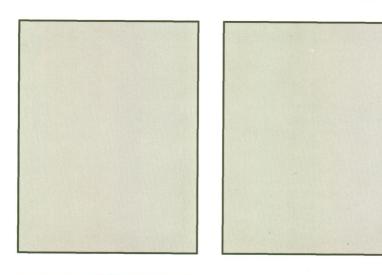
FOR COMMERCIAL FRUIT GROWERS



Michigan Fruit Management Guide

(formerly Fruit Spraying Calendar)

2004

Available on the Internet at: www.msue.msu.edu/epubs/pestpubs/E154/index.htm

MICHIGAN STATE UNIVERSITY **EXTENSION**

Extension Bulletin E-154, Information Current as of November 1, 2003, Revised Annually, Destroy Previous Editions

Fruit Extension and Research 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	Region and District Agent	Code-A-Phone Numbers
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http://www.msue.msu.edu/vanburen/disthort.htm Al Gaus Berrien County Horticulture Agent Berrien County Extension 1737 Hillandale Road Benton Harbor, MI 49022 Voice: (269) 944-4126, Fax: (269) 982-8666 http://www.msue.msu.edu/berrien/hort/	(269) 944-4126 ext. 1	Duke Elsner Agriculture and Natural Resources Agent Grand Traverse County 2200 Dendrinos Drive S7 Traverse City, MI 49686 (231) 922-4620, Fax: (231) 922-4636 Andy Norman Coordinator-MSU-NMC Plant Science Program District Turfgrass Agent	
Bill Shane District Fruit Agent SW Michigan Research and Extension Center 1791 Hillandale Road Benton Harbor, MI 49022	(269) 944-1477 ext. 4	2200 Dendrinos Drive S100 Traverse City, MI 49684 (231) 929-3902 or (800) 689-6857 Fax: (231) 929-3902	
(269) 944-1477 (Ext. 205), Fax: (269) 944-3106 <u>http://www.msue.msu.edu/swmrec</u> John Wise TNRC Research and Extension Coordinator Trevor Nichols Research Complex 6237 124 th Avenue Fennville, MI 49408 (269) 561-5040, Fax: (269) 561-5314		Jim Nugent District Horticultural and Marketing Agent Northwest Michigan Horticulture Research Station 6686 Center Highway Traverse City, MI 49684 (231) 946-1510, (888) 749-3019 Fax: (231) 946-1404 http://www.maes.msu.edu/nwmihort	
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WEST CENTRAL Mira Bulatovic-Danilovich, District Horticultural and Marketing Agent Oceana Co. Extension Office 210 Johnson Street Hart, MI 49420 (231) 873-2129, Fax: (231) 873-3710 email: <u>bulatovi@msue.msu.edu</u>	(888) 345-0515	(810) 732-2177, Fax: (810) 732-1400 email: <u>tritten@msue.msu.edu</u> <u>http://www.msue.msu.edu/genesee/</u>	
Carlos Garcia-Salazar West-Central Region Small Fruit Agent Ottawa County Extension Office 333 Clinton Street Grand Haven, MI 49417 (616) 846-8250 Fax: (616) 846-0655			

For Commercial Fruit Growers Michigan Fruit Management Guide 2004

Available on the Internet at: http://www.msue.msu.edu/epubs/pestpubs/E154/index.htm

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 office.

The information contained herein does not supersede the label directions. To protect yourself, others and the environment, always read the label before applying any pesticide.

2004 Fruit Management Guide Production Team: John Wise, Molly Sklapsky, Michael Haas, Anne Hanley and Lee Duynslager MSU Center for Integrated Plant Systems Trevor Nichols Research Complex



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2004 Michigan Fruit Management Guide

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Introduction

This publication is intended only as a guide to assist fruit growers in the selection of pesticides and pest control tools as they plan their pest management programs for the growing season. The insects and diseases listed in this spray schedule are not always present or economically important in all fruit plantings each year. During every growing season, growers should adjust their pest control programs to fit their specific conditions. This requires a knowledge of conditions observed during past growing seasons and the conditions encountered during the present growing season. Successful pest management is 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 variations 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.

To provide a more complete understanding of the complexities of fruit culture, Michigan State University provides a Fruit IPM newsletter, Fruit Crop Advisory Team Alert Newsletter (a subscription form is located in the back of this book). This newsletter is available on the Internet at http://msue.msu.edu/ipm/fruitCAT.htm. Other fruit information is available from the MSU Fruit Team http://www.msue.msu.edu/fruit.

We also recommend the following publications and videotapes. This guide, and other Michigan State University Extension resources, may be ordered from the MSU Bulletin Office. A complete listing of available publications is available on the Bulletin Office web site at: <u>http://web2.msue.msu.edu/bulletins/intro.cfm</u>. To contact the Bulletin Office by phone dial 517-353-6740.

Category	Number	Title
Certification	E 2195	Pesticide Applicators Core Training Manual: Certification, Recertification &
		Registered Technician Training
	E-2037	Fruit Crops Pest Management Pesticide Applicator Cert. Manual
	E-2195	Pesticide Applicator Core Training Manual (available in Spanish)
	E-2215	Using Pesticides Safely: A Guide for the Applicator
Economics	E-1107	Cost of Producing Fresh Market Apples in Western Michigan, 1998
	E-1108	Cost of Producing Tart Cherries in NW MI
	RR551	Short-term Costs and Returns to Michigan Apple, Blueberry
Equipment	E-0840	Tractor-mounted Air Blast Sprayers
	E-2559	Lighting Systems for Fruit & Vegetable Sorting
	E-2712	Air Blast Orchard Spraying
ertilization	E-0852	Fertilizing Fruit Crops
	E-2482	Plant Tissue Sampling to Determine Fruit Fertilizer Needs
	FAS104	Orchard A Syst: Pesticide and Nutrition Management
Viscellaneous	E-2759	Fruit Crop Ecology and Management
	NCR-551	Biotechnology: Genetically Engineered Fruits & Vegetables
Pesticide	E-2335	On-farm Agrichemical Storage & Handling
	E-2341	Record-keeping System
	E-2343	Field File Folders-Recordkpng Syst for Crop Prod
	E-2413	Washing Pesticide-Soiled Clothing (magnet) (available in Spanish)

Publications available from the MSU Bulletin Office. New listings are shown in bold, italics.

Aublications available from the MSU Bulletin Office (continued). New listings are shown in pour, manual.

Category	Number	Title
Small Fruit	E 0839	Strawberry Varieties for Michigan
	E 2845	Michigan Blueberry Facts – Japanese Beetle
	E 2847	Michigan Blueberry Facts – Fruit Rot Identification Guide
	E 2889	A Pocket Guide for Grape IPM Scouting in NC & Eastern States
	E-0682	Commercial Strawberry Culture in Michigan
	E-1456	Highbush Blueberry Varieties for Michigan
	E-1680	Propagating Highbush Blueberries
	E-1728	Strawberry Diseases in Michigan
	E-1730	Raspberry Diseases in Michigan
	E-1731	Blueberry Diseases in Michigan
	E-1732	Common Diseases of the Grapevine in MI
	E-1759	Plum Pox Detection Guide
	E-2011	Managing the Nutrition of Highbush Blueberries
	E-2642	Table Grape Varieties for MI
	E-2643	Wine Grape Varieties for MI
	E-2644	Vineyard Establishment I - Preplant Decisions
	E-2645	Vineyard Establishment II - Planting & Early Care of the Vineyard
	E-2698	Pest Control in Small Vineyards
	E-2774	Growing Table Grapes in a Temperate Climate
	NB-12	Highbush Blueberry Production Guide
	VT-019	Pruning Blueberries (Videotape)
	VT-020	Pruning Raspberries (Videotape)
	VT-021	Pruning Grapes (Videotape)
Tree fruit	E 2840	A Pocket Guide for IPM Scouting in Stone Fruits
	E 2890	Cherry Orchard Floor Management: Improve Profit & Stewardship
	E-1330	How to Recognize & Control Black Knot
	E-2290	Minimize Apple Bruising in the Packing Line
	E-2419	Avoidance/Mgmt—Nematode Problems in MI Tree Fruit Production
	E-2470	Cost of Producing Plums in NW MI
	E-2720	A Pocket Guide for IPM Scouting in Michigan Apples
	FAS105	Seasonal IPM Checklist for Orchards
	NCR-045	Diseases of Tree Fruits in the East
	NCR-063	Common Tree Fruit Pests
	NCR-394	Guide to Clearwing Borers (Sesiidae) of the N. Central U.S.
	VT-018	Pruning Mature Fruit Trees (Videotape)
	VT-043	Apple Packing House Operations (Videotape) (available in Spanish)

The following compendia on diseases of fruit crops are available from APS Press, 3340 Pilot Knob Road, St. Paul, MN 55121-2097; phone: 1-800-328-7560, or on the web at: <u>http://store.yahoo.com/shopapspress/index.html</u>: Apple and Pear Diseases; Blueberry and Cranberry Diseases; Grape Diseases; Raspberry and Blackberry Diseases and Insects; Stone Fruit Diseases, and Strawberry Diseases.

How to Use the Fruit Management Guide

The evaluation of how well certain pesticides control specific pests listed in the Fruit Management Guide 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: pink stage 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.: 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, Lannate is good 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

control tool(s) to use for the complex of insects in your crop at that time, refer to the rates provided and apply them in calm weather conditions to achieve the best coverage possible.

Information on fungicide effectiveness can be found in the Fungicide section on pages **11** and **41**; and the Herbicide section starting on page **144**.

The schedule part of the handbook only lists performance ratings for products on labeled pests. Some insecticides/miticides may provide control of pests not currently listed on the label, or on non-target organisms. To attain further information about how a product may impact beneficial insects, predacious mites and/or other non-labeled pests, consult the "Effectiveness of Insecticides/Miticides in Controlling Pests" tables for apples (pg. 54), stone fruits (pg. 89), grapes (pg. 104) and blueberries (pg. 136). On the bottom of this table, these insecticides are rated as T = highly toxic, M = moderately toxic and S = relatively safe to the beneficial insects.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

Guide to Abbreviations Used in This Bulletin

B = bait	
D = dust	
DF = dry flowable	
EC = emulsifiable concen	trate or emulsion
F = flowable	
G = granule	
L or LC = liquid concentra	ate
LS = liquid solution	

S = sprayable SC = suspension concentrate SP = soluble powder W or WP = wettable powder WDG = water-dispersible granules WSP = water soluble package XLR = extra low rate

Guidelines for Safe Use of Pesticides

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.

Protecting Groundwater

Many people who live in rural Michigan 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. 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 varies with pesticide properties, soil moisture, 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. Refer to the section "Groundwater and Surface Water Contamination" for information on how to prevent contamination.

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.

Absorption is the process by which chemicals are taken up by plants. Once absorbed, most pesticides are degraded within plants. However, some residues may persist inside the plant 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.

Groundwater and Surface Water Contamination

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, and most pesticides detected in groundwater and surface water are from nonpoint sources. This type of pollution 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).

Keeping Pesticides Out of Groundwater and Surface Water

A pesticide that is not volatilized, absorbed by plants, bound to soil, or broken down can potentially move through the soil to groundwater. The movement of groundwater is often slow and difficult to predict. Substances that enter groundwater in one location can turn up years later in other locations. A major difficulty in dealing with groundwater contaminants is that the sources of pollution are not easily recognizable. The problem is occurring underground, out of sight.

It is very difficult to clean contaminated groundwater or surface water. The best solution is to prevent contamination in the first place. The following pesticide application practices can reduce the potential for surface and groundwater practices.

Use integrated pest management programs—Keep pesticide use to a minimum by combining chemical control with other pest management practices.

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.

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

Calibrate accurately—Calibrate equipment carefully and often to avoid over and under application.

Measure accurately—Carefully measure concentrates before they are placed into the spray tank. Do not "add a little extra" to ensure that the pesticide will do a better job.

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 form 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 spills do occur, contain and clean them up quickly with an absorbent material like cat litter.

Change the location of mixing areas—Mix and load pesticides on an impervious pad if possible, where spills can be contained and cleaned up. If mixing is done in the field, change the location of the mixing area regularly.

Dispose of wastes properly—Obey laws regulating the disposal of pesticide wastes. Triple rinse or pressure rinse containers. Pour the rinsewater into the spray tank and use for treating the site or the crop.

Store and mix pesticides away from water sources such as wells, ponds, and springs.

The Michigan Groundwater Stewardship Program (MGSP)

The MGSP has been authorized through the year 2010 by the state legislature. It is funded by

assessments on the sale of nitrogen fertilizers and pesticides, generating \$3.5 million dollars each year. The program delivers educational programs, technical assistance and cost share that meet the needs and interests of local pesticide and fertilizer users. Growers may request an assisted farmstead pollution risk assessment (Farm*A*Syst), develop a groundwater stewardship plan, install groundwater stewardship practices using cost share funds, attend an on-farm demonstration and participate in an educational workshop sponsored by the MGSP.

The MGSP also sponsors the Spill Response Program (1-800-405-0101) to assist individuals dealing with pesticide, fertilizer and manure spills; Clean Sweep to dispose of unused and unwanted pesticides in an environmentally sound manner; and Container Recycling to boost the industry's efforts for collecting plastic and aerosol pesticide containers.

Contact your MSU Extension, Conservation District or USDA NRCS representative to learn more about the MGSP serving your county.

Pesticide Emergency Preparedness

At the time that the pesticide is purchased, ask the chemical dealer for a complete specimen label of the product you bought. This label and labeling information packet is an exact duplicate of the label information that is affixed to and/or must accompany the pesticide container. Use the specimen label material as a reference during any pesticide emergency. Bring the label along with any person who has become poisoned and needs medical attention.

Closely follow all the warning statements outlined in the *Precautionary Statements* section of the pesticide label. Be certain that you use all protective clothing and equipment as specified by the label. Make certain all persons involved in the operation of the farm know and can carry out the information in the *Statement of Practical Treatment*. (See also the section on SARA Title III.)

Transporting Pesticides

Have pesticides delivered by your dealer directly to your pesticide storage facility if possible. Transporting pesticides, especially large quantities, can involve a high degree of assumed liability by the grower. Department of Transportation shipping rules must be followed for transporting large quantities of pesticides, including proper placarding of the vehicle, liability insurance, special handling requirements, etc.

Storing Pesticides

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 feed, seed, food, or fertilizer with pesticides. Do not store any protective clothing or equipment in the pesticide storage facility. Store herbicides 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.

For additional information on pesticide storage, refer to Midwest Plan Service bulletin 37, *Designing Facilities for Pesticide and Fertilizer Containment,* and MSU Bulletin E-2335, *On-Farm Agrichemical Storage and Handling.*

Handling and Mixing Pesticides

Always wear protective clothing and equipment when handling, mixing, and applying pesticides and during cleanup of application equipment. Always wear what is required on the label.

Mix pesticides downwind and below eye level. Avoid excessive splashing and sloshing. If pesticides are spilled on you, wash them off immediately with lots of water, and change clothing. Resume spraying only after cleaning up any spills. Try to use closed handling/mixing systems when appropriate.

Mix only what is required for the area to be sprayed according to label directions. Avoid mixing excessive amounts. To do otherwise will create a hazardous waste which is difficult and expensive to dispose of. Keep unauthorized persons out of the area when you handle pesticides.

Applying Pesticides

Prior to any application, the equipment used must be thoroughly checked for sound operation and accurately calibrated. Poor maintenance and calibration practices lead to excessive residues on the crop and could harm humans, animals, crops, and other parts of the environment. Inspect the equipment during use to prevent the unintentional misapplication of chemicals. If equipment needs repair, stop spraying and fix the problem immediately.

Do not spray when the wind is greater than 10 miles per hour and/or weather conditions (e.g. inversions) are conducive to pesticide drift away from the target area. Make every effort to AVOID PESTICIDE DRIFT!

Handling and Disposing of Pesticide Containers

Pesticide containers are considered hazardous waste unless they are triple or pressure rinsed and the rinsate is used as additional dilution in the spray mixture. After triple or pressure rinsing all emptied pesticide containers, perforate both ends so that the container cannot be reused. All metal and plastic triple rinsed containers should be offered for recycling. If this option is not available, dispose of them in a state licensed sanitary landfill. Dispose of all paper containers in a sanitary landfill or a municipal waste incinerator. Do not bury or burn any pesticide containers. Do not reuse any empty pesticide containers for any purpose.

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 not exceeding labeled rates. Wash off the outside of the equipment in the target area. Only after rinsing out the equipment 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.

Unused and Unwanted Pesticides

Unused and unwanted pesticides are considered hazardous waste by both federal and state regulations. To be exempt from the stringent requirements for the disposal of hazardous pesticide waste, make every effort to purchase the exact amount of pesticides that will be needed during the growing season. Take extreme care in the calibration and application of any pesticide so that leftovers are not generated at the end of the job. Use any pesticide containing rinsates and unused pesticides exactly according to labeled use directions. If these procedures cannot be met, contact Michigan Department of Environmental Quality Hazardous Waste Management Division for instructions on the legal disposal of pesticide waste.

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. Many insecticides are highly toxic to pollinating bees and wild bees. Be aware of how bee poisonings can occur from applying pesticides and how to prevent them. Take the following precaution to reduce the chance of bee poisoning:

- Do not apply pesticides toxic to bees if the site contains a crop or weeds which are in bloom. Mow cover crops and weeds to remove the blooms before 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 because the minute capsules can be carried to the hive.

- Reduce drift during application. Use drift control materials whenever possible.
- 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 or use contaminated water; or feed on pesticidecontaminated prey.

Worker Protection Standard

New federal rules for worker protection have been in effect since 1995. The Worker Protection Standard (WPS) covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries, and greenhouses. The operators of these businesses are required to provide employees with:

- Information in the form of pesticide safety training, pesticide safety poster, access to labeling information, and access to an application list of pesticide treatments on the establishment.
- Protection to ensure that employees will be protected from exposures to pesticides. Employers are required to prohibit handlers from applying pesticides in any way that will expose workers or others; exclude workers from areas being treated with pesticides; exclude workers from areas that remain under a Restricted Entry Interval (REI); protect early entry workers who are doing permitted tasks in an area under REI;

notify workers about treated areas; monitor handlers who are using highly toxic pesticides; and provide instruction for use of personal protective equipment.

 Mitigation in the form of decontamination sites for washing up in the field, and emergency assistance to make transportation available to a medical facility in the event of a pesticide-related injury or illness.

Details for compliance with the Worker Protection Standard as well as other regulations affecting worker safety can be obtained at the county MSU Extension office.

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 is 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 Endangered 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 state Department of Natural Resources or Extension 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 and Bactericides for Fruit Crops

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(Each compound has been assigned a number to be used in the calendar sections for efficiency ratings)

This section contains basic descriptions of fungicides mentioned in this book. For information on specific crop use see the disease control recommendations for that crop. For a crop specific PHI (pre-harvest interval) see the Days to Harvest tables on pages 165-166.

The arsenal of fungicides and bactericides for disease control in fruit crops is constantly changing. The registration of new materials with unique chemistries has increased the options for disease control and pesticide resistance management. Integration of crop protection chemicals with scouting and good cultural practices can reduce disease problems and increase the effectiveness of disease control materials. Growers are advised to read labels carefully for use instructions and restrictions. Some products listed here have not been thoroughly tested in Michigan or have not shown levels of control sufficient to warrant their recommendation in the specific fruit sections. However, we feel that growers should know about these materials to be able to make informed decisions on their use. Some products listed here may be of interest to organic growers or growers who wish to use a more environmentally friendly approach to fruit production. A "reduced-risk" designation indicates that the product has a favorable toxicological profile.

Fungicides

12. Abound (azoxystrobin) is a broad-spectrum strobilurin fungicide registered on *grapes, blueberries, currants, gooseberries, apricots, cherries, nectarine, peaches, plums, plumcots,* and *prunes.* Abound is surface-systemic and has limited post-infection activity. Abound is extremely phytotoxic to some apple varieties, causing damage from either spray drift or residue left in the tank. To limit the potential for resistance development, make no more than 2 sequential applications of Abound. Abound is a reducedrisk product.

1.Agri-Mycin (streptomycin sulfate) is an antibiotic labeled for control of the bacterial disease fire blight in *apples* and *pears*.

15. Aliette (fosetyl-AL) is a systemic fungicide registered on *strawberries*, *blueberries*, *brambles*, *grapes*, *apples*, *pears* and *non-bearing stone fruit*. It has protectant and curative properties. Do not tank-mix Aliette with copper products, surfactants, or foliar fertilizers, or spray Aliette within several days of a copper application.

AQ10 (*Ampelomyces quisqualis*) is a biofungicide registered on grapes, strawberries, blueberries, raspberries, blackberries, currants, gooseberries, cranberries, and quince. A. quisqualis is a fungus that parasitizes powdery mildew fungi. Adding an adjuvant such as Nufilm (0.02% v/v) enhances its efficacy.

Sequential applications are needed to maintain the population of *A. quisqualis*. At low disease incidence (<3%), AQ10 can be used alone. At higher disease pressure, AQ10 must be used in rotation with sulfur or other efficacious products. Do not tank-mix AQ10: sulfur, dithiocarbamates, potassium salts of fatty acids, or strobilurins. AQ10 is OMRI listed for organic fruit production and is considered a "reduced risk" product,

64. Armicarb 100 (potassium bicarbonate) is an salt and acts as a protectant (contact) fungicide. Armicarb 100 is registered on *grapes*, *blueberries*, *strawberries*, *brambles*, *apples*, *cherries*, *pears*, *peaches*, and *plums*. Armicarb is a reduced-risk product.

Aspire (Candida oleophila) is a biofungicide yeast for control of pathogens causing post-harvest decays in berries, pome fruit, and stone fruit. It cannot survive at temperatures above 90°F, making it safe for human handling and exposure. It competes with pathogens on the fruit surface for space and nutrients. The technical bulletin lists efficacy against blue mold, gray mold, green mold, sour rot, and stem end rot. Aspire can be applied as a drench or in-line application. Sodium hypochlorite should not be mixed in the same tank with Aspire. Aspire has only been tested on blueberries in Michigan and did not control post-harvest anthracnose fruit rot. Further testing is required to assess its efficacy against other diseases.

Auxigro (gamma aminobutyric acid and L-glutamic acid) is a plant metabolic primer labeled for *stone fruit, grapes*, and *strawberries*. It is a blend of naturally occurring amino-acids and protein. The label lists growthpromoting and disease-suppressive effects. This product has not been sufficiently tested on these crops in Michigan to provide a disease control rating.

13. Bayleton (triadimefon) is a systemic, sterol-inhibitor (SI) fungicide with post-infection activity. It is registered on *grape*, *apples* and *pears*. Bayleton may be used on a protective or post-infection schedule. Alternating or tank-mixing Bayleton with non-SI fungicides is recommended for resistance management.

Benlate (benomyl) has been withdrawn from the market, but existing stocks can still be used. Benlate is a locally systemic benzimidazole fungicide that should be used in combination with a non-benzimidazole fungicide (e.g., Captan or Ziram, where labeled) to reduce the risk of resistance development. Benlate is *not* labeled for container-grown blueberries, home plantings, or after "Upick" operations have started. **57. Bordeaux Mixture** is powdered bluestone (copper sulfate) plus lime. See Copper Compounds.

