text-align: right;">mail - \$30</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>(must have 9600 baud or faster)</td> <td style="text-align: right;">FAX - \$70</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>Landscape CAT Alert</td> <td style="text-align: right;">mail - \$30</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td>(must have 9600 baud or faster)</td> <td style="text-align: right;">FAX - \$70</td> <td style="text-align: right;">\$ _____</td> </tr> <tr> <td style="text-align: right;">Total amount enclosed</td> <td></td> <td style="text-align: right;">\$ _____</td> </tr> </table>	Fruit CAT Alert	mail - \$30	\$ _____	(must have 9600 baud or faster)	FAX - \$70	\$ _____	Field Crop CAT Alert	mail - \$30	\$ _____	(must have 9600 baud or faster)	FAX - \$70	\$ _____	Vegetable CAT Alert	mail - \$30	\$ _____	(must have 9600 baud or faster)	FAX - \$70	\$ _____	Landscape CAT Alert	mail - \$30	\$ _____	(must have 9600 baud or faster)	FAX - \$70	\$ _____	Total amount enclosed		\$ _____
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Landscape CAT Alert	mail - \$30	\$ _____																										
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Total amount enclosed		\$ _____																										

Make check payable to **Michigan State University**. Send your check and this form to: CAT Alerts, Room 11 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039 (Phone 517-432-2203).



PESTICIDE EMERGENCY INFORMATION

For any type of an emergency involving a pesticide, immediately contact the following emergency information center for assistance.

Current as of January 1996



Human Pesticide Poisoning

MICHIGAN POISON CONTROL SYSTEM

From anywhere in Michigan, call

1 - 8 0 0 - P O I S O N - 1
1 - 8 0 0 - 7 6 4 - 7 6 6 - 1

Special Pesticide Emergencies

Animal Poisoning

Your veterinarian:

Phone No.

or

Animal Health Diagnostic Laboratory (Toxicology) Michigan State University:

(517) 355-0281

Phone No.

and

Fire Marshal Division, Michigan State Police: M - F: 8-12, 1-5

(517) 322-5847

* Telephone Number Operated 24 Hours

Pesticide Fire

Local fire department:

Phone No.

and

Operations Division, Michigan State Police:

***(517) 336-6605**

Traffic Accident

Local police department or sheriff's department:

Phone No.

and

For environmental emergencies:

***1-800-292-4706**

also

***1-800-405-0101**

Michigan Department of Agriculture Spill Response

Environmental Pollution

Pollution Emergency Alerting System (PEAS), Michigan Department of Environmental Quality:

Pesticide disposal information

Michigan Department of Environmental Quality, Waste Management Division.

Monday - Friday: 8 a.m.-5 p.m.

(517) 373-2730

National Pesticide Telecommunications Network

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Texas Tech University Health Services Center.

Monday - Friday:

8:00 a.m. - 6:00 p.m. Central Time Zone

1-800-858-7378

1997

JANUARY

S	M	T	W	T	F	S
			1	2	3	4
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JULY

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NOVEMBER

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JUNE

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DECEMBER

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21	22	23	24	25	26	27
28	29	30	31			

Fungicides

Insecticides

Tree Fruit

Apples

Pears

Peaches-Nectarines

Prunes-Plums

Red Tart Cherries

Sweet Cherries

Small Fruit

Grapes

Strawberries

Brambles

Blueberries

Growth Regulators

Herbicides

Nematicides

Wildlife Control

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