4. Bravo (chlorothalonil) is a protectant fungicide registered on *peaches, nectarines, cherries, apricots, plums, blueberries,* and *cranberries.* In some instances, Bravo can be phytotoxic to blossoms and fruit.

20. Cabrio (pyraclostrobin) is a broad-spectrum strobilurin fungicide registered on *blueberries, strawberries, brambles, currants, gooseberries,* and *cherries.* Cabrio is surface-systemic and has limited post-infection activity. To prevent resistance development, a maximum number of sprays per season is specified on the label. Cabrio is a reduced-risk product.

50. Captan (captan) is a protectant fungicide with a broad spectrum of activity labeled for *blueberries, strawberries, grapes, apples, cherries, plums/prunes,* and *peaches.* In Michigan, Captan can be used on *brambles* under a Section 24C (Special Local Needs label). Captan is **not** labeled on pears. Captan can cause leaf injury to certain sweet cherry varieties and to leaves and fruit of plums, especially on young tissue under slow-drying conditions. Captan, like other sulfur-containing compounds, can cause phytotoxicity in association with oil applications.

50. Captec (captan) is a liquid (flowable) formulation of captan. See Captan. Captec should not be used within 10-14 days following oil sprays.

25. Captevate (fenhexamid and captan) is a mixture of the active ingredients fenhexamid and captan, registered on *strawberries* and *blueberries*. It is a useful for fungicide resistance management. See Elevate and Captan.

53. Carbamate (ferbam). See ferbam.

58. Copper compounds (copper hydroxide, copper oxychloride, copper sulfate (COCS), tribasic copper sulfate, and copper salts of fatty & rosin acids) are used as protectants against fungal and bacterial diseases in grapes, strawberries. raspberries, blackberries. blueberries, cranberries, currants, gooseberries, apples, pears, peaches, and nectarines. Fresh hydrated lime is commonly added as a safener to help prevent foliar injury. Lime is not compatible with Tenn-cop, a liquid formulation composed of copper salts of fatty & rosin acids. There are many easy-to-use commercially formulated copper products. Kocide, Champ, and Cuprofix are examples. Cuprofix does not need added lime. Fixed copper formulations and lime should not be used with Guthion, Imidan Sevin, Thiodan, Bayleton, Benlate, Captan, Carbamate or Karathane. Copper is OMRI listed for organic fruit production, although specific formulations may not be. Copper has a negative effect on earthworm populations.

59. Dithane (mancozeb) is a protectant EBDC (ethylene bisdithiocarbamate) fungicide labeled on *apples, pears,*

grapes, and cranberries. When applying multiple EBDC products, the total amount of all such products must not exceed the lowest amount of active ingredient specified for any individual product per acre per season.

24. Echo (chlorothalonil) is similar to Bravo. There are two formulations labeled for fruit: Echo 720 and Echo 90 DF. The latter is a dry flowable with a higher rate of active ingredient.

65. Elevate (fenhexamid) is a protectant fungicide with locally systemic properties registered on *strawberries, grapes, blueberries, gooseberries, currants, brambles* and *stone fruit*. Avoid making more than 2 consecutive applications before switching to a fungicide with a different mode of action. Elevate is a reduced-risk product.

8. Elite (tebuconazole) is a systemic SI fungicide registered on *cherries, peaches* and *grapes*. Elite can be used on a preventive or post-infection schedule (within 72 hours after the beginning of an infection period). Elite should be alternated or tank-mixed with non-SI fungicides for resistance management purposes.

27. Endura (boscalid) is a carboxamide fungicide labeled for control of Botrytis bunch rot and powdery mildew in *grapes*. It is surface-systemic and had limited post-infection activity. To prevent resistance development, do not make more than three sequential applications of Endura and five applications per season. Endura is a reduced-risk product.

53. Ferbam (ferbam) is a broad-spectrum protectant fungicide registered on *apples, cherries, peaches, nectarines, grapes,* and *cranberries.* Ferbam may leave a dark residue on fruit. Ferbam is incompatible with lime, and may increase russeting of some apples.

17. Flint (trifloxystrobin) is a broad-spectrum strobilurin fungicide registered on *grapes, apples, pears, peaches, plums, prunes, and cherries.* Flint is phytotoxic to Concord grapes. Flint is surface-systemic and had limited post-infection activity. To limit the potential for resistance development, make no more than 2 sequential applications of Flint or other strobilurin fungicides. Rotation with non-strobilurin fungicides is recommended. Flint is a reduced-risk product.

Gallex (2,4-Xylenol and meta-Cresol) is an eradicant paint for crown gall on *apples*, *pears*, *peaches*, *nectarines*, *cherries*, *plums*, *grapes*, *blueberries*, and *brambles*. Gallex is painted on existing galls in the spring and early summer. Expose below-ground galls by hosing the soil away with water and allow to dry for 1 or 2 days before treatment. Large galls may be partially or completely removed before treatment. Gallex also reduces burr knot of apple. Do not mix or combine Gallex with other pesticides. No PHI is indicated. Efficacy of Gallex has not been confirmed in Michigan. **Galltrol** (*Agrobacterium radiobacter* strain K84) is a bacterial inoculant for suppressing crown gall in *apples*, *pears*, *peaches*, *nectarines*, *cherries*, *plums/prunes*, *blueberries*, and *brambles*. Galltrol is similar to Norbac. *Agrobacterium radiobacter* is a naturally occurring bacterium that is widespread in soil and produces a toxic compound that prevents other *Agrobacterium* species from causing crown gall disease. Galltrol is used as a preplant dip or spray of planting material. It is sold as a live bacterial culture on a Petri plate. Galltrol may also be applied as a soil drench. Do not use chlorinated water or combine with Captan, Nemacur, Vydate or other pesticides or fertilizers. Generally one pre-plant application will give good control. Galltrol will not control crown gall of grape, which caused by a different bacterial strain.

2. Indar (fenbuconazole) is a systemic SI fungicide labeled for *peaches* and *cherries*. In Michigan blueberries, Indar has been used under a Section 18 (emergency exemption) label for several years, and this Section 18 is also expected in 2004. The use of spray adjuvants with Indar is not labeled for blueberries, but is permitted for stone fruit.

66. JMS Stylet Oil (paraffinic oil) is registered for disease and insect control on *apples, pears, peaches, cherries, grapes, blueberries, gooseberries, currants, brambles* and *strawberries.* Good spray coverage is necessary for effective control. Applications can also be made post harvest to reduce overwintering of insects. Do not spray JMS Stylet Oil on sensitive varieties as it can burn the foliage. An organic formulation of JMS Stylet Oil is OMRI listed. JMS Stylet Oil is a reduced-risk product.

Kaligreen (potassium bicarbonate) is similar to Armicarb. It is a contact fungicide labeled for powdery mildew control on *apples, pears, grapes, cherries, nectarines, peaches, plums/prunes, blueberries, strawberries, brambles, gooseberries,* and *currants.* Kaligreen may also be applied post-harvest to decrease overwintering inoculum. Kaligreen requires more efficacy testing in Michigan. Kaligreen is a reduced-risk product and is OMRI-approved for organic fruit production.

63. Lime sulfur (calcium polysulfide) is registered for use on apples, pears, cherries, peaches, plums/prunes, grapes, blueberries, and brambles. Different formulations may be labeled for different crops, so check the label before applying. When applied in the fall and/or spring (bud break), this product can reduce overwintering pathogen inoculum in and on perennial wood. It should not be used as a stand-alone treatment. Target diseases are scab and leaf curl in tree fruit; anthracnose, spur blight, cane blight, powdery mildew, and rust in brambles; anthracnose, powdery mildew, and black rot in grapes; and Phomopsis. Fusicoccum and other canker/dieback diseases in blueberries. Lime sulfur also controls hatching eggs and nymphs of scale insects, pear psylla, aphids, and mites. It is a very caustic material with a smell of rotten eggs. Timing is critical, and crop injury may result if sprayed on expanded foliage. Some lime sulfur products are OMRI-listed for organic production.

Maneb (maneb = mancozeb without zinc) is an EBDC fungicide with a similar spectrum of control and use restrictions as Dithane. See Dithane.

59. Manzate (mancozeb) is an EBDC fungicide. See Dithane.

Messenger (harpin) is registered for use on grapes, blueberries. cranberries. strawberries, brambles. currants, apples, pears, cherries, nectarines, peaches, plums, and prunes. The active ingredient is a protein that stimulates natural plant defenses. This means that Messenger has no direct effect on pathogens. Application of Messenger must be made 5 to 7 days in advance of an infection period allowing the plant to build up its defenses. In Michigan, Messenger has reduced Phomopsis twig blight in blueberries and powdery mildew in grapes. Messenger may also in some cases increase plant growth and yield or cold hardiness. Messenger is considered a reduced-risk product.

22. Mycoshield (oxytetracycline calcium complex) is an antibiotic labeled for control of bacterial spot on *peaches* and *nectarines* and fire blight on *pears*. In Michigan apples, Mycoshield has been used under a Section 18 label for fire blight control for several years, and this label is also expected in 2004.

NoGall (Agrobacterium radiobacter strain K1026) is a bacterial inoculant for control of crown gall disease in apples. pears. peaches. nectarines. cherries. plums/prunes, blueberries, and brambles. Strain K1026 is similar in activity to strain K84 (Galltrol or Norbac) but has been genetically modified so that its resistance to the toxin cannot be transferred to the crown gall pathogen. NoGall is used as a pre-plant dip or spray and is sold as a live bacterial culture on a finely ground peat medium. It has a much better shelf life than the gel formulation, but should still be refrigerated. NoGall will not control crown gall of grape, which is caused by a different bacterial strain.

Norbac is similar to Galltrol. See Galltrol.

5. Nova (myclobutanil) is a systemic SI fungicide that is labeled on *apples, cherries, peaches, grapes, strawberries, raspberries, blackberries, gooseberries, and currants.* It is advisable to alternate Nova with fungicides with a different mode of action as a resistance management strategy.

Oxidate (hydrogen dioxide) is a broad-spectrum bactericide/fungicide labeled for use in *apples, grapes, blueberries, cranberries, strawberries, brambles, pears, cherries, peaches, nectarines,* and *plums.* The label lists control of a broad range of diseases. However, the

efficacy of the material for disease control has not been sufficiently tested in Michigan to recommend it for any crop. Oxidate works like hydrogen peroxide, killing fungal and bacterial cells upon contact. It appears to be rather short-lived on the plant surface, so that timing becomes crucial.

7. Orbit (propiconazole) is a locally systemic SI fungicide registered on *peaches*. It has protectant and curative activity. It is advisable to alternate Orbit with fungicides with a different mode of action as a resistance management strategy.

59. Penncozeb (mancozeb) is an EBDC fungicide. See Dithane.

70. Pristine (pyraclostrobin and boscalid) is a broadspectrum strobilurin + carboxamide fungicide labeled for grapes, apples, pears, peaches, nectarines, plums, prunes, grapes, blueberries, strawberries, brambles, gooseberries, and currants. Pristine is surface-systemic with limited post-infection activity. To prevent resistance development, a maximum number of sprays per season is specified on the label. Pristine is a reduced-risk product.

54. Procure (triflumizole) is a systemic SI fungicide labeled on *apples, pears* and *grapes*. It has less post-infection activity than Nova or Rubigan. It is advisable to alternate Procure with fungicides with a different mode of action as a resistance management strategy.

Prophyt (potassium phosphite) is a systemic fungicide registered for downy mildew control on *grapes*. Its mode of action is considered similar to that of Aliette. It has protectant and curative properties and also acts as a foliar fertilizer. Prophyt is a reduced-risk product. This product has not been sufficiently tested in Michigan to provide a disease control rating.

61. Ridomil Gold (mefenoxam) is a systemic fungicide with excellent activity against *Pythium and Phytophthora* diseases. This fungicide is registered on *strawberries*, *raspberries*, *blueberries* and non-bearing and bearing tree fruit, except pears where it is available only for non-bearing trees. See the label for timing information for Ridomil application to tree fruit plantings

60. Ridomil Gold/Copper (mefenoxam and copper) is a systemic fungicide labeled for grapes. It is similar to Ridomil Gold, except that copper has copper has been added as a fungicide resistance management tool. See Ridomil and Copper compounds.

55. Ridomil Gold/MZ (mefenoxam and mancozeb) is a systemic fungicide labeled for grapes. It is similar to Ridomil Gold, except that mancozeb has been added as a fungicide resistance management tool. If other fungicides containing EBDC active ingredients are used during the growing season, do not exceed a total of 19.2 lbs of EBDC active ingredient per acre. See Ridomil and Dithane.

62. Quadris (azoxystrobin) is a broad-spectrum strobilurin fungicide with the same active ingredient as Abound. Quadris is registered for use in *strawberries*. Quadris is surface-systemic with limited post-infection activity. Because of the potential for resistance development, do not apply more than 2 sequential applications of Quadris and no more than four applications per year.

3. Rovral (iprodione) is a protectant fungicide registered on grapes, cherries, peaches, nectarines, plums, strawberries, brambles, gooseberries, and currants. Alternating Rovral with fungicides with a different mode of action may delay the buildup of resistant strains. Where resistant strains are already present, control may be less than expected. Refer to the label for application restrictions.

10. Rubigan (fenarimol) is a locally systemic SI fungicide registered on *grapes*, *apples*, *pears*, and *cherries*. It has protectant and curative activity. Rubigan should be tank-mixed or alternated with a non-SI fungicide to reduce the risk of resistance development. Tank mixing with copper-containing products may result in reduced effectiveness of Rubigan.

Scholar (fludioxonil) is labeled on *stone fruit* for use as a protective post-harvest spray or dip. It Treated fruit should not be stored in direct sunlight, as Scholar may be degraded by exposure to sunlight. Scholar is a reduced-risk product.

29. Serenade (*Bacillus subtilis*) is a biocontrol product registered on *apples*, *pears*, *cherries*, *grapes*, and *blueberries*. Serenade may be alternated or tank-mixed with other registered fungicides to enhance disease control. Thorough coverage is important for control. Serenade is OMRI listed for organic fruit production.

16. Sovran (kresoxim-methyl) is a broad-spectrum strobilurin fungicide labeled for *grapes*, *apples*, and *pears*. Sovran is phytotoxic to some sweet cherry cultivars; use caution when spraying near sweet cherry orchards. Sovran is surface-systemic with limited post-infection activity. Make no more than 2 sequential applications of strobilurin fungicides per season to prevent/delay development of fungicide resistance. Sovran is a reduced-risk product.

14. Sulfur (elemental sulfur) is used as a protectant for control of powdery mildew on *grapes, strawberries, blueberries, brambles, apples, cherries,* and *peaches.* Sulfur is also moderately effective against brown rot, apple scab, and cherry leaf spot. Sulfur is available in dust, wettable powder, and liquid formulations. Examples of sulfur products are: Wettable Sulfur, Microthiol Special, Microthiol Disperss, Microfine Dispersible Sulfur, Microsperse Wettable Sulfur, Kumulus, Sungro Wettable

Sulfur, Wettable Sulfur Fine Grind, Yellow Jacket Wettable Dusting Sulfur, Liquid Sulfur Six, and Dusting Sulfur. Generally, wettable and liquid formulations are easier to apply than dusts, and formulations with finer particles are more effective. Sulfur is also effective against plantfeeding mites, but can be damaging to predatory mite populations. Sulfur can injure sensitive grapes (see Table 2 in the grape section). Sulfur injury may also occur in tolerant varieties when temperatures of 85°F or above occur soon after application and on strawberries under certain climatic conditions. The efficacy of sulfur is reduced at temperatures below 65°F. Sulfur is incompatible with oil and should not be used within two weeks before and after an oil spray. No pre-harvest intervals are listed, however, late applications of sulfur may leave undesirable residues on grapes that can interfere with the winemaking process. Sulfur products can also be used as a micronutrient supplement, since sulfur is an essential nutrient for plant growth. Sulfur is OMRI listed for organic fruit production, although specific formulations may not be.

67. Switch (cyprodinil and fludioxonil) is a mixture of active ingredients with systemic and protectant properties. It is registered on *blueberries, strawberries, brambles, gooseberries,* and *currants.* To avoid resistance development, make no more than 2 sequential applications before using a fungicide with a different mode of action. No aerial applications are allowed.

11. Syllit (dodine) is a protectant fungicide with postinfection and some eradicant activity. It is labeled on *apples, peaches, cherries* and *strawberries*. Resistance of apple scab and cherry leaf spot pathogens to Syllit is common in Michigan. Syllit is not compatible with fixed coppers, Bordeaux mixture, lime or lime sulfur. Russeting of yellow apples may occur if Syllit is used during cool, slow drying conditions or close to freezing temperature episodes.

19. Thiram (thiram) is a protectant fungicide registered on *strawberries, apples* and *peaches* for a broad spectrum of fungal diseases. Thiram also has animal-repellent properties.

9, 56. Topsin-M (thiophanate-methyl) is a broad-spectrum systemic fungicide registered on *apples, cherries, plums, peaches, strawberries* and *grapes*. A Section 18 for use in Michigan *blueberries* is expected again in 2004. Fungicide resistance can be a problem with this fungicide. Topsin-M should be tank-mixed with a non-benzimidazole fungicide (e.g., Captan or Ziram) to reduce the risk of resistance development. If benomyl-resistant strains are already present in a field, they are likely to also be resistant to Topsin M.

6. Vangard (cyprodinil) is a systemic fungicide with protectant and post-infection activity, registered on *grapes*, *apples*, *peaches*, *tart cherries*, and *plums*. Do **not** apply

Vangard to sweet cherries. Vangard shows no crossresistance to other currently available fungicides, making it a useful tool for fungicide resistance management. It is rainfast 2 hours after application. Under heavy disease pressure, other registered fungicides should be used in combination or rotation with Vangard.

51. Ziram (ziram) is a broad-spectrum protectant fungicide registered on *grapes, blueberries, apples* and *pears*. Ziram is also a source of zinc as a nutrient. Ziram is **not** labeled on plums/prunes and can cause leaf damage on this crop. There are two formulations of Ziram (Ziram 76 DF and Ziram Granuflo) available, which may differ in their label specifications.

Fungicide Resistance

The repeated use of certain fungicides allows less sensitive (fungicide-resistant) strains of the targeted fungi to build up over time. Reduced sensitivity may occur naturally in some strains due to random mutations in their genes. Gene mutations may change the chemical affinity of the fungicide's target site within the cells, reducing fungicide efficacy. When exposed to a particular fungicide, these strains have a selective advantage over sensitive strains. A buildup of resistant strains will eventually result in diminished levels of disease control with the same amount of chemicals applied. This is generally referred to as field resistance. It should be noted that reduced disease control may also be caused by improper fungicide application, high disease pressure, or other factors not related to the presence of resistant pathogens.

Chemicals with a specific or single-site mode of action are more likely to lead to development of resistance than broad-spectrum chemicals, since a single mutation may allow the fungus to survive. For instance, Captan, a broadspectrum fungicide, has been used extensively for decades without the development of field resistance, whereas resistance to SI fungicides, which inhibit sterol biosynthesis, has been widely reported. A pathogen shows cross-resistance when it has reduced sensitivity to two or more fungicides. Usually these fungicides belong to the same chemical group and have the same mode of action. For instance, a fungus strain resistant to Rubigan may also be resistant to Nova, since both are SI fungicides. A sensible approach, therefore, is to combine or alternate fungicides with different modes of action in a spray program. This will help prolong the effective life of the fungicides as well as optimize disease control. It is also important to incorporate alternative methods of disease control, such as host plant resistance, cultural methods, and disease predictions, to reduce the total amount of fungicide used and thereby the selection pressure on fungal populations. Table 1 shows the various fungicides available for disease control in fruit crops. An "X" indicates a shared mode of action.

Fungicide Modes of Action and Fungicide Classes

The Fungicide Mode of Action table divides fungicides into 14 groups based on their chemistry and mode of action. These groups are divided into two general types: protectant and systemic.

Protectant fungicides kill spores as they germinate and before they have a chance to infect the plant. These materials poison the metabolism of the fungal cell at many levels. They usually remain on the outside of the plant and are not absorbed. If they are absorbed they can cause phytotoxicity because the fungicide can also poison plant cells. Because protectants are multi-site poisons and fungi would have to develop multiple mutations to overcome them, resistance is unlikely. Protectant fungicides include:

- *Phthalimides*, such as Captan,
- Chloronitriles, such as Bravo
- Dithiocarbamates, such as the EBDC fungicides maneb, mancozeb, zineb; and related materials such as ferbam, ziram and thiram
- Inorganics, such as sulfur, copper and salts.

Systemic fungicides are absorbed into the plant and not susceptible to wash off by rain or irrigation after the products have dried. They often have **back action** or **post infection** activity. This is the ability to kill or weaken a fungus after it has infected the plant (usually within 72 h or less). For this reason they are also called **curative** or **eradicant** fungicides. These fungicides work by poisoning a specific chemical reaction or pathway in the fungal cell. As a group, systemic fungicides are susceptible to resistance development, but the different classes vary in their risk of resistance development. Systemic fungicides include:

- Anilinopyrimidines, a new group of fungicides including Vangard
- Benzimidazoles, some of the earliest systemic fungicides, such as Benlate and Topsin M. Where resistance occurs, it is usually absolute.
- Carboxamides, a new group including Endura.
- Dicarboximides, such as Ronilan and Rovral
- Guanidines, such as dodine.
- Phenylamides, such as Ridomil
- Phosphonates, are phosphoric acid derivatives, such as Alliette and Prophyt.
- Sterol inhibitors, such as the DMI and morpholine fungicides, which inhibit different points in the sterol synthesis pathway. There is cross resistance within, not between, these two groups. Examples of DMI fungicides are Nova, Elite, etc. Resistance tends to be gradual and not absolute.
- Strobilurins, such as Abound, were developed from a natural fungicide produced by a forest mushroom. Their single-site mode of action makes them prone to resistance development.

Increasingly, pesticide formulations include two active ingredients of different classes to reduce the risk of fungicide resistance development. For the same reason, restrictions are placed on the number of consecutive applications and total applications per season.

There are also products that do not fit into these two broad fungicide classifications. For example, **host plant defense inducers** are materials that stimulate natural plant defenses against invasion by plant pathogens. There are also **biofungicides**, which are living microorganisms, such as bacteria, yeasts, or fungi, that compete with or kill plant pathogen.

Fruit fungicides that have a shared mode of action.

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Compiled by M. Longstroth and A.Schilder. *P=Anilinopyrimidines; B=Benzimidazoles; C=Chloronitriles; CX=Carboxamides; D=Dicarboximides; DC=Dithiocarbamates; EBDC=Ethylene bisdithiocarbamates; G=Guanidines; Ha=Hydroxyanilides; I=Inorganics; P=Phenylamides; PH=Phosphonates; PP=Phenylpyrroles; PT=Phthalimides; S=Strobilurins; SI=Sterol inhibitors, U= unclassified.

Insecticides and Miticides for Fruit Crops

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(Each compound has been assigned a number to be used in the calendar sections for efficiency ratings)

61. Acramite (bifenazate) belongs to a new class of miticides called carbazates and is registered for use in pome fruits, stone fruits, grapes and strawberries for control of mites. Acramite is a contact miticide that is primarily active against motile stages of European red mite and two spotted spider mite, but also nymphal stages that hatch after application. For best performance maintain spray tank water at or near pH 7.0.

59. Actara (thiamethoxam) belongs to a new class of called neonicotinoids insecticides (thianicotinyl subclass). Actara is registered for use in apples, pears, as well as stone fruits targeting aphids, leafhoppers, plant bugs, leafminers, psylla and plum curculio. This translaminar (locally systemic) material has long residual inside the plant, and is particularly effective on piercing/sucking insect pests, as well as the sap-feeding stage of leafminers. Because most of Actara's surface residue is quickly absorbed into the plant, negative impact on natural enemies is minimized.

41. Agri-Mek (avermectin) is registered on apples for the control of mites, white apple leafhopper and spotted tentiform leafminer, on pears for the control of pear psylla and pear rust mite, on grapes for twospotted spider mite, and on strawberries for mite Though not a labeled use, Agri-Mek has control. moderate activity on apple rust mite and San Jose scale. The active incredient 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 it has long residual inside the foliage. Agri-Mek will also control spider mites on pear foliage when applied for pear psylla at first cover. On pears this product must be applied with 1 gallon of paraffinic spray oil to effectively penetrate the leaf tissue. The same is recommended on apples, but the label allows for the use of some other penetrating surfactants or with no addition of an oil. For grapes a nonionic surfactant needs to be added to improve wetting of foliage and smooth out spray deposits. For best mite control apply when mites first appear and before populations build beyond threshold.

17. Apollo (clofentezine) is a miticide labeled for control of European red mite and spider mites on apples, pears, peaches, nectarines and cherries. Apollo is an active mite ovicide, providing 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 both from direct contact with the spray and contact with treated plant surfaces, but can also affect adult female mites by rendering their eggs inviable. On apples it

can be used at the traditional tight-cluster stage or with the recent label amendment it can be applied later in the season up to a 45-day PHI. In all cases, it may be applied ONLY once per year. Apollo is not toxic to predator mites.

40. Asana XL (esfenvalerate) is a synthetic pyrethroid insecticide registered for use on apples, pears, stone fruits and blueberries. It works primarily as a contact poison on a broad spectrum of insect pests, including leafrollers, leafhoppers, beetles, internal feeders (fruitworms, codling moth, oriental fruit moth) and fruit flies. Because of it's compatibility with oil it can be used for pre-bloom insect control. In blueberries Asana should not be sprayed within 7 days of pollination to avoid risk of bee repellency. This material is also highly toxic to mite predators and should be used carefully to prevent mite population buildup.

60. Assail (acetamiprid) belongs to a new class of insecticides called neonicotinoids (chloronicotinyl subclass). Assail is registered for use in apples and pears, targeting aphids, leafhoppers, leafminers, psylla, plum curculio, apple maggot, oriental fruit moth and codling moth. This translaminar (locally systemic) material has long residual inside the plant. Assail has a broad spectrum of pest activity, being effective on piercing/sucking insect pests, as well as controlling several internal feeding insects of fruit.

Assail's WSP formulation is registered on grapes for leafhoppers and aphids.

55. Avaunt (indoxacarb) is a member of the new Oxadiazine class of insecticides with a novel mode of action that acts by inhibiting sodium ion entry into nerve cells, resulting in paralysis and death of the pest species. The primary route of entry into the target pest is by ingestion, although the product is also absorbed through the insect cuticle. Because of this, thorough coverage of the crop is critical for good pest control. Avaunt is relatively short-lived in the environment, but has particularly good rain-fast characteristics. Avaunt is registered for use in apples and pears for control of oriental fruit moth, codling moth, redbanded leafroller, plum curculio, tarnished plant bug, apple maggot and leafhoppers.

20. Brigade (bifenthrin) is a synthetic pyrethroid registered for use on strawberry for the control of many insect and mite pests, including strawberry sap beetle and spider mites. This product has a short period of activity after application and is disruptive to natural enemies. For sap beetles it should be applied as soon as beetles are detected, to target them before they enter the fruit.

43. B.t.'s, *Bacillus thuringiensis*, bioinsecticides like Dipel, Javelin, Agree, Biobit, Deliver and Crymax control lepidopteran larvae but must be ingested by susceptible larvae to be effective. Time applications for early egg hatch, and two or three applications are generally required. Effectiveness varies depending on thoroughness of coverage, rate applied, weather conditions and plant vigor. B.t.'s can be used during bloom and do not impact most natural enemies. B.t.'s are most effective when applied during warm weather conditions, when daily highs are in the 70's F. Dipel and Javelin are listed by the Organic Materials Review Institute (OMRI) for use in organic production.

62. Calypso (Thiacloprid) belongs to a new class of insecticides called neonicotinoids (thianicotinyl subclass). Calypso is registered for use in apples and pears, targeting aphids, leafhoppers, leafminers, psylla, plum curculio, apple maggot, oriental fruit moth and codling moth. This material is translaminar (locally systemic), but its residue has a stronger plant surface profile than the other neonicotinoids. Calypso has a broad spectrum of pest activity, being effective on piercing/sucking insect pests, as well as controlling several internal feeding insects of fruit.

65. Capture (bifenthrin) is a synthetic pyrethroid registered for use on pears, strawberry and caneberry for the control of many insect and mite pests, including strawberry sap beetle and spider mites. This product has a short period of activity after application and is disruptive to natural enemies. For sap beetles it should be applied as soon as beetles are detected, to target them before they enter the fruit.

3. Carzol (formetanate hydrochloride) is a nonphosphate miticide-insecticide registered for use on apples, pears and peaches to control European red or two-spotted spider mites, white apple leafhopper, tentiform leafminer, stink bugs and pear rust mite. It is most effective for controlling immature and adult forms of European red and two-spotted mites.No more than 1.25 lbs/acre can be applied in any one crop season and cannot be applied after petal fall. Since this product is not stable in alkaline water, its spray mixture must be freshly prepared just before application. This material is moderately toxic to honeybees, highly toxic to mite predators and comparatively non-toxic to fish, birds, man and animals.

49. Confirm (tebufenozide) is an insect growth regulator insecticide registered for use on apples, pears, caneberries and blueberries for the control of lepidopterous insect pests such as the tufted apple obliquebanded budmoth. leafroller, redbanded leafroller, codling moth, and cranberry fruitworm. This compound works by mimicking the action of the natural insect hormone 20-hydroxyecdysone, the molting physiological inducer of the and metamorphosis process in insects. It must be ingested by the larvae, and may take several days to cause mortality. The addition of an agricultural adjuvant (such as Latron B-1956) to Confirm 2F is recommended to improve initial sprav deposition.

13. 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.

44. Danitol (fenpropathrin) is a pyrethroid insecticide/ miticide registered for use on apples, pears, strawberries and grapes with activity against a broad spectrum of insects as well as certain mites. To reduce the risk of resistance developing to this product and to conserve natural enemies, restrict post-bloom applications to a single spray. Successive sprays against the same pest should be alternated to a different insecticide class. This material is also highly toxic to mite predators and should be used carefully to prevent mite population buildup. Danitol is restricted to 2 2/3 pints per season (no more than two applications in strawberries). If Danitol is tank-mixed with Ziram, a suspension agent is required.

5. Diazinon is active against a variety of fruit pests, offering residual activity of 10 to 14 days and has clearance for use on apples, blueberries, 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 obliquebanded leafroller, which are common in Michigan.

6. Dimethoate is marketed as *Cygon* and *De-Fend* for control of a wide range of insects on bearing 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 organophosphates to humans and animals. Apples and grapes have recently been dropped from the Dimethoate label, though existing stock can still be used.

64. Entrust (spinosad) is registered on apples, pears, strawberries, blueberries and stone fruits for control of leafrollers, codling moth, oriental fruit moth, green fruit worm, spotted tentiform leafminer, thrips and maggot fly pests. Entrust is listed by the Organic Materials Review Institute (OMRI) for use in organic production. The active ingredient, spinosad, is a waste metabolite produced during the growth of a bacteria, belonging to the Naturalyte class of insecticides. The primary route of entry into the target insects is through ingestion, although the product is also absorbed through the cuticle. Entrust provides 7 - 10 days of residual control, depending on the target pest, but good coverage will increase consistency of crop protection. No more than 9 oz of Entrust should be applied per acre per season. The use of a adjuvant can enhance coverage and penetration of leaf surfaces. Entrust has shown good safety to many beneficials, but can be toxic to bees if contacted before sprays are dried.

52. Esteem (pyriproxifen) is an Insect Growth Regulator (IGR) insecticide that acts by suppressing embryo-genesis within the insect egg and by inhibiting metamorphosis and adult emergence of target insects. Esteem has no activity on adult insects, but hatching of eggs laid by treated adults will be suppressed. Esteem is registered for use in apples and pears, for the control of codling moth, San Jose scale, spotted tentiform leafminer, rosy apple aphid, and pear psylla, and in peaches, plums, apricots and cherries for the control of scale insects and suppression of Oriental fruitmoth. Esteem is also registered in blueberries (bushberry crop group) for the control of fruitworms and lecanium scale. Since Esteem is an insect growth regulator, and activity depends on the insect's development, evidence of activity will be slower than with conventional contact insecticides. To optimize insecticide resistance management practices, use of Esteem is restricted to two applications per season. Esteem may be used in alternation with other IGR materials possessing dissimilar modes of action and/or other chemical classes of insecticides.

67. **GF120 NF** Fruit Fly Bait (spinosad) is registered on apples, pears, blueberries and stone fruits for control of the fruit fly pests. GF120 NF is listed by the Organic Materials Review Institute (OMRI) for use in organic production. The toxicant within GF120 is spinosad, a selective insect control product produced by the fermentation of a naturally occurring soil bacterium. The primary route of entry into the target insects is through ingestion, which is enhanced by the bait mixture in which the poison is formulated in. GF120 must be applied with specialized equipment, and is designed for low-volume application by air.

8. Guthion (azinphos-methyl) is an organophosphate (OP) insecticide registered for use in apples, pears, cherries, peaches, nectarines, caneberries and blueberries. Grapes, plums and strawberries have recently been removed from the Guthion label, though existing stock can still be used. It provides good broad-spectrum control of many primary fruit pests with a residual action of 10-14 days. It will not provide commercial control of insects that have attained resistance to OPs, like the white apple leafhopper, spotted tentiform leafminer, and obliguebanded leafroller. It is also known to be of general low toxicity to predacious mites, which are important as biological control agents for mite pests of fruit. The maximum yearly amount of Guthion 50 WP to be applied has been reduced to 9 lbs on apples and pears, and 6.75 lbs on peaches and nectarines. The Pre-Harvest Interval (PHI) for apple use has also been increased to 14 days, with a 21-day PHI if the last application is greater than 2 lbs of Guthion 50 WP per acre.

9. Imidan (phosmet) 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 organophosphate resistant strains of white apple leafhopper, spotted tentiform leafminer and obliquebanded leafroller, which are common in Michigan. To prevent premature product breakdown, spray-tank water may need to be buffered if pH is greater than 7.0.

50. Intrepid (methoxyfenozide) is an insect growth regulator in the diacylhydrazine class of insecticides registered for use on apples, pears, grapes and stone fruits for the control of lepidopterous insect pests such as the obliquebanded leafroller, codling moth, oriental fruitworm, spotted tentiform leafminer, grape berry moth, and tufted apple budmoth. This compound works by mimicking the action of the natural insect hormone 20-hydroxyecdysone, the physiological inducer of the molting and metamorphosis process in insects. It must be ingested by the larvae, and may take several days to cause mortality. The addition of an agricultural adjuvant (such as Latron B-1956) to Intrepid 2F is recommended to improve spray deposition.

10. Kelthane (dicofol) is a miticide registered for use in apples, pears, grapes, and strawberries, and 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 a contact miticide that is primarily active against motile stages of European red mite and two spotted spider mite, but also nymphal stages that hatch after application. Kelthane is moderately toxic to mite predators, and temperature does not affect its activity against pest mites. To avoid the possibility of resistance, use only 1 to 2 times a season, and only once against the same generation of mites. Good spray coverage is necessary for good performance of Kelthane. Use of a spreader-sticker is advised.

11. Lannate (methomyl) is registered for use on apples, peaches, grapes, strawberries and blueberries and is primarily effective as a contact insecticide, though ingestion can be important. Methomyl residues remain effective for about 3-7 days, so timing is important. Methomyl controls fruitworms, certain leafroller and leafminer pests, which are difficult to control with other broad-spectrum compounds. It also controls indirect pests such as aphids. 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 may not be used in U-Pick plantings. Methomyl is extremely toxic to fish and bees, so avoid use when bees are active and keep out of any body of water. CAUTION: Outbreaks of wooly apple aphid may result from a season-long (multiple applications) of Methomyl.

32. Lorsban (chlorpyrifos) is an organophosphorous insecticide that has great affinity for organic matter such as bark or soil. It is registered for use as a trunk spray on apples and cherries (also peaches and nectarines for Lorsban 4E), and it effectively controls American plum borer, dogwood borer and peachtree borers. Foliar applications may be used pre-bloom for scale and rosy aphid control, either alone or in combination with oil. Lorsban is NO LONGER registered for post-bloom foliar use on apples. Lorsban also has a special local needs 24(c) label in grapes for pre-bloom control of climbing cutworms (effective 2004), targeted at the trunks of the vines. Lorsban 4E is best timed at the start of bud feeding, and repeated 10-14 days later if cutworm feeding continues.

13. Malathion is a mild organophosphate insecticide that is registered for use in apples, pears, apricots, cherries, blueberries, grapes, peaches, caneberries, strawberries, and nectarines, and controls an unusual variety of fruit insects and is especially useful against several species of aphids. However, its residual effectiveness seldom exceeds 2 to 4 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. It is generally compatible with every insecticide and fungicide in common usage.

14. MPEDE 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.

54. NEEM-based (azadirachtin) products are available for use on most all Michigan fruit crops for a wide range of pests, marketed as Ecozin, AzaDirect, Agro-Neem and Neemix. The active ingredient of NEEM was originally derived from extracts of the Neem tree, a native plant of India. This compound controls insects in the larval, pupal and nymphal stages by interfering with the metabolism of ecdysone, therefore preventing normal development. It also works as a repellent on the adult stage of many insect pests. Because of its short residual life, it may need to be reapplied every 5-10 days if pest populations persist. This pesticide is toxic to fish and aquatic invertebrates, and to bees exposed to direct treatment or residues on blooming crops or weeds. The recommended tank water pH range is between 5.5 and 6.5. AzaDirect and Neemix are listed by the Organic Materials Review Institute (OMRI) for use in organic production.

34/35. Permethrin (Ambush and Pounce) is a synthetic pyrethroid. These compounds exhibit low mammalian toxicity while having high insecticidal activity. They act as stomach and contact poisons.

Permethrin is cleared for seasonal use on peaches and cherries, and may be used before petal fall on apples and pre-bloom on pears. This material is highly toxic to mite predators and should be used carefully to prevent mite population buildup.

19. Provado (imidacloprid) belongs to a new class of insecticides called neonicotinoids (chloronicotinyl subclass). Provado is registered on apples and pears as a 1.6 F and on grapes as a 75 WP in a SoluPak. This translaminar (locally systemic) material has long residual inside the foliage, and is effective on sucking insect pests such as leafhoppers, psylla and aphids. It will also control organophosphate-resistant pests such as white apple leafhopper, and spotted tentiform leafminer, but must be applied at early petal fall for effective timing on the first generation STLM sapfeeding larvae. Because most of Provado's surface residue is quickly absorbed into the plant, negative impact on natural enemies is minimized.

45. Pyramite (pyridaben) is an insecticide/miticide registered for use in apples, pears, grapes, and stone Pyramite 60 WP works as a contact fruits. miticide/insecticide that provides good knockdown and residual control of mites, leafhoppers and psylla, and should be applied when pest populations are beginning to build and before they reach economic thresholds. It is effective on a broad spectrum of mite pests (European red mites, two spotted spider mites, pear rust mites, apple rust mites), but requires thorough coverage to ensure pests will contact the product. Pyramite is restricted to post-harvest use (300 day PHI) in apricots and cherries, whereas it has a lot of in-season flexibility for use in apples, pears, plums, prunes, peaches and grapes.

57/58. Pyrethrum (PyGanic and Evergreen) is a botanical insecticide produced primarily in the flowers of Tanacetum cinerariaefolium, a species of the chrysanthemum plant family. Pyrethrum is an ancient insecticide that is still used to control insects because of it's benefits of being non-persistent, and decomposing rapidly in the environment. Pyrethrum is low in acute toxicity to man and other vertebrate animals, is non-carcinogenic, causes no adverse reproductive affects and is non-mutagenic. PyGanic is listed by the Organic Materials Review Institute (OMRI) for use in organic production. Evergreen is another pyrethrum based compound, which includes piprinol butoxide (PBO) to enhance it's insecticidal activity, but consequently results in exclusion from the OMRI listing. PyGanic and Evergreen insecticides have the typical pyrethrum-flush, rapid knockdown, and pest kill attributes that are characteristic of pvrethrin-based compounds. PyGanic and Evergreen are approved for use on most all fruit crops. Some of the pests controlled by PyGanic and Evergreen include; leafhoppers, stink bugs, aphids, thrips, Japanese beetle and loopers.

42. Savey (hexythiazox) is a miticide for control of European red mites and two-spotted spider mites on apples, cherries, peaches, plums and strawberries. It is an active mite ovicide and larvacide, providing

control ranging from 10 weeks to full season depending on mite pressure, the extent of 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 can be used at the traditional pink stage or with the recent label amendment it can be applied later in the season up to a 28-day PHI. For stone fruits it can be used after bloom up to a 28-day PHI. In all cases, it may be applied ONLY once per year. It is not effective against rust mites and is not toxic to predator mites.

23. Sevin (carbaryl) is formulated as a 50 WP, 80 S and 4 lb/gal flowable (XLR Plus) and is labeled for use in nearly every fruit crop grown in Michigan. Its residual effectiveness varies from 5 to 14 days, depending on the target pest to control. The preharvest intervals for fruit crops range from 3 - 7 days, making it in many cases an effective tool for nearharvest pest control. Sevin may encourage aphid buildups and is toxic to bees. This material is highly toxic to mite predators and should be used carefully to prevent flaring mite populations. It is compatible with most pesticides and 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 in apples within 30 days after full bloom.

46. SpinTor (spinosad) is registered on apples, strawberries, blueberries and stone fruits for control of leafrollers, codling moth, oriental fruit moth, green fruit worm, spotted tentiform leafminer, and thrips. The active ingredient, spinosad, is a waste metabolite produced during the growth of a bacteria, therefore belongs to the Naturalyte class of insecticides. The primary route of entry into the target insects is through ingestion, although the product is also absorbed through the cuticle. SpinTor provides 7 - 14 days of residual control, depending on the target pest, but good coverage will increase consistency of crop protection. SpinTor should be applied no more than four times per season. The use of a penetrating or silicone surfactant can enhance coverage and penetration of leaf surfaces. SpinTor applications should not be made with less than a 1 - 2 hour rain free period. SpinTor has shown good safety to many beneficials, but can be toxic to bees if contacted before sprays are dried.

24. Superior Oil "Superior Oil" has been recommended as one of the preventive European red mite control programs in tree fruit. 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.

53. SURROUND WP (kaolin) is registered for use on apples, pears, blueberries and wine grapes. The use of Kaolin for fruit insect pest management is based on a new concept called Particle Film Technology. Kaolin is a common food additive already approved by the FDA as a generic filler and bulking agent. The objective of Particle Film Technology for insect pest management is to create a protective barrier between the plant and the pest that 1) reduces host recognition of the pest, and 2) prevents normal movement and damaging activity (i.e; egg laying, feeding, sheltering). In addition, if picked up onto body parts of the insect or mite, the abrasive nature of the material can cause significant irritation leading to repellency or even mortality of the pest. SURROUND WP can be applied to fruit crops through conventional orchard sprayer equipment. As a freshly applied spray it appears as a milky liquid, but with evaporation leaves a dry white film on the plant. Because it does not work like conventional contact poisons, complete coverage of the plant is critical, and performance is improved when applied to large, contiguous blocks. Adequate coverage is achieved primarily through use of proper rates of the product and sufficient gallons per acre of Multiple applications are typically water carrier. needed to attain initial coverage, as well as to compensate for actively growing plant tissue and to respond to wash-off from rain or excessive wind. Surround WP is listed by the Organic Materials Review Institute (OMRI) for use in organic production.

26. Thiodan and Phaser (endosulfan) are registered on many fruit crops for the control of aphids, plant bugs, tentiform leafminer adults, as well as greater and lesser peach tree borers. A 50% wettable powder and 3 lb/gal emulsifiable concentrate are available with no more than two applications after petal fall and during the fruiting season. Post-harvest sprays of endosulfan reduce late season infestations and there are no restrictions for post-harvest use of the product. Endosulfan may also be used as a pre-plant dip for nursery stock. Endosulfan is labeled in blueberry for post-harvest control of the blueberry bud mite. Unlike Lorsban, endosulfan may be used for all stone fruits. Endosulfan is highly toxic and requires the same caution granted any chlorinated product similar to it.

28. Vendex is formulated as a 50 WP 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, pears, stone fruits, grapes and strawberries to control European red, two-spotted, and rust mites. 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 fruit crop sprays. No phytotoxicity or adverse effects on fruit finish have been reported. Apply when mites appear. It is of low toxicity to predaceous mites and can be utilized to adjust predator-prey ratios. 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.

30. Vydate is a systemic and contact carbamate insecticide-acaricide-nematicide. It is currently labeled as a nematicide and miticide on non-bearing fruit trees, and as an insecticide-miticide on bearing apples. 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 pt/100 gal or fruit thinning may occur. Outbreaks of wooly apple aphid may occur from a season-long program of Vydate.

66. Warrior (lambda cyhalothrin) is a synthetic pyrethroid insecticide that is labeled for use on pome and stone fruit crops. It is labeled for control of a broad spectrum of sucking and chewing pests, including leafrollers, leafhoppers, plum curculio, scarab beetles, and internal feeders like codling moth and oriental fruitworm. This material is also highly toxic to mite predators and should be used carefully to prevent mite population buildup. Warrior has a unique

microencapsulated formulation called "Zeon Technology", that protects the foliar residue from UV degradation so as to enhance the compound's residual activity. Warrior is restricted to 1.6 pints per acre per season.

63. Zeal (etoxazole) is a growth regulator miticide labeled for use in apples for the control of mites. Zeal is primarily active against major tetranychidae mites (spider mites and red mites) in the egg and larval stages of growth, providing control ranging from 8 weeks to full season depending on mite pressure, the extent of tree vegetative growth and predator mite populations. Zeal controls susceptible mites by inhibiting the molting process through disruption of the cell membrane. Since Zeal's activity depends upon mite development, control may not be observable for pronounced several days. Etoxazole exhibits translaminar movement in plant leaves, enhancing activity when the pest is located on the undersides of leaves. Zeal is not known to have risk of crossresistance with other currently registered miticides. Zeal is restricted to one application per acre per season.

Monitoring Insects

Biological monitoring refers to checking a crop 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 over wintering 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.

Traps

Different trapping techniques can be used to monitor the presence and seasonal activity of fruit insect pests. The bait trap is designed to monitor fruit flies, visual sticky traps can be used for leafhoppers and to monitor natural enemies, and pheromone traps are designed to attract moth species which are fruit pests.

Visual trap By using a color attractive to plant-feeding insects, scouts and growers can detect a pest early in

its development, and monitor changes in its population. Most of these traps are yellow, though a white one may be used for tarnished plant bug. Traps are hung in the crop and checked weekly for insects trapped on its surface.

Bait trap The bait trap attracts adult fruit flies (cherry fruit flies, apple maggot, or blueberry maggot) through a combination of their attractive color and the odor given off by the bait (usually a mixture of protein hydrolasate and ammonium acetate). The flies are trapped in a sticky substance coating the trap. By inspecting them at regular intervals, their presence and relative activity, or abundance, can be judged. The attractive powers of these traps are not known, and if fly populations are low (as in most commercial fruit plantings) the ability of the trap to attract and therefore detect individuals, is questionable. However, traps placed in surrounding woods, abandoned fruit crops. or commercial sites with annual problems are useful for this purpose. Other designs of baited traps that attract Japanese beetles and rose chafers can be used to detect the start of their activity.

Pheromone Traps

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 precoated 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 provide insect detection, adult emergence and general monitoring information for lepidopterous fruit pests, such as the red-banded leafroller, codling moth, cranberry fruitworm, grape berry moth, obliquebanded leafroller, tufted apple bud moth, and Oriental fruit moth. These traps may be used to determine insect presence or absence in a crop to assess pest pressure, emergence trends, and economic damage or timing thresholds. They eliminate much of the guesswork in targeting controls for many of the important direct fruit insects pests. These traps are not a replacement for direct visual monitoring in the orchard of the other key life stages of these pests.

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) 268-5693 or 5911 Gempler's P.O. Box 270 Mt. Horeb, WI 53572 (800) 272-7672

Tree-Row Volume

J. W. Johnson

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 3X 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 X 23.2 X 20 = 580,180. 580,180 ÷ 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 **26** 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 X 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/ 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 foliaged 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.

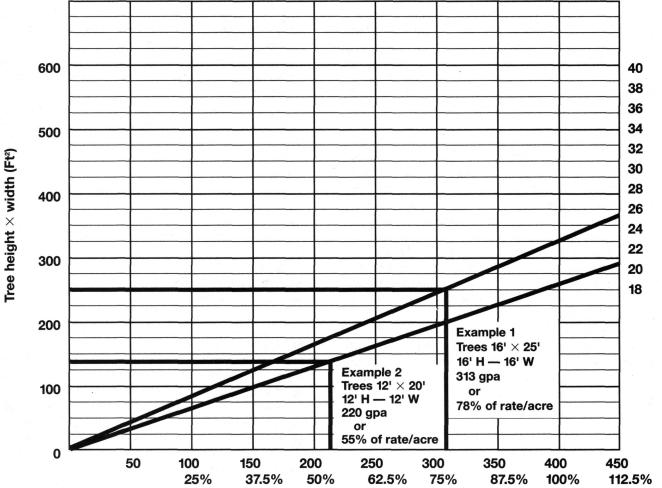
Failure to apply the proper rates per acre can lead to disastrous results when dealing with thinners, growth regulators and other rate sensitive materials. At the very least, overestimating causes excess materials to be applied and underestimating could lead to lack of control.

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, until a grower gains experience with this method, 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.)

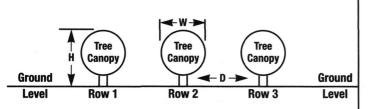


Top row—gallons/acre dilute Bottom row—% of rate/acre -50 12 Distance between rows

Percent of Standard Chart

(Standard is 400 gal/A)

Calculating Percent of Standard



To determine your blocks PERCENT OF STANDARD, take the width and 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%.

H = Tree Height W = Tree Width D = Distance Between Rows

Heigh	t &	Square							Distar	nce Bet	ween F	lows				
Wid		Feet	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 8	12 14	96 112	51	45 53	40	36	33	30	28	•		•	•	•	•	•
8	14 16	12	60 69	53 60	47 53	42 48	38 44	35 40	32 37	•	•	•	•	•	•	·
10			64	56	50						•	•	•	•	•	
10	12 14	120 140	64 75	56 66	50 58	45 53	41 48	38 44	35 40	32 38	•	•	•	•	•	•
10	16	160	86	75	67	60	55	50	40	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		7		•
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 18	20	360			8		123	113	104	97	90	84	79	75 83	•	
18	22 24	396 432					135 147	124 135	114 125	106 116	99 108	93 101	87 95	90	•	•
20	20	400					147	125	116	107	100	94	88	83	79	•
20	20	400						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	<u>`</u> 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 runoff, 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 x (dilute), 2X (1/2 water), 3x (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 2 EC:

Dilute Spray:

Use 7.7 ounces of Ambush

2 EC per acre in 240 gallons of water.

Concentrate Spray:

To spray a 2x concentrate spray, use 7.7 ounces of Ambush 2 EC in 120 gallons of water per acre; To spray a 3x concentrate spray, use 7.7 ounces of Ambush 2 EC in 80 gallons of water per acre.

Percent of Stand	ard Gallons of	20	30	40	50	60	70	80	90	100	110	
Water/Acre (Dilut	te)	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											
Superior Oil		1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	gallon
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
Vydate	2 L	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

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 Extension, 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 Baskerville-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 Management Guide. Look for the information in the dark bar with the name of the growth stage. This information should help you better understand growth conditions in your orchard for better insect management decision-making.

for the Peach Ridge Weather Station **APPLE PEST GUIDE**

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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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASE		BACTERICIDES
Phytophthora Collar Rot	See "Tree Fruit Fungicides," pages 41-45	57/58. Copper compounds
Fire Blight Copper Silvertip-1/4" green tip	57/58g	Copper hydroxide (Champ, Champion, Kocide, many others) – see label.
		Copper oxychloride (COCS, others) – see label. Basic copper sulfate (Basicop, Blue Shield, many others) – see label.
		Copper sulfate plus mancozeb Cuprofix Disperss see label.
		Comments: Use of copper at this stage does not eliminate the need for streptomycin during bloom. Adding spray oil at 1 qt/100 gal of spray solution (do not concentrate the oil) improves efficacy, but also increases the chance of phytotoxicity.

Apple Scab Control

SILVER TIP

Select scab fungicides from the following table. No single fungicide or class of fungicides can be used exclusively due to registration restrictions, differences in efficiency and control spectrum, anti-resistance strategies, and compatibility restrictions. Integrate at least two or three classes of fungicides into the scab control program each season. Individual applications may consist of a single product or a mixture, applied in no more than 2 or 3 consecutive applications. See page **42** for a possible use strategy.

		Restrie	ctions*
Rate/acre	Timing and Comments	PHI (days)	Maximum/ acre/season
6 - 8 lb	<i>Primary scab:</i> Begin applications at green tip and continue on a 5 to 7 day schedule through first cover.	14 days	64 lb
4 - 8 lb	Secondary scab: Apply at 10 to 14 day intervals in second and later cover sprays.		
3 - 4 lb	<i>Tank Mixtures:</i> Mix with Nova, Procure, Rubigan, Vangard, etc. when needed for scab control. Begin applications at green tip and continue on a 7 to 10 day schedule depending on mixing		
	6 - 8 lb 4 - 8 lb	 6 - 8 lb <i>Primary scab</i>: Begin applications at green tip and continue on a 5 to 7 day schedule through first cover. 4 - 8 lb <i>Secondary scab</i>: Apply at 10 to 14 day intervals in second and later cover sprays. 3 - 4 lb <i>Tank Mixtures</i>: Mix with Nova, Procure, Rubigan, Vangard, etc. when needed for scab control. Begin applications at green tip and continue on a 	Rate/acreTiming and CommentsPHI (days)6 - 8 lbPrimary scab: Begin applications at green tip and continue on a 5 to 7 day schedule through first cover.14 days4 - 8 lbSecondary scab: Apply at 10 to 14 day intervals in second and later cover sprays.14 days3 - 4 lbTank Mixtures: Mix with Nova, Procure, Rubigan, Vangard, etc. when needed for scab control. Begin applications at green tip and continue on a 7 to 10 day schedule depending on mixing14 days

(Continued on next page)

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..SILVER TIP (CONTINUED)

		Restrict	
Rate/acre	Timing and Comments		Maximum/acre/ Season
		(ddys)	ocuson
	Application" schedule. Do not combine or integrate the two treatment schedules.		
6 lb	<i>Pre-Bloom schedule:</i> Begin applications at green tip and continue on a 5 to 7 day schedule through bloom.	Pre –Bloom schedule Do not apply	24 lb
6 lb		after bloom.	
6 lb	성영 영어 가슴을 많이 많이 같았다.		
6 lb			
3 lb	Extended Application schedule: Tank mix with a fungicide from a different chemical group. Begin	Extended Application	21 lb
3 lb	applications at green tip and continue on a 7 to	schedule 77 days	
3 lb		second cover.	
3 lb			*
5 - 8 oz	Pre-Bloom, Bloom, Postbloom: Begin applications at green tip or when	14 days	5 lb
	conditions become favorable for primary scab development and continue on a 7 to 10 day		
8 - 16 oz	Pre-Bloom, Bloom, Postbloom: Begin applications at green tip and continue on a	14 days	4 lb
8 - 12 oz	Pre-Bloom, Bloom, Postbloom: Begin applications at green tip or when	30 days	84 fl oz
	conditions become favorable for primary scab		
2.0 - 2.5 oz	Begin at green tip and continue as needed on a 7 to 10 day schedule	14 days	11 oz
	Maximum of 4 total applications of Flint or other strobilurin fungicide per acre per season and no more than 2-3 sequential applications of Flint or other strobilurin		
4.0 - 6.4 oz		30 days	25.6 oz
	Maximum of 4 total applications of Sovran or other strobilurin fungicide per acre per season and no more than 2-3 sequential applications of Sovran or other strobilurin		
	Not recommended in Michigan because of	7 days	
5 oz	<i>Pre-Bloom only</i> . Begin applications at green tip and continue on a 7-day interval. Use tank mix beginning at pink.	72 days	22 oz
3 oz	<i>Pre-Bloom, Pink, Bloom.</i> Apply tank mixture on 7- to 10-day interval. A shorter interval is preferred during periods of wet weather.		
	Not recommended in Michigan because of resistant apple scab.	0 days	
	6 lb 6 lb 3 lb 3 lb 3 lb 3 lb 5 - 8 oz 8 - 16 oz 2.0 - 2.5 oz 4.0 - 6.4 oz	6 lb Use either the "Pre-Bloom" or "Extended Application" schedule. Do not combine or integrate the two treatment schedules. Pre-Bloom schedule: Begin applications at green tip and continue on a 5 to 7 day schedule through bloom. 6 lb 6 lb 6 lb 7 8 lb 9 lb	Rate/acre Timing and Comments PHI (days) 6 lb Use either the "Pre-Bloom" or "Extended Application" schedule. Do not combine or integrate the two treatment schedules. Pre-Bloom schedule: Begin applications at green ip and continue on a 5 to 7 day schedule through bloom. Pre -Bloom schedule 6 lb Begin application schedule: Tank mix with a fungicide from a different chemical group. Begin applications at green tip and continue on a 7 to 10 day schedule through second cover. Extended Application applications at green tip and continue on a 7 to 10 day schedule through second cover. 3 lb Fre-Bloom, Bloom, Postbloom: Begin applications at green tip or when conditions become favorable for primary scab development and continue on a 7 to 10 day schedule. 14 days 8 - 16 oz Pre-Bloom, Bloom, Postbloom: Begin applications at green tip and continue on a 7 to 10 day interval through second cover. 30 days 8 - 12 oz Pre-Bloom, Bloom, Postbloom: Begin applications at green tip and continue on a 7 to 10 day interval applications of green tip and conditions become favorable for primary scab and continue on a 7 to 10 day spray interval. 30 days 2.0 - 2.5 oz Begin applications at green tip and continue on a 7 to 10 day ischedule 14 days Maximum of 4 total applications of Flint or other strobilurin fungicide per acre per season and no more than 2-3 sequential applications of Sovran or other strobilurin fungicide per acre per season and no more than 2-3 sequential applications of Sovran or other strobilurin fungicid

*Restricted Entry Intervals (REI) are listed on page 169 with all other fungicides. When using combinations base reentry on the fungicide with the longest interval.

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		Sterol inhibitors and strobilurins control scab
Apple Scab (Primary)	See Silver Tip and pages 31-32	and powdery mildew. Captan, Vangard, and
Powdery Mildew	See "Tree Fruit Fungicides" pages 41-45	EBDC fungicides do not control powdery
		mildew.
INSECTS/MITES		INSECTICIDES
European Red Mite	17e, 24e, 42e	3. Carzol 92 SP (1 lb)
San Jose Scale	5g, 24e, 32e, 52e, 62g	5. Diazinon 50 W (4 lb)
Spotted Tentiform Leafminer (adult	3g, 26f, 34e*, 35e*, 40e*, 52g, 59e, 60e,	14. MPEDE (1 % - 2% v/v)**
and eggs)	62e	17. Apollo SC (4 - 8 fl oz)
Rosy Apple Aphid	5e, 14+24e**, 24e, 32e, 52g, 59e, 56,	24. Superior Oil (Biocover; Sunspray6F)
	60e, 62e	(1% - 2% v/v)
		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)*
		42. Savey 50 WP (3 - 6 oz)
		42. Savey 50 DF (3 - 6 oz)
		52. Esteem 35WP (5 oz)
		59. Actara 25WG (4.5 oz)
		56. Supracide 2E (3 - 12 pts)
		60. Assail 70WP (1.1 oz)
		62. Calypso 480SC (2 - 4 oz)
		Comments:
		*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

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		Mildew control is critical at this time.
Apple Scab (Primary)	See Silver Tip and pages 31-32	Sterol inhibitors and strobilurins control
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	scab and powdery mildew.
INSECTS/MITES		INSECTICIDES
European Red Mite	3g, 30f, 42e, 44g	3. Carzol 92 SP (1 lb)
Aphids	6e, 11g, 26e, 30g, 32g	6. Dimethoate 2.67 EC (6 pt)
Tarnished Plant bug	3g, 6e, 11g, 26f, 34e, 35e, 40e, 44g, 66g	6. Dimethoate 25 WP (8 lb)
Green Fruitworm	11g, 26f, 32e, 34e, 35e, 40e, 44e, 66e	6. Dimethoate 400 (4 pt)
Obliquebanded Leafroller	8p/f, 9p/f, 11f/g, 32f/g, 34g, 35g, 40g, 44g, 66g	8. Guthion 50 WP (2 lb)*
Oriental fruit moth	47g	9. Imidan 70 WP (3 lb)*
Comments:		11. Lannate 90 SP (1 lb)
The effectiveness of materials	s for control of OBLR varies depending upon levels of	26. Thiodan 50 WP (4 lb)
resistance that have develope		26. Thiodan 3 EC (2 2/3 qt)
	rmine the application rate and number of treatments	30. Vydate 2 L (4 - 8 pt)
	r product. Monitor the orchard with pheromone traps	32. Lorsban 50 WP (2 - 3 lb)
and by visual inspection of fru		34. Ambush 2 EC (12.8 fl oz)
		34. Ambush 25 WP (12.8 oz)
		35. Pounce 3.2 EC (8 fl oz)
***Place pheromone dispen	sers in the orchard prior to moth emergence in the	35. Pounce 25 WP (12.8 oz)
	etermine the application rate and number of	40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
	a particular product. Monitor the orchard with	42 . Savey 50 WP (3 - 6 oz)
pheromone traps and by visu		42 . Savey 50 DF (3 - 6 oz)
,		44. Danitol 2.4 EC (10.6 - 21.3 oz)
		47. Oriental fruit moth mating disruption
		products*** ▲
		66. Warrior 1CS (2.56 - 5.12 oz)
		Comments:
		* Water soluble pouch formulations will
		not dissolve well if the spray water contains
		boron. It is recommended that the pouches be
		added, and fully dissolved, before the boron is
		added.

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		BACTERICIDES
Apple Scab (Primary)	See Silver Tip and pages 31-32	1. Agrimycin 17 WP (1.5 lb)*
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	22. Mycoshield 17 WP (1.5 lb)*
Fire Blight	1e, see Fire Blight, page 46-47	GROWTH REGULATOR
-	2g, see Fire Blight, page 46-47	23. Apogee 27.5% (36 - 48 oz)** + Regulaid
		(see label)
Comments:		Comments:
Apply Bactericides beginning at 10% bloom and continue on a 5 to 7 day schedule through petal fall. Apply Apogee at first petal fall on king blooms. Apogee will not affect the occurrence of blossom blight but, when used effectively, may reduce the occurrence of shoot blight. Apogee should not be substituted for streptomycin (Agrimycin, etc.) for blossom blight control. If needed, streptomycin can be combined with Apogee. See Fire Blight, page 46-47 .		*Use Mycoshield (17% oxytetracycline)at 1.5 Ib/150 gallons of water per acre (200 ppm solution) as part of an anti-resistance strategy for streptomycin. It can be combined with streptomycin for improved fire blight control and resistance management. Mycoshield can only be used on apples in 2004 if EPA grants a special Section 18 emergency registration. **Based on 300-400 gallons of dilute spray per acre, respectively.
INSECTS/MITES		INSECTICIDES
Codling Moth	44g	44. Codling moth mating disruption products*▲

Comments:

*--Place pheromone dispensers in the top 2 feet of the canopy prior to moth emergence in the spring. Refer to the label to determine the application rate and number of treatments recommended for a particular product. Supplement the pheromone disruption product with insecticide sprays for larval control if pest pressure is too high for pheromone alone to provide control. Monitor the orchard with pheromone traps and by visual inspection of fruit.

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		BACTERICIDES
Apple Scab (Primary)	See Silver Tip and pages 31-32	1. Agrimycin 17 WP (1.5 lb)*
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	22. Mycoshield 17 WP (1.5 lb)*
Fire Blight	1e, see Fire Blight, page 46-47 2g, see Fire Blight, page 46-47	Comments: *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 be combined with streptomycin for improved fire blight control and resistance management. Mycoshield can only be used on apples in 2004 if EPA grants a special Section 18 emergency registration.
INSECTS/MITES		INSECTICIDES
Aphids	11g, 19e**, 55g, 59e, 60e, 62e	3. Carzol 92 SP (1 lb)
White Apple Leafhopper	3e, 6f, 11e, 14g, 19e**, 41g, 45f, 53g, 55g, 59e, 60e, 62e	 Diazinon 50 WP (4 lb) Dimethoate 2.67 EC (6 pt)
Tarnished Plant bug	6e, 26g, 34e***, 35e***, 40e, 44e, 53g, 55g, 66e	 6. Dimethoate 25 WP (8 lb) 6. Dimethoate 400 (4 pt)
Plum Curculio	5g, 8e, 9e, 34g***, 44g, 35g***, 40g, 44g, 53f/g, 55e, 59e, 60e, 62e, 66g	8. Guthion 50 WP (2 lb) 9. Imidan 70 WP (3 lb)
Spotted Tentiform Leafminer (Larvae)	11e, 19e**, 41e, 46e, 50g, 59e, 60e, 62e	11. Lannate 90 SP (1 lb) 14. MPEDE (1% - 2% v/v)
Obliquebanded Leafroller	8p/f, 9p/f, 11f/g, 34g, 35g, 40g, 43g, 44g, 46e, 49g, 50g, 64e, 66g	17. Apollo SC (4 - 8 fl oz) 19. Provado 1.6 EC (4 - 8 fl oz)**
Other Leafrollers	8e, 9e, 11e, 34e***, 35e***, 40e, 43g, 44e, 46e, 50g, 55g, 64e, 66e	26. Thiodan 50 WP (4 lb) 34. Ambush 25 WP (12.8 oz)***
European Red Mite	3g, 17e, 41e, 45e, 42e, 44g, 61g, 63e	35. Pounce 25 WP (12.8 oz)***
Codling Moth	52f, 53f	40. Asana XL 0.66 EC (8.0- 14.5 fl oz)
Oriental Fruit Moth	5g, 8e, 9e,11e, 40e, 44e, 46f, 50g, 55f, 46f, 60e, 62e, 64f, 66e	41. Agri-Mek 0.15 EC (10 - 20 oz) 42. Savey 50 DF (3 - 6oz)
Comments:		42. Savey 50 WP (3 - 6 oz) plus paraffinic spray oil (1 gal)
*Must maintain coverage for a		43. Bacillus thuringiensis (B.t.) ****
	arly petal fall to control Spotted Tentiform Leafminer	Deliver AC (0.5 - 2.0 lb)
	For Leafhopper control, use 4 fl oz/A; use the 8 fl	Dipel DF 1 - 2 lb
oz/A rate for Leafminer and Ro		44. Danitol 2.4 EC (10.6 - 21.3 oz)(16 - 21.3
***Ambush and Pounce may I	early egg hatch and complete coverage is required	oz for PC,OFM,OBLR)
	ations are generally required. B.t. is most effective	45. Pyramite 60 W (4.4 - 6.6 oz)
under warm weather conditions		46. Spintor 2 SC (6 - 10 oz)
	g leafhoppers only, use 2 - 2.75 oz/acre.	49. Confirm 2 F (20 oz)
· · · · · · · · · · · · · · · · · · ·	, , , , ,	50. Intrepid 2 F (12 - 16 oz)
		52. Esteem 35 WP (5 oz) 53. Surround WP (25 - 50 lb)* ▲
		59 . Actara 25 WG (4.5 - 5.5 oz) *****
		55. Avaunt 30 WG (5-6 oz)
		60. Assail 70 WP (1.1 oz)(3.4 oz for PC,OFM)
		61. Acramite 50 W (0.75 - 1.0 lb)
		62. Calypso 480 SC (2 - 4 oz)(4 - 8 oz for PC,OFM)
		63. Zeal 72 WDG (2 - 3 oz)
		64. Entrust 80 WP (2 - 3 oz) ▲
		66. Warrior 1 CS (3.4 - 5.12 oz)

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		BACTERICIDES
Apple Scab	16e, 17e, 50g, 51g, 52g	1 . Agrimycin 17% (1.5 lb)*
Powdery Mildew	See "Tree Fruit Fungicides" pages 41-45	Comments:
Fire Blight	1e Following (within 24 hours) a hailstorm. See	*The fewer streptomycin applications made
	Fire Blight, page 46-47	in summer, the longer the product is likely to
Blister Spot on Mutsu	See "Tree Fruit Fungicides" pages 41-45	be effective. The use of streptomycin after
		bloom is only recommended in conjunction
		with a hailstorm event.
		FUNGICIDES
		16. Sovran 50 W (4.0 - 6.4 oz)
		17. Flint 50 W (2.0 - 2.5 oz)
		50. Captan 50 WP (4 - 8 lb)
		51 . Ziram 76 DF (4 - 6 lb)
		52 . Nova 40 W (5 - 8 oz),
		Rubigan 1 EC (8 - 12 fl oz),
		or Procure 50 WS (8 - 16 oz)
	•	Protectant scab fungicide
INSECTS/MITES		INSECTICIDES
Plum Curculio	See Petal Fall	5. Diazinon 50 WP (4 lb)
Leafrollers	See Petal Fall	8. Guthion 50 WP (2 lb)
European Red Mite	See Petal Fall, 17e, 41e, 42e, 44g 45e, 61g ,	9. Imidan 70 WP (3 lb)
European Red Mile	63e	11 . Lannate 90 SP (1 lb)
Spotted Tentiform Leafminer	41e	17. Apollo SC (4 - 8 fl oz)
Codling Moth	5g, 8e, 9e, 11g, 23f, 40g, 44g, 46f, 50g, 52f,	23. Sevin 50 WP (8 lb)
Couling Motin	53f, 55f, 60g, 62g, 64f, 65f/g, 66g	23. Sevin 80 S (5 lb)
White Apple Leafhopper	See Petal Fall	23 . Sevin XLR+ (2 - 3 gt)
Apple Rust Mite	17f, 42f, 45e	40. Asana XL 0.66 EC (8.0- 14.5 fl oz)
Comments:	1/1, 421, 436	41. Agri-Mek 0.15 EC (10 - 20 oz) plus
*Apply as often as needed to m	aintain coverage	paraffinic spray oil (1 gal) (Sun
Apply us often us needed to m	untum oovoluge.	Ultrafine or other summer oil)
		42 . Savey 50 WP (3 - 6 oz)
		42 . Savey 50 DF (3 - 6 oz)
		44. Danitol 2.4EC (10.6 - 21.3 oz)
		45. Pyramite 60 WP (4.4 - 6.6 oz)
		46. SpinTor 2 SC (7.5 - 10 oz)
		50. Intrepid 2 F (12 - 16 oz)
		52 . Esteem 35 WP (5 oz)
		53. Surround WP (25 - 50 lb)* ▲
		55. Avaunt 30 WG (5 - 6 oz)
		60. Assail 70 WP (3.4 oz)
		61. Acramite 50 W (0.75 - 1.0 lb)
		62. Calypso 480 SC (4 - 8 oz)
		63. Zeal 72 WDG (2 - 3 oz)
		64. Entrust 80 WP (3 oz) ▲
		65. CM granulosis virus (see labels) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz)
		00. Wallof 1 03 (3.4 - 3.12 02)

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab	See First Cover	
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	이 물건 것 같아. 그는 것 같아요. 정말 같아.
Blister Spot on Mutsu	See "Tree Fruit Fungicides," pages 41-45	
INSECTS/MITES		INSECTICIDES
Codling Moth	5g, 8e, 9e, 11g, 23f, 40g, 44g, 46f, 50g, 52f,	5. Diazinon 50 WP (4 lb)
	55f, 60g, 62g, 64f, 65f/g, 66g	8. Guthion 50 WP (2 lb)
Potato Leafhopper	(See Comments) 3e, 8e, 9e 11e, 19e, 55g, 57,	9 . Imidan 70 WP (3 lb)
	58, 59e, 60e, 62e	11. Lannate 90 SP (1 lb)
Rose Chafer	8g, 9g, 11f, 19f, 23g, 59f, 55f	19. Provado 1.6 EC (4 fl oz)
	See "Special Apple Insect Controls", page 48-	17. Apollo SC (4 8 fl oz)
	49	23. Sevin 50 WP (8 lb)
San Jose Scale (crawlers)	5g, 52e	23. Sevin 80 S (5 lb)
Tufted Apple Budmoth	8g, 11g, 46g, 49e, 50e, 52g, 55g	23 . Sevin XLR+ (2 - 3 qt)
	og, 11g, 40g, 49e, 50e, 52g, 55g	40. Asana XL 0.66 EC (8.0 - 14.5 fl oz)
Comments:		44. Danitol 2.4EC (10.6 - 21.3 oz)
	rate to Michigan from southern states, generally in	46 . SpinTor 2 SC (7.5 - 10 oz)
	all fruit crops, and cause leaf margins to turn brown	49 . Confirm 2 F (20 fl oz)
	ons build quickly in June and usually peak in early	50 . Intrepid 2 F (12 - 16 oz)
July.		52. Esteem 35 WP (5 oz)
		55. Avaunt 30 WG (5 - 6 oz)
		57. Pyganic EC 1.4 (16 - 32oz)
		58. Evergreen EC 60-6 (8 - 16oz)
		59. Actara 25 WG (4.5 - 5.5 oz)
		60. Assail 70 WP (3.4 oz)
		62. Calypso 480 SC (4 - 8 oz)
		63. Zeal 72 WDG (2 - 3 oz)
		64. Entrust 80 WP (3 oz) ▲
		65. CM granulosis virus (see labels) ▲
		66. Warrior 1CS (3.4 - 5.12 oz)

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab	See First Cover	
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	
INSECTS / MITES		INSECTICIDES
Codling Moth	See First Cover	5. Diazinon 50 WP (3 - 4 lb)
Apple Rust Mite	28g, 45e, 54g	6. Dimethoate 400 (4 pt)
Mites (adults)	10g, 14g**, 28g, 30g, 44g, 45e, 61g	6. Dimethoate 2.67 EC (6 pt)
Mites (immature)	10g, 14g**, 28g, 30g, 44g, 45e, 61g, 63e	6. Dimethoate 25 WP (8 lb)
Redbanded Leafroller	See Petal Fall	8. Guthion 50 WP (2 lb)
Green Apple Aphid	6f, 11g, 19e, 30g, 40f, 54g, 57, 58, 59e, 60e,	10. Kelthane 35 WP (4 - 8 lb)
	62e	10. Kelthane 50 WP (3 - 5 lb)
Tufted Apple Budmoth	See Second Cover	11. Lannate 90 SP (1 lb)
Obliquebanded Leafroller	See Petal Fall	14. MPEDE (1% v/v)**
Spotted Tentiform Leafminer	See Petal Fall	19. Provado 1.6 F (8 fl oz)
Potato Leafhopper	See Second Cover	- 23. Sevin XLR+ (2 - 3 qt)
Tarnished Plantbug	26g, 40e, 44e, 54g, 55e, 66e	- 26. Thiodan 50 WP (4 lb)
Woolly Apple Aphid *	5g, 23f, 26g, 54f	- 28. Vendex 50 WP (1 - 2 lb)
Comments:		30. Vydate 2 L (4 pt)
	e Provado and Actara, are active on this pest, but	40. Asana XL 0.66 EC (8.0 - 14.5 fl oz)
not currently labeled for use.		44. Danitol 2.4 EC (10.6 - 21.3 oz)
	such as Kelthane or Vendex will improve mite	45. Pyramite 60 WP (4.4 - 6.6 oz)
•	utions. Use only as a tank-mix, it will not control	54. Neem compounds [AzaDirect (32 fl oz),
mites alone.		Ecozin (10 oz)] \blacktriangle
	nsect and Mite Problems and Controls,"	55. Avaunt 30WG (5 - 6 oz)
page 48-49		57. Pyganic EC 1.4 (16 - 32oz) ▲
page 10 10		58. Evergreen EC 60-6 (8 - 16oz)
		59. Actara 25WG (4.5 - 5.5 oz)
		60. Assail 70WP (3.4 oz)
		61. Acramite 50W (0.75 - 1.0 lb)
		62. Calypso 480SC (2-4 oz)
		63. Zeal 72WDG (2 - 3 oz)

66. Warrior 1CS (2.56 - 5.12 oz)

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

est Efficiency		Suggested Chemicals (Rate/acre)	
DISEASES		그 가격한 다 안 가지 않는 것이 사람 것 같이 다.	
Apple Scab (Secondary)	See First Cover		
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45	ter fin her of an	
Sooty Blotch, Fly Speck	See "Tree Fruit Fungicides," pages 41-45		
INSECTS / MITES		INSECTICIDES	
Apple Maggot	5g, 6e, 8e, 9e, 11g, 23f, 40g, 44f, 46f, 53e*, 60e, 62e, 64f, 66g, 67f	5. Diazinon 50 WP (4 lb) 6. Dimethoate 400 (4 pt)	
Codling Moth	See First Cover, Second Cover	6. Dimethoate 2.67 EC (6 pt)	
Obliquebanded Leafroller	11f/g, 40g, 43g, 44g, 46e, 49g, 50g, 64e, 66g	6. Dimethoate 25 WP (8 lb) 8. Guthion 50 WP (2 lb)	
Oriental Fruit Moth	5g, 8e, 9e, 11g, 23g, 40e, 44e, 46f, 50g, 55f, 60e, 62e, 64f, 66e	9. Imidan 70 WP (3 lb) 11. Lannate 90 SP (1 lb)	
Japanese Beetle	8e, 9e, 23g, 40g, 44g, 53f, 54f, 57f, 58f, 66g	23. Sevin 50 WP (8 lb) 23. Sevin 80 S (5 lb)	
agent when sprays for apple ma *Apply as often as needed to ma **-These are short-lived pyrethru ***Primarily a repellent. ****B.t.'s should be timed for ea		 40. Asana XL 0.66 EC (8.0 - 14.5 fl oz) 43. Bacillus thuringiensis (B.t.) **** Deliver AC (0.5 - 2.0 lb) Dipel DF 1 - 2 lb ▲ 44. Danitol 2.4 EC (10.6 - 21.3 oz) 46. Spintor 2 SC (6 - 10 oz) 49. Confirm 2 F (20 oz) 50. Intrepid 2 F (12 - 16 oz) 53. Surround WP (25 - 50 lb) ▲ 54. Neem compounds [AzaDirect (32 fl oz), Ecozin (10 oz)]*** ▲ 55. Avaunt 30 WG (5 - 6 oz) 57. Pyganic EC 1.4 (16 - 32oz)** ▲ 58. Evergreen EC 60-6 (8 - 16oz)** 	

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)	
DISEASES			
Apple Scab	See First Cover		
Powdery Mildew	See "Tree Fruit Fungicides," pages 41-45		
Sooty Blotch, Fly Speck	See "Tree Fruit Fungicides," pages 41-45		
INSECTS / MITES	ž	INSECTICIDES	
Apple Maggots	See Fourth Cover	32 . Lorsban 50 WP (3 lb/100gal)*	
Codling Moth	See First Cover	32. Lorsban 4 E (1.5 qt/100 gal)*	
Redbanded Leafroller	See Petal Fall	Comments:	
Obliquebanded Leafroller	See Fourth Cover	*Labeled for trunk spray only.	
Dogwood Borer	32e*, See "Special Apple Insect and Mite		
.	Problems and Controls," page 48-49		
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	See First Cover	
Sooty Blotch, Fly Speck	See "Tree Fruit Fungicides," pages 41-45	
INSECTS/MITES		INSECTICIDES
Aphids	See Third Cover	5. Diazinon 50 WP (4 lb)
Apple Maggot	See Fourth Cover	8. Guthion 50 WP (2 lb)****
Codling Moth	5g, 8e, 9g, 11g, 23f, 40f, 44f, 46f, 50g,	9. Imidan 70 WP (3 lb)
- P	55f, 60g, 62g, 64f, 65f/g, 66f	11. Lannate 90 SP (1 lb)**
Redbanded Leafroller	See Petal Fall	19. Provado 1.6 F (4 oz)
Spotted Tentiform Leafminer larvae	11e, 19e, 30e, 40e, 44e, 46e, 59e, 60e	23. Sevin 50 WP (4 lb)***
White Apple Leafhopper	11e, 19e, 23e, 44g, 55f, 59e, 60e	23. Sevin 80 S (2 1/2 lb)***
Tufted Apple Budmoth	8g, 40e, 44e, 46g, 50e, 55g	23. Sevin XLR+ (1 - 2 qt)***
San Jose Scale	5g,	30. Vydate 2 L (4 pt)***
Obliquebanded Leafroller	See Fourth Cover	40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
Oriental Fruit Moth	5g, 8e, 9g, 11g, 23f, 40f, 44f, 46f, 50g,	44. Danitol 2.4 EC (10.6 - 21.3 oz)
	55f, 60g, 62g, 64f, 66f	46. Spintor 2 SC (6 - 10 oz) 50. Intrepid 2 F (12 - 16 oz)
		55. Avaunt 30 WG (5 - 6 oz) 54. Actara 25 WG (2.0 - 2.75 oz) 60. Assail 70 WP (1.1 oz) 62. Calypso 480 SC (4-8 oz) 64. Entrust 80 WP (3 oz) ▲ 65. CM granulosis virus (see labels) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz) Comments: **No more than 5 applications may be made per year. ***No more than 2 applications may be made per year.
		****No more than 9 lbs can be applied per year.

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Phytophthora Collar Rot	See "Tree Fruit Fungicides," pages 41-45	

Tree Fruit Fungicides

Table 1. Background information on apple fungicides

Fungicide Categori	es	
Inorganic		and the second
Sulfur	•	2-3 days of protectant activity
		(forward action)
	•	no after-infection activity (some say
		9 hours—Mills Table)
	•	poor retention and fair redistribution
	•	high rates required for scab control, lower
		rates often used to suppress powdery
		mildew
Copper		also used for fire blight control
Coppo.		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
Anilinopyrimidine		
Vangard	•	a protectant fungicide
(cyprodinil)	•	about 48 hours of after-infection at full rate
	•	often combined with a protectant
		does not control powdery mildew
Strobilurins	-	dood flot control pondery fillidew
Flint		
	•	use a maximum of 2 - 3 consecutive
(trifloxystrobin)		(block) applications for resistance
		management
	•	alternate block sprays with block sprays of
		unrelated fungicides
	•	5-6 days of protectant activity
	•	hours of after-infection activity are less than
		the 100 hours listed on labels
	•	back-to-back sprays do not increase after-
		infection control
	•	also controls powdery mildew, sooty blotch,
		and fly speck
Sovran	•	use a maximum of 2 - 3 consecutive
(kresoxim		(block) applications for resistance
methyl)-		management
	•	alternate block sprays with block sprays of
		unrelated fungicides
	•	5-6 days of protectant activity
	•	hours of after-infection activity at high rates
		are less than the 96 hours listed on labels
	•	back-to-back sprays do not increase after-
		infection control
	•	also controls powdery mildew, black rot,
		sooty blotch, and fly speck
Sterol Inhibitors		
Rubigan	•	2-3 days of protection activity
(fenarimol)		96 hours (4 days) of after-infection activity
		at high rates and no SI resistance
	•	back-to-back sprays give increased after-
	•	back-to-back sprays give increased after- infection control
	•	infection control
	•	infection control also controls powdery mildew
Nova	•	infection control also controls powdery mildew 3-4 days of protection activity
	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity
Nova	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance
Nova	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after-
Nova	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control
Nova (myclobutanil)	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control also controls powdery mildew
Nova (myclobutanil) Procure	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control also controls powdery mildew 2-3 days of protection activity
Nova (myclobutanil)	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control also controls powdery mildew 2-3 days of protection activity 48-72 hours (2-3 days) of after-infection
Nova (myclobutanil) Procure	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control also controls powdery mildew 2-3 days of protection activity 48-72 hours (2-3 days) of after-infection activity at high rates and no SI resistance
Nova (myclobutanil) Procure	•	infection control also controls powdery mildew 3-4 days of protection activity 96 hours (4 days) of after-infection activity at high rates and no SI resistance back-to-back sprays give increased after- infection control also controls powdery mildew 2-3 days of protection activity 48-72 hours (2-3 days) of after-infection

Table 1 (continue Background info		ation on apple fungicides
Fungicide Categor		
Benzimidazoles		
Topsin-M	•	like Benlate
(thiophanate-	•	scab resistance is a problem in Michigan-
methyl)		Topsin-M is not recommended for scab
moury		control
	•	OK for powdery mildew control and summe
		diseases
Dithiocarbamate (I	EBD	C's)
Polyram	•	an example of an EBDC fungicide
(metiram)	•	5-6 days of protection when used at full rate
	•	18-24 hours of after-infection activity
	•	very good retention and redistribution
Dithane DF	•	examples of EBDC fungicides
Manzate 200	•	5-6 days of protection when used at full rate
Penncozeb	•	18-24 hours of after-infection activity
(mancozeb)	•	very good retention and redistribution
Other EBDC's	•	Manex, Maneb (see label for registration
		status on apple)
Relatives of EBDC	's	
Carbamate	•	a second cousin to EBDC's
(ferbam)	•	weak as a protector—3-5 days
	٠	no after-Infection activity
	٠	good retention and redistribution
	٠	unsightly residues on fruit if applied close to
		harvest
	•	associated with enlargement of fruit
		lenticels and russeting of Golden Delicious
Ziram (ziram)	•	Much like Ferbam—a weak protector
	•	3-5 days of protection activity
	•	no after-infection activity
Thiram (thiram)	•	Much like Ferbam—a weak protector
	•	3-4 days of protection activity
Guanidine		
Syllit (dodine)	•	24-36 hours of after-infection activity
	٠	will inactivate sporulating lesions- two
		applications at high rates one week apart
		are needed
	•	scab resistance is a significant problem in
		Michigan—Syllit is not recommended for
		scab control
Phthalimides		
Captan	•	5-6 days of forward action (protectant
(captan)		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

Apple Scab

Approaches to scab control

Protective sprays are the best way to control apple scab. After-infection sprays can be used in an emergency, after unprotected infected periods. Post-symptom (eradication) approaches should be avoided; they are expensive, only moderately effective, may increase problems with fungicide resistance, and visible scab lesions will remain.

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 apple fungicides listed below may be used as protectants, although some act in other ways as well.

Efficiency and Control Spectrum Ratings for Apple Fungicides.

Class of fungicide/ Fungicide and rate per acre Powdery Scab Sooty mildew Classic Protectants 5 1 4 Captan 50 W 6-8 lb 5 1 4 EBDC 6 lb (full rate) 5 1 * EBDC 3 lb (half rate) 3 1 2** Carbamate 76 W 6 lb 4 1 4 Thiram 65 W 6 lb 4 1 4 Ziram 76 DF 4-6 lb 3-4 1 3 Sulfur 95 W 9 lb 1 3-4 1 Sterol inhibitors/demethylation inhibitors plus protectant 7 7 Procure 50 WS (8-16 oz) plus Captan 50% W (3-4 lb) or EBDC (3 lb) 4-5 4 3*** Nova 40 W (5-8 oz) plus Captan 50% W (3-4 lb) or EBDC (3 lb) 5 5 3*** Rubigan 1 EC (9-12 oz) plus Captan 50% W (3-4 lb) or EBDC (3 lb) 5 5 3*** Strobilurins 5 5 3*** Flint 50% 2-2.5 oz 6 4 4-5 Anilinopyrimidines 7 7 7 Vangard 75 WG 5 oz	Fungiciaes.			
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Topsin M 70% WSB 8 oz plus Captan 50% WP 6 lb	plus a protectant 3-4 lb	4-5	1	*
plus Captan 50% WP 6 lb				
plus Captan 50% WP 6 lb	Topsin M 70% WSB 8 oz			
OR Ziram 76 DF 6 lb R 5 5				
	OR Ziram 76 DF 6 lb	R	5	5

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

R = significant resistance problems

*= not rated because of long interval between last application and harvest

** = overall effectiveness reduced because of 77 day PHI

 *** = assumes Captan as mixing partner because of the long PHI for EBDC fungicides

After-infection spray program—After-infection fungicides are effective for a few days after the beginning of an infection period. They are used against unprotected infection periods and in schedules with standard protectants. Accurate scab warning systems need to be available for identifying infection periods. Fungicides with after-infection activity should be used at their full recommended rate; at lower rates their ability to stop infection is reduced or lost.

Greenhouse studies indicate that in orchards with high populations of SI-resistant apple scab strains, Nova, Procure, and Rubigan will likely exhibit poor afterinfection control activity. The timing of programs that exploit the after-infection, curative properties of SI fungicides, such as schedules involving 10- to 14-day intervals and the Integrated Reduced-Spray (IRS) Program, will need to be adjusted to favor protective control.

After-infection or kid	K-Dack	After	pie rungiciaes.
Class of funciaida/	Rate/	infection	
Class of fungicide/ Product Name	acre	activity (hr)	Comments
Classic protectants Captan, EBDC's	full rates	18-24	No after-infection
Captan, EBDC s	tuli rates	18-24	activity when used at half-rate.
Sterol inhibitors			
Nova 40 W	8 oz	96	Less after-
Procure 50 WS	12-16 oz	48-72	infection activity a
Rubigan 1EC 1st spray	12 oz	96	reduced rates.
2nd spray	8-12 oz		After-infection
			control will be
			more difficult in
			orchards with SI-
			resistant strains.
Strobilurins	-		
Flint 50 W	2-2.5	48?	Neither fungicide
Sovran 50 W	6.4 oz	48?	has provided
			adequate scab
			control when
			applied a few
			hours before the
			96 - 100 hr after-
			infection times
			listed on labels.
			Assume about 48
			hr of after-
			infection control
			until data are
			available.
			Repeat
			applications 7
			days apart have
			not improved
			after-infection
			control.
Anilinopyrimidine			
Vangard 75 WG	5 oz	48	

Apple scab infections occur during wetting periods when moisture stimulates the pathogen spores to germinate and penetrate plant tissue. The scab prediction table given here can be used to determine whether or not conditions have been sufficient for infection so that appropriate spray decisions can be made. Listed are the Mills table as revised by Alan Jones, used by Michigan growers for many years, and a more recent revision of the table by MacHardy, Gadoury, and Stenvand. Work by Jones and others have shown that, although the majority of primary scab spores (ascospores) are released during daylight hours, nighttime release can occur as well. Secondary spores (conidia) are available for infection during wetting periods anytime, once the pathogen has become established on foliage or fruit. The same table can be used for primary (ascospore) or secondary (conidia) infection.

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

Temperature Average (°F)	Mills revised by Jones	MacHardy & Gadoury (1989), as amended by Stenvand et al. (1997)
34	48	41
36	48	35
37	41	30
39	33	28
41	26	21
43	21	18
45	17	15
46	16	13
48	15	12
50	14	11
52	12	9
54	11.5	8
55	11	8
57	10	7
59	10	7
61-75	9	6
77	11	8

Notes: The infection period is considered to start at the beginning of the rain. Symptoms, if the infection is successful, will generally appear after 9 days incubation with average daily temperatures at 60° F and after 16 days or more with average daily temperatures below 50° F.

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 made as soon as possible after infection occurs or, if necessary, as soon as possible after lesions appear. In orchards where dodine resistance is suspect, use Captan 50% WP at 6 lb/acre on a protectant program. The use of strobilurins for postsymptom control is not recommended to delay development of resistance.

Resistance management—The recent introduction of two new classes of fungicides, the anilinopyrimidines and strobilurins, offers new opportunities for more effective anti-resistance management strategies. The use of antiresistance strategies will help to prolong the life of old classes of fungicides as well as the life of new fungicides. Resistance can be managed by reducing the total number of applications per season for each class of fungicides, alternating different classes of fungicide in blocks of 2 to 3 successive applications, and using unrelated fungicides in mixtures. An example of a resistance management program for apple scab is outlined below. Other scenarios are also possible.

Anti-resistan	Anti-resistant scab management based on rotating different classes of fungicides.				
Approximate timing of protective scab sprays					
Green tip	Pre-bloom	Pink and bloom	Petal fall, 1st cover	Summer	
1 to 2 applications:	2 applications:	2 applications:	2 applications:		
EBDC or Captan	Strobilurin	Sterol inhibitor	Strobilurin	Classic protectant	
(full rate)	(Flint or Sovran)	mixed with EBDC or	(Flint or Sovran)	except EBDC	
OR	OR	Captan (half rate)	OR	OR	
Vangard	EBDC or Captan (full	OR	Classic protectant	a benzimidazole mixed with	
	rate)	EBDC or Captan (full	except EBDC at full	Captan or Ziram	
	OR	rate)	rate		
	Vangard + EBDC				
	or Captan				

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	×
Flint 50 W	2.0-2.5 oz
OR	
Sovran 50 W	4.0-6.4 oz
OR	
Topsin M 70 WSB plus	8 oz
Captan 50% WP or Ziram 76 DF	6-8 lb

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.

Cedar-Apple Rust

TIMING: Pink to third cover

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

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.

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 40 W 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	
Flint 50 W	2.0-2.5 oz
OR	
Sovran 50 W	4.0-6.4 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 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.

Phytophthora Collar Rot

This disease is caused by several species of fungi in the genus *Phytophthora*; these fungi cause a brown decay just below ground in the collar, crown, and roots. Collar rot should not be confused with fire blight in common dwarfing rootstocks such as M.26, M.9, and M.7 because controls for collar rot will not control fire blight.

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 Gold EC is applied as a soil drench consisting of 1/2 pt of Ridomil Gold EC 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.

Tree trunk diameter	Diluted mixture/tree
Less than 1 inch	1 quart
1 – 3 inches	2 quarts
3 – 5 inches	3 quarts
More than 5 inches	4 quarts

Nonbearing Apple Trees. In nurseries and field

plantings of nonbearing trees, make the first application of Ridomil Gold EC 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 qts per treated acre (1.5 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*.

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 judgment 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 rootstocks 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
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Daily risk	Orchard risk rating		
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. Mycoshield can only be used on apples in 2004 if a special Section 18 emergency registration is granted by EPA.

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 throughout Van Buren County and, beginning in 2000, in some areas of Berrien county adjacent to Van Buren County. Resistant strains also have been detected in Kent County and in Newaygo County.

Mycoshield is useful as a replacement for streptomycin in areas where streptomycin resistance has been a problem or in combination with streptomycin 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.

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.

temperature0.1 inch0.1 inchDaily risk ratingUnder 65° FNoneLow	Chart for Assessing Daily Risks				
temperature0.1 inch0.1 inchDaily risk ratingDaily risk ratingUnder 65° FNoneLow		Rainfall			
Daily risk rating Under 65° F None Low			More than		
		and the second			
	der 65° F	None	Low		
65° F to 69° F Low Moderate	F to 69° F	Low	Moderate		
70° F to 80° F Moderate High	F to 80° F	Moderate	High		
Over 80° F High High	er 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.

Shoot Fire Blight Management with Apogee. Apogee (prohexadione calcium) inhibits gibberellin biosynthesis, this results in an early cessation of terminal growth. Shoots with inhibited growth are less susceptible to fire blight; therefore, the potential for the build up of fire blight during the summer is reduced significantly. Apogee only decreases host susceptibility; it does not affect the pathogen directly. Apogee is not a substitute for streptomycin during bloom for blossom blight control.

Timing. Apogee 27.5% W should be applied at full bloom to early petal fall on king blooms for maximum effectiveness. The decrease in susceptibility will not start to become effective until about 10 days to 2 weeks after application.

Application rate and number. The rate is 36 to 48 oz of Apogee 27.5% W per acre for trees that require 300 to 400 gallons of dilute spray per acre, respectively, or 12 oz per 100 gallons of dilute spray. The effectiveness of lower per acre rates for blight control drops off quickly. In Michigan, one application of Apogee should be sufficient for preventing fire blight spread in the summer, but, overly vigorous trees may need a second application (see label).

Additives. The non-ionic surfactant, Regulaid, should be used with Apogee. Follow the manufacturer's rate recommendations. If Apogee is being applied in hard water (water that contains high levels of calcium carbonate), 1 lb of spray-grade ammonium sulfate (AMS) should be used for each pound of Apogee.

Comments. Growth control with Apogee is not concentration dependent. There is no difference in shoot growth control between dilute and concentrate sprays. Apogee as a concentrate spray is equally effective compared to a dilute spray provided the total amount of chemical per acre is the same.

The level of growth control with Apogee is rate dependent. The greatest and quickest reduction in growth is obtained at the recommended rate, and the effect on growth declines as the rate is reduced. **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 streptomycin immediately regardless of the risk assessment ratings.

Severity of fire blight on apple trees on M.7a or M.7 EMLA rootstocks at the Southwest Michigan Research and Extension Center following a severe epidemic in 2000.

Variety	Severity scores for Cultivars ^{y,z}
Lucky Rose	1.0
Valstar	1.3
Novamac	1.3
Williams Pride	1.5
Mollies Delicious	1.5
Runkel	1.5
	1.5
Nova Spy Red Delicious strains	
	1.5
Zestar!	1.7
Empire strains	2.0
Honeycrisp	2.0
Royal Court	2.0
Enterprise	2.0
Pinova	2.0
Acey Mac	2.5
Corodel	2.5
Winsap/Staymen strains	2.6
Braeburn strains	2.7
Jonamac	2.7
Pristine	2.8
Cameo	2.8
Jonagold strains	2.9
Macoun	3.0
Liberty	3.0
Mac strains	3.3
Golden Delicious strains	3.4
Spigold	3.7
Arlet	4.0
Melrouge	4.0
Rome strains	4.2
Gala strains	4.4
Suncrisp	4.5
Jonathan strains	5.0
Paulared	5.0
Fortune	5.8
York strains	6.0
Pink Lady	6.0
Gingergold	6.0
Vote edepted from W/ W/ Shap	

^yData adapted from W. W. Shane, 2000, Annual Report, SW Michigan Research & Extension Center, Michigan State University, Benton Harbor, MI.

^zScores were based on the scale: 1 = low to 6 = severe. Data are mean rating scores for a minimum of three trees.

Special Apple Insect and Mite Problems and Controls

Mites

Superior oil applied at the right time with good coverage at the full rate can provide control of mites until mid-summer, but can cause phytotoxicity if applied within 48 hours of freezing temperatures.

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. Savey and Apollo can be applied pre-bloom for over-wintering European red mite eggs, but now have in-season use with their respective 28-day and 45-day pre-harvest intervals. 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 timings, 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.

Pyramite and Acramite are good contact miticides which when used early season can provide six or more weeks of control, or in mid-summer as a "clean up" application if early season products have lost control of mites. Carzol early in the season (cannot be applied after petal fall) provides control of adult mites (along with some insect pests), but is toxic to predator mites. 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-toback application on the same generation of mites to prevent resistance from building. Vydate will kill some mites, but is very toxic to predators, and causes fruit drop if used 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 that 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 some insecticides such that larvae are readily exposed to a lethal dose while still within the plant tissue. The larvae can be controlled with trunk applications of Lorsban 50 WP at the rate of 3 pounds per 100 gallons

of water. Lorsban 4E is also be labeled for use at a rate of 1.5 quarts per 100 gallons of water. These must be applied directly to the trunk from a distance of no more than 4 ft using low volume handgun or shielded spray equipment. Do not allow spray to contact foliage or fruit. A single spray timed for the peak egg hatch in late June to mid-July will provide control.

Japanese Beetle

This insect is a native pest to Japan and was first found in the U.S. in 1916. Since that time it has gradually dispersed across the eastern states and in the last ten years has become well established in southern parts of Michigan. The insect overwinters as a white grub, feeding on roots in the soil, then emerges as an adult in mid-summer to feed, mate and lav eggs. The adults can emerge in the thousands per acre and being strong flyers can move heavily into fruit crops, especially along the edges of plantings. Japanese beetles prefer grapes, peaches and plums but will readily feed on other fruits like blueberry and apple. Japanese beetle adults can be controlled with many of the conventional contact poisons (organophosphates, carbamates, pyrethroids), but high rates and good plant coverage (aerial applications often not sufficient) are essential to provide a lethal dose. There are several novel compounds like SURROUND WP (Kaolin), Pyrethrum-based products (i.e.; PyGanic and Evergreen), and NEEM-based products (i.e.; AzaDirect, Ecozen and Neemix) that provide significant repellency effects, but have limited lethal activity. These compounds have the advantage of intervals compared short pre-harvest to most conventional insecticides. Controlling larvae is not effective in commercial orchards, but the natural insecticide, Bacillus popillae, 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 Michigan. 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 larvae 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 awarf 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.

CODLING MOTH INTEGRATED PEST MANAGEMENT

L. Gut and J. Wise Department of Entomology

BIOLOGY

There are typically two generations of codling moth (CM) per year in Michigan, with a partial third generation in exceedingly warm years (Figure 1). The spring flight of CM adults generally begins when apples are in bloom. In Michigan, second and third flights generally begin in mid-July and toward the end of August, respectively.

Fruit injury caused by CM is of two types. A deep entry is where the larva enters into the center of the fruit and feeds on seeds. Brown frass can usually be seen extruding from the entry hole. A sting is a shallow entry where the larva does some feeding but does not gain entry into the fruit.

MATING DISRUPTION

Mating disruption of CM entails placement of pheromone dispensers in trees in sufficient numbers to interfere with mate location. The best opportunity for control is where orchard topography, size and shape, wind, and canopy structure allows for uniform distribution of pheromone within the orchard. The best candidates are orchards that are relatively flat and even-canopied. Orchards with large numbers of missing trees or uneven canopies are considered poor candidates for CM mating disruption.

Monitoring

Pheromone traps and visual inspection of fruit should be used to assess the effectiveness of CM control in a pheromone-treated orchard. Use of one trap for every 2 to 2.5 acres is optimal; 1 trap per 5-8 acres is acceptable in large, uniform blocks. Place traps baited with high-load lures in the upper third of the canopy. If using red septa lures (10 mg or 10X), replace them every 3 weeks for the first generation or every 2 weeks for second generation. Other high-load lure types are available, with some lasting an entire generation. Check with manufacturer's to determine replacement intervals. If a cumulative catch of 4 or more moths is recorded in any one trap, a supplemental control may be necessary.

Pheromone traps provide some measure of the effectiveness of mating disruption, however, fruit should always be visually inspected in conjunction with trapping. Examine 15 to 20 fruit on at least 10 trees per orchard. Concentrate fruit inspections in the upper canopy and along orchard borders. A supplemental treatment is advised if wormy fruit are observed. If damage is confined to an orchard border, treating three to six rows along the problem border may be adequate.

Treatment

Isomate C Plus (Pacific Biocontrol Corp.) is currently the most widely used disruption product in Michigan. This polyethylene tube dispenser is commonly referred to as a rope or twist-tie. It is applied by hand at densities of 200-400 per acre and releases pheromone for approximately 5 months. Other CM disruption products are available; follow the manufacturer's guidelines for application rates and longevity under Michigan conditions.

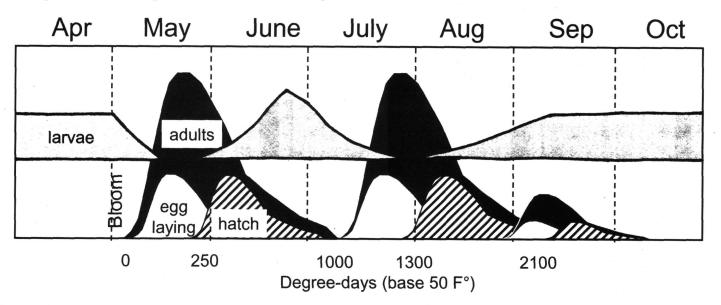


Figure 1. Codling moth seasonal history.

In orchards treated with low rates (<275/acre) plan on supplementing the pheromone with insecticides or other controls. Using pheromone in conjunction with insecticides is also suggested for orchards with a recent history of CM fruit injury or in the first year of a disruption program.

Mating disruption is most effective when the application is well timed and dispensers are properly positioned. Pheromone dispensers should be in place prior to the predicted start of the first flight period (before bloom on 'delicious'). Place dispensers within two feet of the top of the tree canopy and near foliage to protect them from UV radiation and high temperatures.

INSECTICIDES

Monitoring

Pheromone traps, in conjunction with degree-day (DD°) models, can be used to determine the need and timing for treatment. Place pheromone traps prior to bloom at a density of at least 1 trap per 5-8 acres. Check traps twice a week and begin accumulating degree-days (base 50°F) on the day at which the first moth is trapped, provided moths are captured on two successive trapping dates. The start of sustained moth capture is referred to as **biofix**. Inspect traps weekly for the remainder of the season; count and remove captured moths.

Many factors can influence trap performance. To optimize trapping efficiency, place them in areas of the orchard that are known hot spots. Position traps at midcanopy (5-8 ft). If using red septa lures, replace them every 3 weeks first generation or every 2 weeks second generation. Other lure types are available, with some lasting an entire generation. Check with manufacturer's to determine replacement intervals. Larger traps, such as the Triangle, Wing, and some versions of the Diamond have proven to be most effective at trapping CM males. Change trap bottoms if dirty, or at least every 6 weeks.

CODLING MOTH IPM (continued)

Treatment

Use of the DD° model rather than the calendar method should be used to time sprays. If the codling moth larva is the primary target of an insecticide, apply the first spray at 250 DD°, which coincides with the start of egg hatch. Apply the first spray against the second generation between 1250 and 1300 DD°. Timing of additional sprays will depend on the product used. Some insecticides provide 21 days of residual control, while others may only provide 10 days. Rainfall in excess of 1/2 inch will substantially reduce the residual of most materials. The egg hatch period lasts 30 to 45 days so several treatments may be required for control of each generation.

Thresholds based on cumulative moth catch can be used as a tool to determine the need to apply control treatments. A cumulative catch of 5-7 moths during the first generation or 3-5 moths during the second generation in any one trap may indicate the need for a spray. Do not total captures from more than one trap to attain the threshold (Table 1).

Number of moths trapped				
	Week 1	Week 2	Week 3	Week 4
Trap	0	2	2	2
1			4 cumulative	6 cumulative
Trap	1	1	1	0
2		2 cumulative	3 cumulative	3 cumulative

Table 1. Example of	determining	CM cumul	ative
moth catch.			

Moth capture in a pheromone trap in conjunction with the DD° model can be used as a basis for codling moth management decisions. Sprays are only applied if catch is over threshold and are targeted for egg hatch as predicted by the model. Examples of the decision process are presented in Table 2.

Tim	ning	Event	Management action			
1 st generation	2 nd generation	2013 A. 201	Orchard 1	Orchard 2	Orchard 3	
0 DD°	1060 DD°	Start of flight		Begin accumulation		
250 DD°	1250-1300 DD°	First egg hatch	Over threshold TREAT Reset catch to zero New accumulation	Under threshold DO NOT TREAT Continue accumulation	Under threshold DO NOT TREAT Continue accumulation	
350 DD°	1350-1400 DD°	20% egg hatch	Continue accumulation	Over threshold TREAT Reset catch to zero New accumulation	Still under threshold DO NOT TREAT Continue accumulation	
10-21 days a	10-21 days after treatment		Over threshold TREAT Reset catch to zero New accumulation	Under threshold DO NOT TREAT Continue accumulation	Under threshold DO NOT TREAT Continue accumulation	
10-21 days a	fter treatment	Loss of residual	TREAT if over thresh	old and model indicates	continued egg hatch	
1000 DD°	2100 DD°	End of flight	Visu	ally inspect fruit for CM	njury	

Table 2. Decision-making for codling moth management.

CODLING MOTH IPM (continued)

Insecticides for codling moth management

Common Name		EPA Registration			
(Trade Name)	Manufacturer	Number	Rate/A	PHI	REI
azinphosmethyl (Guthion 50WP)	Bayer	3125-193	2 lb	14 d	48 hr
	Guthion provides exce pressure and 14-21d in toxicity to predaceous apple and pear is 9 lb p	n low to moderate p mites. The maximu	ressure situations. It	t is generally cons	sidered of low
phosmet (Imidan 50WP)	Gowan	10163-169	2.25-3.0 lb	7 d	24 hr
	Imidan provides excel considered of low toxici			on of 10-14d. In	t is generally
carbaryl	Rhone-Poulenc	264-316	5 lb	3 d	12 hr
(Sevin 80S) (Sevin XLR Plus)	Rhone-Poulenc	264-333	2-3 qt	3 d	12 hr
	Sevin provides good co highly toxic to mite pred Sevin is a fruit thinning	lators and should be	used carefully to prev		on buildup.
esfenvalerate	Dupont	352-515	4.8-14.5 oz	21-28 d	12 hr
(Asana XL 0.66EC)					
	Asana provides good c mite predators and its apple and pear are 21 a	use may cause sev	ere outbreaks of phyte		
Lambda-cyhalothri	n Syngenta	100-1112	3.4-5.12 oz.	21 d	24 hr
(Warrior 1CS)	Warrior provides good effective in the spring th carefully to avoid outbr be applied is 1.6 pints.	han summer. Warrie	or is highly toxic to mit	e predators and si	hould be used
acetamiprid (Assail 70WP)	Bayer		3.4 oz	d	hr
	Assail provides good c timing and coverage is may take several days cause outbreaks of ph applied on apple and pe	required to achieve s to cause mortality ytophagous mites.	control. Assail must Field trials have in The maximum yearly	be ingested by the dicated that use	ne larvae, and of Assail car

(Continued on next page)

CODLING MOTH IPM (continued)

Common Name		EPA Registration			
(Trade Name)	Manufacturer	Number	Rate/A	PHI	REI
methoxyfenozide	DowAgrosciences	707-277	16 oz	14 d	4 hr
(Intrepid 2F) spinosad (SpinTor 2SC) (Entrust)	Intrepid provides good coverage is required to several days to cause improve initial spray de lepidopterous larvae, beneficial insects. The 64 oz per acre. DowAgrosciences SpinTor provides fair requires excellent timin several days to cause improve initial spray d highly toxic to bees	d control of CM wit o achieve control. I e mortality. The ad eposition. This mate but is also active a maximum yearly an 62719-294 62719-282 to good control of ng and coverage. S e mortality. The ad eposition. Avoid us exposed to direct	h a residual action htrepid must be inge dition of an agricultu- erial is an insect grow against adults and e hount of Intrepid 2F t 7.5 oz 2-3 oz. CM with a residual pinTor must be inge dition of an agricultu- te when bees are ac spray. Dried residual	of 10-14d. Excelle sted by the larvae, ural adjuvant is rec wth regulator that pr eggs. It is not ha to be applied on app 7 d 1 d 1 action of 7-10d. sted by the larvae, ural adjuvant is rec stively foraging as t	ent timing and and may take ommended to rimarily affects rmful to mos ole and pear is 4 hr 4 hr 6 do contro and may take ommended to his material is effects. The
narrow range oil	maximum yearly amou Entrust is the OMRI-ap to be applied on pome Sun	proved formulation	for spinosad. The m		-
Sunspray Ultra-fine		002-20	1-2 gai	1 d	711
	Narrow range oils prov should be repeated e treatments may be er within a few weeks of a	very 7-14 days du nhanced with more	ing the egg laying dilute applications.	period. The effect Oils may be phyt	tiveness of o totoxic if used
h iocloprid (Calypso)	Bayer	264-806	4-8 oz	4 hr	4 hr
· · · · · · · · · · · · · · · · · · ·	Calypso provides goo coverage is required to prolonged control. The 16 oz per acre.	o achieve control. 🗸	Apply higher rates wi	here CM densities	are high or fo
granulosis virus (Cyd-X) (Carpovirusine)	Certis Sumitomo Corp.	70051-44 49911	4-6 oz 13.5 oz	4 hr 4 hr	4 hr 4 hr
,	CM granulosis virus is good control of this pe cause mortality. Thus, necessary to maintain	est. The virus must apply in sufficient w	be ingested by larva ater for thorough co	ae, and may take s verage of tree cano	several days py. Repeat a

Insecticides for codling moth management (continued)

	GF 120 Fruit Fly Bait A	67	ш																							S	٦
	Warrior	99	U	U	ш		ш		ш	ш	G	U	ш	U				ш	ш	٩	ш	-	ш	-	F	F	-
	CM granulosis virus	65	-	F/G	-	-	-	-	-	_	-	-	-	-		-	-	_	_	-	_	-	-	-	s	s	S
			-		-	_	-											_			-	_	_		-		_
	Entrust A	2	ш	ш	U		ш		U	ш	ш		ш				_			ш					Σ	S	Σ
	Iseal	63				ш													_			ш					
	Calypso	62	U	U				ш			U	ш		G	ш		G	ш		ш	G		ш		Σ	S	Σ
	Acramite	61				U																ш			Σ	S	S
	lisszA	60	U	U				ш				U			ш		1.5			ш		1.1	ш		Σ	S	Σ
	Actara	59	U					ш				U		U	ш		ш			ш	U		ш	U	F	S	Σ
	trusvA	55					U			ш	U	ш	U		G						ш		G		F	S	S
	veem compounds ▲	54						ს				٩		L.		G					G			ш	S	S	ŝ
	Surround A	53	ш			ш						ш		ш							G		G		z	Σ	Σ
S	Esteem	52		LL.					U	ш	ш		U		U		ш	ш		U					S	S	Ś
le	Intrepid	50		υ			ш		U	ш	U		ш							U					S	S	S
dd	Confirm	49		ш			G			C	ш		U												S	S	ŝ
∢	Spintor	46	ш	ш	G		ш		G	ш	ш		ш	-						ш					Σ	S	Σ
o	Pyramite	45	-	_		ш										ш	_			_		G	ш		Σ	Σ	Σ
.) its	Danitol	44	ш	σ	ш	G	(0)		ш	ш	U	U	ш	U		_	_	_	ш		ш	G	G		F	+	+
es	Savey B.t.s ▲	42 43		-	-	ш	U		G	G			U	_	_	ш	_	_					_		s	s S	ŝ
at D	Agri-Mek	414				Ш				-			-		-	5	-	-	_	ш	-	ш	U	-	T S	S	s S
o t t	Sn52A	40	U	U	ш		ш	ш	ш	ш	G	U	ш	G	ш	0	Р	۵.	ш	Р	ш		5 D	-	F	-	F.
d p	ysndmA	35 4	L	υ	ш		ш	ш	ш	ш	-	U	ш	-	ц.	Р	Р	٩.	ш	4	ш	-	Р	٩	F	F	F
hre	Pounce	8	LL.	U	ш		ш	LL.	ш	ш		U	ш	-	ш	٩	Р	۵.	ш	٩	ш		Р	Ъ	F	⊢	F
Art s la	Lorsban ¹	33			ш				ш	ш		-			ш		ш		٩			-		ш	F	S	S
d Miticides in Controlling Arthropod Pes pest does not necessarily indicate that it is labeled for that use.	Vydate	ŝ		٩		G	٩	U	٩	ш		٩	٩		G	ш				ш		ш	ш	Ъ	S	⊢	F
th Di	xəpuəV	28				ш										U						G			S	S	ŝ
Oll	nsboidT	26						ш	ш	٩					ш	ш	ш		ш	٩	ш		ш	ш	Σ	Σ	Σ
Jtr	Superior Oil ¹	24				ш		٩							ш										S	S	ŝ
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a a	Dimethoate	ø	ш	L		Р	ш	ш	-			Ъ	٩		ш	Р				ш	ш	Р	ш	G	F	Σ	F
eS ting	nonizsiQ	2	U	U			U	Ъ	LL.	C	U		U		Р	Р	-	C		٩	٩	-	٩	ш	F	S	F
			-	-		ш										ш			G		U	ш	ш		Σ	⊢	Σ
s ra	Carzol	3									_							-									
ecticid		_	dult	arva	ana		arva	tive	arva	ana	arva	dult	arva	dult	ctive	ctive	dult	awler	dult	ana	ctive	ctive	ctive	ctive			
Effectiveness of Insecticides and Miticides in Controlling Arthropod Pests of Apples (Note that a product's effectiveness rating on a pest does not necessarily indicate that it is labeled for that use.)	Ratings of control are E = excellent, G = good, F = fair, and P = poor. Rating against beneficials are T = highly toxic, M = moderately toxic, and S = relatively safe.	Insect / Mite Life Stage 3	Apple Maggot Adult	Codling Moth Larva	Cutworms	European Red Mite Active	Fruit Tree Leafroller Larva	Green Apple Aphid Active	Green Fruitworm Larva	Obliquebanded Leafroller Larva	Oriental Fruit Moth	Plum Curculio Adult	Redbanded Leafroller Larva	Rose Chafer Adult	Rosy Apple Aphid Active	Rust Mite Active	San Jose Scale Adult	San Jose Scale Crawler	Spotted Tentiform Leafminer Adult	Spotted Tentiform Leafminer Larva	Tarnished Plantbug Active	Two-spotted Spider Mite Active	White Apple Leafhopper Active	Wooly Apple Aphid Active	Bees	Mite Predators	Insect Predators ¹ Use only before pre-pink!

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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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: \blacktriangle

LATE DORMANT OR DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		INSECTICIDES
Pear Psylla	34e, 35e, 40e, 44e, 52g, 53g*, 66e	24. Superior Oil (6 gals)**
		34. Ambush 2 EC (9.6 fl oz)
San Jose Scale	24e**, 52e, 56g	35. Pounce 3.2 EC (6 fl oz)
Comments:		40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
See page 59 for information	on pear psylla resistance and insecticide options	44. Danitol 2.4 EC (16 - 21.3 oz)
*Must maintain coverage for		52. Esteem 35 WP (5 oz)
**Unless applied dilute (30	0 gal/A) the use of oil is questionable.	53. Surround WP (25 - 50 lb)*
		56. Supracide 2 E (3 - 12 pts)
		66. Warrior 1 CS (3.4 - 5.12 oz)

Pear Scab Control

Fungicide	Rate/acre	Comments	Restrictions
Carbamate 76 WDG	3 - 4 1/2 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		Use either the "Pre-Bloom" (e.g. 6 lb) or	Do not combine or integrate the two
formulations may also be		"Extended Application" (e.g. 3 lb) schedule.	treatment schedules.
available). Note: Polyram is			an Britan attac
not labeled for pears		Pre-Bloom Use: Begin applications at 1/4 to	Do not apply after bloom or more than
Dithane M-45 75% DF	6 lb	1/2 inch green tip and continue on a 7 to	24 lb per acre per year.
OR		10 day schedule through bloom.	
Manzate 200 DF	6 lb		
OR	C III		
Penncozeb 75 DF	6 lb		
Dithane M-45 75% DF	3 lb	Extended Application Schedule or for Use in Tank	Do not apply more than 3 lb per acre
OR		Mixtures: Begin applications at 1/4 to 1/2 inch	per application or 21 lb per acre per
Manzate 200 DF	3 lb	green tip and continue applications on a 7 to 10	season.
OR		day schedule through the second cover spray.	
Penncozeb 75 D	3 lb	Tank mix with non-EBDC fungicide when needed	Do not apply within 77 days of harvest.
		for primary scab control.	
Procure 50 WS	8 - 16 oz	Standard Spray Schedule: Begin applications at	Do not apply more than 64 oz/A per
		1/2 inch green tip stage and continue on a 7 to 10	season.
	10 A	day interval through the second cover spray. Tank	
		mix with an EBDC fungicide (see Extended	Do not apply within 14 days of harvest.
		Application Schedule above) for maximum fruit	
	10 10	disease control.	
	12 - 16 oz	Postinfection: Apply within 48 to 72 hr after the	
		beginning of an infection period. Use the high rate	
		under heavy disease pressure or when applied	
	0.0.05	after 48 hr.	
Flint 50% W	2.0 - 2.5 oz	Begin at green tip and continue as needed	Do not apply within 14 days of harvest.
(trifloxystrobin)		on a 7 to 10 day schedule.	Do not apply more than 11 or per acre
		Maximum of 4 total applications of Flint or	Do not apply more than 11 oz per acre per season.
		other strobilurin fungicide per acre per season	
		and no more than 2-3 sequential applications	
	1	of Flint or other strobilurin fungicide.	

(Continued on next page)

PEARS

GREEN TIP TO PRE-PINK continued

Fungicide	Rate/acre	Comments	Restrictions
Sovran 50% W (kresoxim-methyl)	4 - 6.4 oz	Begin at green tip and repeat on a 10 da schedule. Maximum of 4 total applications of So other strobilurin fungicide per acre pe season and no more than 2-3 sequent applications of Sovran or other strobil fungicide.	harvest. vran or Do not apply more than 25.6 oz per acre per season. ial
Vangard 75 WG tank mixed with a protectant fungicide (generally an EBDC fungicide)	3 oz	Use tank mixtures beginning at pink. <i>Pre-Bloom, Pink, Bloom:</i> Begin application green tip and continue on a 7- to 10-day A shorter interval is preferred during peri- wet weather favorable for disease.	interval. Do not apply Vangard WG alone on
Ziram 76 DF	6 - 8 lb	Begin applications at 1/4 to 1/2" green tip continue through cover sprays as needed	
Pest		Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES			INSECTICIDES
European Red Mite		24e	24 . Superior Oil (1% - 2% v/v)
San Jose Scale		24e, 32e, 52e	32. Lorsban 4 EC (3 pt) 52. Esteem 35WP (5 oz)

Comments:

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

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	3. Carzol 92 SP (1 1/2 lb)
Leafrollers	8e, 9e, 34e, 35e, 40e, 52g, 66e	8. Guthion 50 WP (2 lb)
Green Fruitworm	26f, 34e, 35e, 40e, 66e	9. Imidan 70 WP (2 1/4 lb)
Tarnished Plantbug	3g, 34e, 35e, 40e, 66e	10. Kelthane 35 WP (4 - 8 lb)
Pear Psylla	34e, 35e, 40e, 44e, 45g, 52g, 53g*	26. Thiodan 50 WP (3 lb)
Pear Rust Mite	3e, 10e, 30f, 45e	30. Vydate 2 E (6 pt)
Comments: Spraying at flower bud separa timing for rust mite control. *Apply as often as needed to	tion (green cluster) is the most effective pre-bloom o maintain coverage.	 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) 44. Danitol 2.4 EC (16 - 21.3 oz) 45. Pyramite 60 WP (8.8 - 13.2 oz) 52. Esteem 35 WP (5 oz) 53. Surround WP (25 - 50 lb)* ▲ 66. Warrior 1 CS (3.4 - 5.12 oz)

PEARS

BLOOM		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fire Blight	1e, See Fire Blight, page 46-47	1. Agrimycin 17 WP (1 1/2 lb)
Pear Scab	See Green Tip	
INSECTS		
Pear Sawfly	See "Special Pear Insect Problems and Controls," page 56	

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fire Blight	1e, See Fire Blight, page 46-47	1. Agrimycin 17 WP (1 1/2 lb)
Pear Scab	See Green Tip	
INSECTS/MITES		INSECTICIDES
Plum Curculio	8e, 9e, 34g, 35g, 40g, 53g, 55e, 59e,	3 . Carzol 92 SP (11/2 lb)
	60e, 62e, 66g	8. Guthion 50 WP (2 lb)
Green Fruitworm	26f, 34e, 35e, 40e, 55g, 66e	9. Imidan 70 WP (2 1/4 lb)
Tarnished Plantbug	19g, 26f, 34e, 35e, 40e, 53g, 54g, 55e	10. Kelthane 35 WP (4 - 8 lb)
Pear Rust Mite	3e, 10e, 45e, 53g, 54g	19. Provado 1.6 F (15 oz)
Pear Psylla	19f/g, 45g, 52g, 53e, 54g*, 59g, 60g,	26. Thiodan 50 WP (3 lb)
	62g	26. Thiodan 3 EC (3 qt)
Codling Moth	52g, 53f	34. Ambush 2 E (9.6 fl oz)
Comments:		35. Pounce 3.2 EC (6 fl oz)
*To control Pear Psylla with Neem-b	ased compounds requires multiple	40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
	ased compounds requires multiple	45. Pyramite 60 WP (8.8 - 13.2 oz)
applications.		52. Esteem 35 WP (5 oz)
Apply as often as needed to main	ntain coverage.	53. Surround WP (25 - 50 lb)
		54. Neem compounds [AzaDirect (32 fl oz),
		Ecozin (10 oz)]
		55. Avaunt 30 WG (5 - 6 oz)
		59. Actara 25 WG (4.5 - 5.5 oz)
		60. Assail 70 WP(3.4 oz)
		62. Calypso 480 SC (4 - 8 oz)
·		66. Warrior 1 CS (3.4 - 5.12 oz)

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fire Blight	1e, Following (within 24 hours) a	1. Agrimycin 17 WP (1.5 lb)
	hailstorm, pages 46-47	
Pear Scab	See Green Tip or	
	Rubigan 1 EC + 3 lb Dithane DF	
	or Manzate 200 DF or	
	Penncozeb 80 WP.	
	Do not apply within 77 days of harvest.	
Comments: Where Fabraea	a Leaf Spot or Septoria Leaf Spot (also called	
Mycosphaerella Leaf Spot) a	are problems, continue with applications of Ziram until	
late July.		
INSECTS/MITES		INSECTICIDES
Plum Curculio	See Petal Fall	41. Agri-Mek (20 oz) plus
Pear Psylla	41e, 45g, 53e*	Paraffinic Spray Oil (1 gal)
Pear Rust Mite	41e, 45e, 53g*	45. Pyramite 60 WP (8.8 - 13.2 oz)
Comments:		53. Surround WP (25 - 50 lb)*
*Apply as often as needed to	o maintain coverage.	

PEARS

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES Pear Scab		FUNGICIDES Flint 50 W (2.0 - 2.5 oz)
Comments: Where Fabraea Leaf Spot or Sep applications of Carbamate or Zira	toria Leaf Spot are problems, continue with m until late July.	Sovran 50 W (4.0 - 6.4 oz) Ziram 76 DF (6 - 8 lb) Carbamate 76 WDG (4 lb) Procure 50 WP (8 - 16 oz) + protectant scab fungicide
INSECTS/MITES		INSECTICIDES
Codling Moth	5g, 8e, 9e, 23g, 40g, 44g, 46f, 50g, 55f/g, 60g, 62g, 64f, 65f/g, 66g	5. Diazinon 50 WP (2 - 4 lb) 8. Guthion 50 WP (2 lb)
Oriental Fruit Moth	5g, 8e, 9e, 23g, 40g, 44g, 46f, 50g, 55f/g, 60g, 62g, 64f, 65f/g, 66g	 9. Imidan 70 WP (2 1/4 lb) 10. Kelthane 35 WP (4 - 8 lb)
San Jose Scale (crawlers)	5g, 52e, 66g	19. Provado 1.6 F (16 - 20 oz)
Pear Psylla	19f, 45g, 53e**, 54g*, 59g, 60g, 62g	23 . Sevin 50 WP (6 lb)
Apple Maggot	5g, 8e, 9e, 40g, 44g, 46f/g, 53e**, 54f, 60g, 62g, 64f/g. 66g, 67f/g	23. Sevin 80 S (4 lb) 28. Vendex 50 W (1 - 3 lb)
Mites (adults)	10g, 28g, 45e, 61g	40. Asana XL 0.66 EC (9.6 - 14.5 fl oz)
Mites (immatures)	10g, 28g, 45e, 61g	 44. Danitol 2.4 EC (16 - 21.3 oz) 45. Pyramite 60 WP (8.8 - 13.2 oz)
Pear Rust Mite	10e, 45e, 54g	-45. Fyrannie 60 WF (6.6 - 13.2 02) -46. SpinTor 2SC (7.5 - 10 oz)
applications.	n-based compounds requires multiple	50. Intrepid 2F (12 - 16 oz) 52. Esteem 35 WP (5 oz) 53. Surround WP (25 - 50 lb)** ▲
**Apply as often as needed to ma	iintain coverage.	 54. Neem compounds* [AzaDirect (32 fl oz), Ecozin (10 oz)] ▲ 55. Avaunt 30 WG (5 - 6 oz) 59. Actara 25 WG (4.5 - 5.5 oz) 60. Assail 70 WP(3.4 oz)
		 61. Acramite 50 W (0.75 - 1.0 lb) 62. Calypso 480 SC (4 - 8 oz) 64. Entrust 80 WP (3 oz) ▲ 65. CM granulosis virus (see labels) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz) 67. GF120 NF Fruit Fly Bait (10 - 20 oz) ▲

Special Pear Insect Problems and Controls

Pear Psylla

Pear psylla has become resistant to most conventional insecticides, but recent registrations have increased the tools available for control. Pyrethroid sprays (like Danitol, Asana, Warrior, Brigade and Ambush) for psylla control are effective only against the overwintering generation and should not be used in the summer psylla sprays. Esteem is an insect growth regulator that can be sprayed at white-bud stage for eggs, then again at petal fall for remaining eggs and early nymphs. SURROUND WP (Kaolin) is effective in preventing adult psylla egg laying when applied starting at the green-cluster stage, but only if complete coverage is effectively maintained. It will also control nymphs inseason with good coverage of new foliage and sucker shoots. The summer treatment threshold for pear psylla is 1 psylla nymph/3 leaves. There are several products that should be considered for use in the summer. One application of Agri-Mek at 1st cover (14 days post-petal fall) will generally 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. At least two applications of the neonicotinoid compounds (Provado, Actara, Calypso and Assail) or Pyramite are generally required for seasonlong control of pear psylla. These materials also have the flexibility to be used later in the summer if pear psylla populations do not exceed threshold earlier. Pyramite will also control pear rust mite. NEEM compounds like Aza-Direct and Ecozin 3% EC will control psylla nymphs (and rust mites), but require continued applications to suppress psylla populations.

Pear Sawfly

This insect was reported in Michigan in 1992. Fruit damaged from this pest is found periodically in southern Michigan counties like Van Buren County This insect is related to, and is similar in appearance to, the European apple sawfly, a pest in the Hudson Valley of New York. Pear sawfly females fly during pear bloom, and lay an egg directly into the developing flower pistil. The hatching larva 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.

The rates of materials are based on a standard of 300 gallons per acre dilute spray for mature trees. If rates less than 300 gallons are applied per acre, refer to the rate-per-acre column to insure 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, p = poor for the pesticide in controlling the pest, and n = not labeled or no activity against this pest.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES Peach Leaf Curl Bacterial Spot Valsa Canker Crown Gall Comments: *Rates for fixed coppers s equivalent. For example, to The addition of lime to fi of peach leaf curl sprays (s page 66) is a persistent and leaf curl. Lime is not compa and rosin acids. Apply leaf curl sprays in au Kocide, Tennacop (Citcop), curl (use before bud swell in than Bordeaux. The coppen	4e, 51e, 53e, 57e, 58e* 4n, 51n, 53n, 57f, 58f* See page 67 See page 68 whould contain 4 to 8 lb of metallic copper use Kocide 101 or COCS at 12 lb/acre. ixed copper sprays will increase the effectiveness ee product label for instructions). Bordeaux (see d economical copper/lime combination for peach atible with Tenn-cop or other copper salts of fatty tumn after leaf drop or spring before bud swell. and COCS can also be used against peach leaf n the spring, or in the fall), and are less messy rs have some suppression of bacterial spot, which ceptible varieties (see page 66)	Suggested Chemicals (Rate/acre) FUNGICIDES 4. Bravo 720 (3 1/8 - 4 pt) 51. Ziram 76 DF (3 3/4 - 6 lb) 53. Carbamate 76 WDG (4 1/2 - 6 lb) 57. Bordeaux mixture (see page 66) 58. Fixed coppers (Kocide, Champ, COCS, and others)*
INSECTS Peachtree borer (Pre-plant dip only) Comments: See Special Problems: Pea	See page 67 26e, 32e	INSECTICIDES 26. Thiodan 3 EC 32. Lorsban 4 F (3 qt/100 gal)
DELAYED DORM	/IANT	
Pest INSECTS	Efficiency	Suggested Chemicals (Rate/acre)
San Jose Scale	24e, 32e, 52e, 56	24. Superior Oil (6 gal)**

INSECTS		INSECTICIDES	
San Jose Scale	24e, 32e, 52e, 56	24. Superior Oil (6 gal)**	
Climbing Cutworms	32e, 34e*, 35e*, 40e	32. Lorsban 4 E (3 pt)	
Comments:		34. Ambush 2 EC (9.6 fl oz)*	
Peaches only.		35. Pounce 3.2 EC (6 fl oz)	
**Unless applied dilute (300 gal/A) th	e use of oil is questionable.	40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)	
		52. Esteem 35 WP (5 oz)	
		56. Supracide 2 E (3 - 12 pt)	

and the second

PINK		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		Comments:
Brown Rot	See Bloom*	*Sprays for American brown rot are initiated at
Valsa Canker	See page 67	bloom
INSECTS/MITES		INSECTICIDES
Tarnished Plant Bug	34e, 35e, 40e, 59e, 66e	34. Ambush 2 EC (9.6 fl oz)*
Green Fruitworm	34e, 35e, 40e, 46e, 50e, 64e, 66e	35. Pounce 3.2 EC (6 fl oz)
Oriental Fruit Moth	47g	40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
Comments:	· · · · · · · · · · · · · · · · · · ·	46. Spintor 2 SC (4 - 8 oz)
*Peaches only.		47. Oriental Fruit Moth mating disruption
Place pheromone dispenser	rs in the orchard prior to moth emergence in	products
the spring. Refer to the label to	determine the application rate and number of	50. Intrepid 2 F (12 - 16 oz)
treatments recommended for a	particular product. Monitor the orchard with	59. Actara 25 WG (4.5 - 5.5 oz)
pheromone traps and by visual	inspection of fruit.	64. Entrust 80 WP (2 - 2.5 oz) ▲
		66. Warrior 1 CS (3.4 - 5.12 oz)

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 4g, 5e, 6g, 7e, 8e, 14f, 50g, 70g	2. Indar 75 WSP (2 oz)
Valsa Canker	See page 67	4. Bravo 720 (3 1/2 - 5 1/2 pt)
Comments:		5. Nova 40 W (2.5 - 6.0 oz)
Where pink bud spray is	omitted, or if weather is unusually favorable for	6. Vangard 75 WG (5 oz)**
brown rot, begin bloom s	prays earlier and continue at 2- to 4-day intervals if	7. Orbit 3.6 EC (4 fl oz)
wet, rainy weather prevail	ls.	8. Elite 45 DF (6 oz)
		14. Wettable Sulfur 95 WP (15 lb)
		50. Captan 50WP (8 lb)
		70. Pristine (10.5 - 14.7 lb)
		Comments: **Do not use Vangard past bloom in peaches. Fungicide-resistant plant pathogens may develop where 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	2e, 4g, 5e, 7e, 8e, 14f, 50g, 70g	2. Indar 75 WSP (2 oz)
Powdery Mildew	2g, 4n, 5g, 7g, 8g 14g, 50n, 70e	4. Bravo 720 (3 1/8 - 5 1/2 pt)
Comments:		5. Nova 40 W (2.5 - 6.0 oz)
	mes an economic problem in southwest Michigan,	7. Orbit 3.6 EC (4 fl oz)
particularly on Redskin.		8. Elite 45 DF (6 oz)
		14. Wettable sulfur 95 WP (15 lb)
		50. Captan 50 WP (8 lb)
		70. Pristine (10.5 - 14.7 oz)
INSECTS		INSECTICIDES
Plum Curculio	8e, 9e, 19f, 34e, 35e, 40e, 53g, 59e, 66g	5. Diazinon 50 WP (3 lb)
Oriental Fruit Moth	5g, 8e, 9e, 11f, 23f, 34g, 35g, 40e, 46g,	8. Guthion 50 WP (1 3/4 - 2 1/4 lb)
	50e, 52f/g, 64g, 66e	9. Imidan 70 WP (2 1/4 lb)
Rose Chafer	11f, 19g, 23g, 53f, 54f, 57f, 58f	11. Lannate 90SP (1 - 2 lb)*
Tarnished Plant Bug	11g, 19e, 26f, 34e, 35e, 40e, 53g, 54g, 59e	11. Lannate 2.4LV (3 - 6 pt)*
Green Peach Aphid	5g, 11g, 19e, 26g, 54g, 57, 58, 59e	19. Provado 1.6 EC (4 - 8 fl oz)
Thrips	11g, 46g, 53, 57, 58	23. Sevin 50 WP (6 lb)
Comments:		23. Sevin 80 S (4 lb)
* Use Lannate on peaches	only.	23. Sevin XLR+ (2 qt)
		26. Thiodan 3 EC (3 qt)
**Must maintain coverage	e for adequate performance.	26. Thiodan 50 WP (3 lb)
		34. Ambush 2 EC (9.6 fl oz)
		35. Pounce 3.2 EC (6 ft oz)
		40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
		46. SpinTor 2 SC (6 - 8 oz)
		50. Intrepid 2 F (12 - 16 oz)
		52. Esteem 35 WP (5 oz)
		53. Surround WP (25 - 50 lb)**
		54. Neem compounds [AzaDirect (32 fl oz), Ecozin
		(10 oz)] ▲
		57. Pyganic EC 1.4 (16 - 32 oz) ▲
		58. Evergreen EC 60-6 (8 - 16 oz)
		59. Actara 25 WG (4.5 - 5.5 oz)
		64. Entrust 80 WP (2 - 2.5 oz) ▲
		66. Warrior 1CS (3.4 - 5.12 oz)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 14f, 50g, 70 g	2. Indar 75 WSP (2 oz)
Powdery Mildew	2g, 14g, 50n, 70e	14. Wettable sulfur 95 WP (15 lb)
Peach Scab	2e, 14g, 50e, 70g	50. Captan 50 WP (8 lb)
Bacterial Spot	See page 66	70. Pristine (10.5 - 14.7 oz)
		Comments: Topsin-M is omitted on peaches and nectarines at shuck split through fourth cover in order to delay resistance problems. 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		INSECTICIDES
Plum Curculio	See Petal Fall	5. Diazinon 50 WP (3 lb) 19. Provado 1.6 EC (4 - 8 fl oz)
Oriental Fruit Moth	See Petal Fall	23. Sevin 80 S (4 lb)
Rose Chafer	See Petal Fall	23. Sevin 50 WP (6 lb)
San Jose Scale, Lecanium Scale	5g, 23g, 52e, 66g	26. Thiodan 50 WP (3 lb)
Tarnished Plant Bug	19e, 26f, 40e, 53g, 59e, 66g	26. Thiodan 3 EC (3 qt)
Comments:		40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
*Apply as often as needed to mainta	in coverage.	52. Esteem 35WP (5 oz)
		53. Surround WP (25 - 50 lb)* ▲
		59. Actara 25WG (4.5 - 5.5 oz)
		66. Warrior 1CS (3.4 - 5.12 oz)

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 66	1
X-Disease	See page 67	
	economic problem in southwest Michigan. It is naturing varieties, and fruits should be protected	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall	23 . Sevin 50 WP (1 - 2 lb/100 gal)
Tarnished Plant Bug	See Shuck Split	1
Earwigs	23g	
Rose Chafer	See Petal Fall	1
	ts 1 -inch long with pincers on the rear. They will in peaches with split pits. Apply Sevin to trunk	

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 66	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall	26. Thiodan 3 EC (1 qt/100 gal)
Lesser Peachtree borer	26g, 32e*	32 . Lorsban 4 E (3 qt/100 gal)*
Comments:		Comments
coarse dilute spray, with concer Avoid contact with foliage and fi	weeks later. Apply with a hydraulic gun as a ntration on scaffold limbs, crotches and trunk. ruit.	
THIRD COVER		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES	5 1 1 1 1 1 1 1 1	-
Peach Scab	Fungicides listed under Shuck Split	-
Powdery Mildew	Fungicides listed under Shuck Split	
Bacterial Spot	See page 66	
INSECTS		INSECTICIDES
Oriental Fruit Moth	See Petal Fall	17. Apollo SC (4 - 8 oz)*
Lecanium Scale	See Shuck Split	26 . Thiodan 3 EC (1 qt/100 gal)
Peachtree borer	26g, 32e	32 . Lorsban 4 E (3 qt/100 gal) **
European Red Mite	17e*, 42e*, 45e, 61g	42 . Savey 50 WP (3 - 6 oz)*
Twospotted Spider mite	17e*, 42e*, 45g***, 61e	42 . Savey 50 DF (3 - 6 oz)*
Tarnished Plant Bug	See Petal Fall	45. Pyramite 60 W (4.4 - 6.6 oz)
Comments:		61. Acramite 50W (0.75 - 1.0 lb)
**For peach borer control appl	y sprays the first week in July. Apply to the	Comments:
base of the tree as a coarse dilu	ite spray. Use a hydraulic gun. Avoid contact	*Limited to 1 application/season.
with foliage and fruit. See "Peac	htree Borer ," page 63. If Lorsban 4 E was r no additional spray for Peachtree Borer is	***Use 8.8 oz – 13.3 oz rate for Twospotted Spide Mites
00000000/		

FOURTH COVER Pest Efficiency **Suggested Chemicals (Rate/acre)** DISEASES FUNGICIDES Fungicides listed under First Cover **Brown Rot Bacterial Spot** See page 66 INSECTS **INSECTICIDES Oriental Fruit Moth** See Petal Fall, 9e, 11f, 23f, 40g, 46f, 9. Imidan 70 W (2 - 3 lb) 50g, 64f, 66g 11. Lannate 90SP (1 - 2 lb)* **Japanese Beetle** 11. Lannate 2.4LV (3 - 6 pts)* 9g, 11f, 19g, 23g, 40g, 54f, 57f, 58g, 66g 19. Provado 1.6 EC (4 - 8 fl oz) Thrips 11g, 46g, 57, 58 23. Sevin 80 S (4 lb) 23. Sevin 50 WP (6 lb) 23. Sevin XLR+ (2 qt) 40. Asana XL 0.66 EC (4.8 - 14.5 ft oz) 46. Spintor 2 SC (6 - 8 oz) 50. Intrepid 2 F (12 - 16 oz) 54. Neem compounds [AzaDirect (32 fl oz), Ecozin (10 oz)]** A 57. Pyganic EC 1.4 (32 - 64 oz)*** 58. Evergreen EC 60-6 (8 - 16 oz)*** 59. Actara 25 WG (4.5 - 5.5 oz) 64. Entrust 80 WP (2 - 2.5 oz) A 66. Warrior 1CS (3.4 - 5.12 oz) Comments: *--Use Lannate on Peaches only **--Primarily a repellent. ***--These are short-lived pyrethrums with strong initial knockdown activity. **PRE-HARVEST** Pest Efficiency Suggested Chemicals (Rate/acre) DISEASES **FUNGICIDES** Brown Rot 2. Indar 74 WSP (2 oz) 2e, 7e, 8e, 14f*, 50g, 70g 7. Orbit 3.6 EC (4 fl oz) Comments: 8. Elite 45 DF (6 oz) Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days. 14. Wettable sulfur 95 WP (15 lb) * 50. Captan 50 WP (8 lb) 70. Pristine (10.5 - 14.7 oz) Comments: Fungicide-resistant plant pathogens may develop where 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 product label. *--Apply a maximum of two pre -harvest sprays during the period beginning 10-14 days before harvest through the day of harvest. INSECTS **Oriental Fruit Moth** See Fourth Cover See Fourth Cover Japanese Beetle Thrips See Fourth Cover

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
X-Disease	See page 67	

Special Peach Insect and Disease Problems and Controls

Bacterial Spot

Bacterial spot is best controlled by planting resistant varieties. Older processing peaches such as Suncling, Babygold-5, and Babygold-7 and most older nectarines are relatively susceptible to this disease. Vinegold, Vulcan, Virgil, and Venture, new processing varieties from Ontario, are relatively resistant to bacterial spot. See accompanying table for fresh market peach resistance. Bacterial spot is generally worse on sandy sites exposed to wind. Use sod groundcover and plant resistant varieties on the outside edge of the orchard, especially on the windward side. 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 OR	6 lb
Fixed coppers such as COCS, Kocide, & others	See label

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.

Rate/acre
1 to 1 1/2 lb
4 lb
150 ppm

¹Caution: Phytotoxicity due to Syllit 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. Multiple applications can result in phytotoxicity if there has been no rain since last application and the residue level is high. It also helps to 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.

Bacterial spot resistance rating on leaves of fresh market peaches – four year average at the SW Michigan Research and Extension Center, Benton Harbor, MI. W.W. Shane, Michigan State University

	Bacterial spot resistance	
Variety	rating (3 = poor to 9 =	
	disease-free)	
Allstar	8.5	
Blazing Star	9.0	
Bounty	7.7	
Canadian Harmony	8.3	
Coral Star	8.3	
Cresthaven	8.1	
Glowing Star	8.6	
Harbinger	8.1	
Harrow Beauty	8.9	
Harrow Dawn	8.0	
Harrow Diamond	9.0	
Harrow Fair	8.6	
John Boy	9.0	
Laurol	6.5	
PF-1	8.9	
PF-12A	8.9	
PF-15A	7.7	
PF-17	8.8	
PF20-007	8.4	
PF-23	8.6	
PF24-007	9.0	
PF-27A	9.0	
Red Star	8.2	
Red Haven	8.0	
Rising Star	8.1	
Starfire	9.0	
Suncrest	7.1	

Valsa Canker (also called Cytospora or Leucostoma canker)

Cultural Practices: Delay pruning to pink or later to allow rapid healing. 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. When removing entire limbs, do not leave stubs that are too long (greater than $\frac{1}{2}$ ") or too short (less than $\frac{1}{4}$ "). Remove and burn prunings as soon as possible. Develop trees with wideangle crotches to reduce splitting. Careful use of nitrogen to avoid overvigorous and undervigorous growth is helpful as well.

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

PEACHES AND NECTARINES

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. X-diseased cherry on mazzard rootstock is an important source of the Xdisease agent. Remove infected trees as soon as they are detected.

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
June or July	Garlon 3A plus a surfactant	2 to 3 gal/100 gal	Spray to actively growing plant	most vegetation will be halted in the treated
June to September	Weedone 170	1 to 1 1/2 gal/100 gal	Spray to foliage and stems	area for an extended period of time (years).
Any season	Weedone CB	1 to 5 gal CB/A	Spray basal bark or cut or frilled surface with knapsack sprayer	Do not apply Bromacil, Garlon or Weedone near ditches or where surface water may carry the material to desirable plants.

Brush Killers for Removal of X-Disease Hosts

PEACHES AND NECTARINES 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 bareroot 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.

Peachtree 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 2 2/3 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 peachtree 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 4 E per year. Lorsban 4 E 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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Knot	See Comments	
whenever they are observed. Make p swellings. Do not plant new plum orc	ormant season and continue to remove knots oruning cuts at least 6 to 8 in. below visible hards next to old plantings with black knot. rry seedlings from fencerows and nearby wooded	
INSECTS/MITES		INSECTICIDES
European Red Mite	24e*	24. Superior Oil (6 gal)*
Lecanium Scale, San Jose Scale,	24e*, 32e**, 52e, 56	32. Lorsban 4 EC (3 pt)**
Aphids	32e**, 52g, 56	52. Esteem 35 WP (5 oz)
Peach Twig Borer,	32e**, 56	56. Supracide 2E (3 - 12 pts)
Climbing Cutworms	32e**	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	4g-e, 56g, 50f	4. Bravo 82.5 WDG (2.8 - 3.8 lb) or Bravo 6F (3 1/8 - 4 1/8 pts)	
		50. Captan 50 WP (6 lb)	
		56. Topsin M 70 WP (1 1/2 lb)	
		Comments:	
		Fungicide-resistant plant pathogens may develop where Benlate or Topsin-M are used.	

PRUNES AND PLUMS

BLOOM Pest Efficiency Suggested Chemicals (Rate/acre) **FUNGICIDES** DISEASES **Brown** Rot 4g, 6g, 7e, 14g*, 15f, 50g 56p, 4. Bravo 82.5 WDG (2.8 - 3.8 lb) or Bravo **Black Knot** 4g-e, 6n, 7n, 14n*, 15n, 56g, 50f 6F (3 1/8 - 4 1/8 pts) 6. Vangard 75 WG (5 oz) Comments: 7. Orbit 3.6 EC (4 fl oz, do not apply Where green tip spray is omitted, or if weather is unusually favorable for disease, on "Stanley" type plums) begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails. Note: High rates of wettable sulfur will provide some protection against black 14. Wettable sulfur 95 WP (15 lb) * 15. Elevate 50 WDG (1 - 1.5 lb) knot. 50. Captan 50 WP (6 lb) 56. Topsin-M 70 WP (1.5 lb) 70. Pristine (10.5 - 14.7 oz) Comments Fungicide-resistant plant pathogens may develop where Topsin-M is used over several years. *--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.

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	4g, 7e, 14g*, 15f, 50g, 56p, 70g	4. Bravo 82.5 WDG (2.8 - 3.8 lb) or Bravo
Leaf Spot	7f, 14p*, 50g, 56p, 70g	6F (3 1/8 - 4 1/8 pts)
Black Knot 4g-e, 7n, 14n ⁺ , 50f, 56g		 7. Orbit 3.6 EC (4 fl oz, do not apply on "Stanley" type plums) 14. Wettable sulfur 95 WP (15 lb) * 15. Elevate 50 WDG (1 - 1.5 lb) 50. Captan 50 WP (6 lb) 56. Topsin-M 70 WP (1.5 lb) 70. Pristine (10.5 - 14.7 oz)
Comments: The cherry leaf spot fungus i related cultivars in wet years Pseudomonas species, a dis during windy, wet, cool weat		
		Comments: Fungicide-resistant plant pathogens may develop where Topsin-M is 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.
INSECTS		INSECTICIDES
Plum Curculio	8e, 9e, 19f, 40e, 53g, 59e	5. Diazinon 50 WP (3 lb)
European Red Mite	42e, 45e, 61g	8. Guthion 50 WP (1 3/4 - 2 1/2 lb)
Twospotted Spider Mite	42e, 45g**, 61e	9. Imidan 70 WP (2 1/4 lb)
Oriental fruit Moth	8e, 9e, 40g, 50g, 52g, 64g, 66e	19 . Provado 1.6 EC (4 - 8 fl oz)
Aphids	5g, 19e, 52g, 59e	40 . Asana XL 0.66 EC (4.8 - 14.5 fl oz)
<i>Comments:</i> *Limited to 1 application/se ** Use 8.8 oz - 13.3 oz rate ***Must maintain coverage	for twospotted spider mites	42. Savey 50 WP $(3 - 6 \text{ oz})^*$ 42. Savey 50 DF $(3 - 6 \text{ oz})^*$ 45. Pyramite 60 W $(4.4 - 6.6 \text{ oz})^{**}$ 50. Intrepid 2 F $(12 - 16 \text{ oz})$ 53. Surround WP $(25 - 50 \text{ lb})^{***}$ ▲ 52. Esteem 35 WP (5 oz) 59. Actara 25 WG $(4.5 - 5.5 \text{ oz})$ 61. Acramite 50 W $(0.75 - 1.0 \text{ lb})$ 64. Entrust 80 WP $(2 - 2.5 \text{ oz})$ ▲ 66. Warrior 1 CS $(3.4 - 5.12 \text{ oz})$

PRUNES AND PLUMS

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	4g, 14p, 50g, 56p, 70g	4. Bravo 82.5 WDG (2.8 - 3.8 lb) or Bravo
Leaf Spot	14g, 50g, 56p, 70g	6F (3 1/8 - 4 1/8 pts)*
Black Knot	4g-e, 14n, 50f, 56g	14. Wettable sulfur 95 WP (15 lb)
		50. Captan 50 WP (6 lb)*
		56. Topsin-M 70 WP (1 1/2 lb)
		70. Pristine (10.5 - 14.7 oz)
		Comments:
		*Captan applied from shuck split through
		early July can cause shot-holing of leaves
		and spotting of fruit of Stanley and
		Japanese Plums. Do not apply Bravo after
		shuck split.
INSECTS		
Plum Curculio	See Petal Fall	

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	See Shuck Split	그는 그는 것 같은 것 같은 것 같은 것 같은 것 같이 많이
Leaf Spot	See Shuck Split	이 가지 않는 것이 많은 것이 같이 많을 것이 많을 것이 같다.
Black Knot	See Shuck Split	
INSECTS		INSECTICIDES
Scale*	5g, 52e	5. Diazinon 50 WP (3 lb)
Peachtree Borers**	26g See page68	26. Thiodan 3 EC (1 qt/100 gal)
Plum Curculio	See Petal Fall	52 Esteem 35 WP (5 oz)
		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	8. Guthion 50 WP (1 3/4 - 2 1/2 lb)
Comments:		9. Imidan 70 WP (2 1/4 lb)
Call the local pest manage when sprays for apple mag	ement code-a-phone or determine from the Extension agent ggot should be applied.	

PRUNES AND PLUMS

THIRD AND FOURTH COVER

	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See Shuck Split	
INSECTS/MITES		INSECTICIDES
Apple Maggot	5g, 8e, 9e, 23g, 40g, 53e, 64f. 66g, 67f	5. Diazinon 50 WP (3 lb)
Mites	28g, 45e, 61e	8. Guthion 50 WP (1 3/4 - 2 1/2 lb)
Japanese Beetle	8e, 9e, 19g, 23e, 40g, 54g, 53f, 57f, 58g, 59g, 66g	9. Imidan 70 WP (2 1/4 lb) 19. Provado 1.6 EC (4 - 8 fl oz)
Leafhoppers	8g, 9g, 19e, 23g, 40e, 45f, 53g, 57, 58, 59e, 66e	23. Sevin 80 S (4 lb) 23. Sevin 50 WP (6 lb)
Aphids	5g, 19e, 54g, 57, 58, 59e	23. Sevin XLR+ (2 qt)
Comments: *Primarily a repellent. **These are short-lived pyrethrums with strong initial knockdown activity. ***Apply as often as needed to maintain coverage.		 28. Vendex 50 WP (1 - 2 lb) 40. Asana XL 0.66 EC (4.8 - 14.5 fl oz) 45. Pyramite 60 W (8.8 - 13.3 oz) 54. Neem compounds [AzaDirect (32 fl oz), Ecozin (10 oz)]* ▲ 57. Pyganic EC 1.4 (32 - 64 oz)** ▲ 58. Evergreen EC 60-6 (8 - 16 oz)** 53. Surround WP (25 - 50 lb)*** ▲ 59. Actara 25 WG (4.5 - 5.5 oz) 61. Acramite 50 W (0.75 - 1.0 lb) 64. Entrust 80 WP (2 - 2.5 oz) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz) 67. GF120 NF Fruit Fly Bait (10 - 20 oz) ▲

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	7e**, 14f*,15f, 50g, 70g	7. Orbit 3.6 EC (4 fl oz, do not apply
Leaf Spot	7f**, 14f*, 15p, 50g, 70g	on "Stanley" type plums)**
Comments:		14. Wettable sulfur 95 WP (15 lb)*
Make first preharvest app	lication for brown rot 2 to 3 weeks before harvest and repeat	15. Elevate 50 WDG (1 - 1.5 lb)
in 5 to 10 days.		50. Captan 50 WP (6 lb)
		70. Pristine (10.5 - 14.7 oz)
		Comments:
		Fungicide-resistant plant pathogens may
		develop where Topsin-M is 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.
		**Apply a maximum of two pre- harvest
		sprays during the period beginning 10 - 14
		days before harvest through the day of
		harvest.

The rates of materials are based on a standard of 300 gallons per acre dilute spray for mature trees. If rates less than 300 gallons are applied per acre, refer to the rateper-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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	57/58f-g	57/58. Copper compounds
Crown Gall	See page 68	Copper hydroxide (Champ, Champion, Kocide,
Phytophthora Root Rot	See "Special Tart Cherry Disease Problems and Controls," page 78	 many others) – see label. Copper oxychloride (COCS, others) – see label. Basic copper sulfate (Basicop, Blue Shield, many others) – see label.
		Copper sulfate plus mancozeb Cuprofix Disperse see label.
		Comments: To prevent blossom blight, leaf and fruit spot stages of bacterial canker, initiate sprays at bud burst stage and repeat applications at weekly intervals to late May. Later sprays may cause some leaf yellowing and defoliation.
INSECTS/MITES		INSECTICIDES
Mineola Moth	5g, 8e, 9e, 23g, 34e, 35e, 40e	5. Diazinon 50 WP (3 lb)
Eyespotted Bud Moth	5g, 8e, 9e, 23g, 34e, 35e, 40e	8. Guthion 50 WP (1 1/2 lb)
Mites	24e*	9. Imidan 70 WP (2 1/4 lb)
Scales	24e*, 32e, 52e, 56g	23. Sevin 50 WP (6 lb)
		24. Superior Oil (6 gal)*
		32 . Lorsban 4 E (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)
		52. Esteem 35WP (5 oz)
		56. Supracide 2E (3 - 12 pts)
		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.

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease	
	Controls", page 78	

PRE-BLOOM (WHITE BUD STAGE)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
European Brown Rot	2e	2. Indar 75 WSP (2 oz)
on Cultivar Meteor*		Comments:
Brown Rot (American)**	See Bloom	European Brown Rot is primarily on Meteor but it is
Bacterial Canker	See Dormant	occasionally found on Montmorency. To date,
Comments:		European Brown Rot has only been detected in
	d again at bloom, are needed to control	west central and northwest Michigan. It is a
European Brown Rot.	a again at biooni, are needed to control	problem during bloom when the fungus attacks the
	ns initiated when 10 - 20% of the flowers are	flower parts and moves into the spurs. Indar has
	l of American brown rot. Infection at "white bud"	give significant control in a Michigan test; Rubigan,
	large number of brown rot infected fruit are	Nova, Rovial and Bravo gave poor control in the
	on and a prolonged period of warm (above 60°	same tests.
	conditions occur in unprotected orchards, use	
	- 48 hr after the beginning of the wet weather.	
INSECTS		INSECTICIDES
Green Fruitworm	26f, 32e, 34e, 35e, 40e, 46e, 64e,	26. Thiodan 50 WP (3 lb)
	66e	28. Vendex 50 WP (1 1/2 - 3 lb)
Plum Nursery Mite	28g	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)
		46. SpinTor 2 SC (6 - 8 oz)
		64. Entrust 80 WP (2 - 2.5 oz) ▲
		66. Warrior 1 CS (3.4 - 5.12 oz)
BLOOM		
BLOOM		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See Dormant	2. Indar 75 WSP (2 oz)
European Brown Rot	2e	4. Bravo 720 (3 1/8 – 5 1/2 pt)
on Cultivar Meteor		5. Nova 40 W (2.5 - 6.0 oz)
Brown Rot (American)	2e, 4f-g, 5e, 6g*, 7e, 8e, 14f**, 17g	6. Vangard 75 WG (5 oz)*
		7. Orbit 3.6 EC (4 fl oz)
		8. Elite 45 DF (6 oz)
		14. Wettable sulfur 95 WP (15 lb) **
		17. Flint 50 W (2 - 4 oz)
		Comments:
		*Do not apply Vangard past bloom in tart cherries
		**Flowable sulfur, liquid sulfur and less
		appropriate description of the second of
		concentrated wettable sulfur should be used at
		rates that will give the same amount of sulfur as the
		rates that will give the same amount of sulfur as the 95% wettable powder formulation except where
		rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. Because
		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
		rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. Because

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See Dormant	2. Indar 75 WSP (2 oz)
Brown Rot	2e, 4f-g, 5e, 7e, 8e, 10p/n, 17g	4 . Bravo 720 (3 1/8 - 5 1/2 pt)
Leaf Spot	2f-g, 4e, 5g, 7f, 8g, 10f-g, 17e, 70e	5. Nova 40 W (2.5 - 6.0 oz)
Comments:		7. Orbit 3.6 EC (4 fl oz)
The Elite/Captan tank mix may	be applied as a resistance management	8. Elite 45 DF (6 oz)
	icides. This use is permitted only in Michigan	or Elite 45 DF (4 oz) plus
as a FIFRA Section 2(ee) recor	mmendation.	Captan 50 WP (3 lb)
		10. Rubigan 1 EC (6 - 12 fl oz)
		17. Flint 50 W (2 - 4 oz)
		70. Pristine (10.5 - 14.7 oz)
		Comments:
		Because Benlate-resistant brown rot and leaf spot
		are widespread in Michigan, Topsin-M is not
		recommended for cherries past bloom.
INSECTS		
Green Fruitworm	26f, 32e, 34e, 35e, 40e, 46e, 64e,	5. Diazinon 50 WP (3 lb)
	<u>66e</u>	8. Guthion 50 WP (1 1/2 lb)
Leafrollers	8e, 9e, 32e, 40e, 46e, 64e, 66e	9. Imidan 70 WP (2 1/4 lb)
Plum Curculio	8e, 9e, 19f, 32g***, 34g, 35g, 40g,	19. Provado 1.6 EC (4 - 8 fl oz)
	53g*, 59e, 66g	23. Sevin 50 WP (6 lb)
Rose Chafer	8g, 9g, 23g, 19g, 32g***, 40e, 53f*,	23. Sevin 80 S (4 lb) 26. Thiodan 50 WP (3 lb)
	54f, 59g, 66g	26. Thiodan 3 EC (3 gt)
American Plum Borer	32e**. See "Special Tart Cherry	32. Lorsban 50 W (2 - 3 lb) ***
	Insect Problems and Controls" on	32. Lorsban 4 E (3 qt/100 gal) **
	page 81	-34. Ambush 25 WP (9.6 oz)
Black Cherry Aphid	5g, 19e, 26g, 54g, 57, 58, 59e	35. Pounce 25 WP (9.6 oz)
		40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
		46. Spintor 2 SC (4 - 8 oz)
		53. Surround WP (25 - 50 lb)* ▲
		54. Neem compounds [AzaDirect (32 fl oz), Ecozir
		(10 oz)] 🔺
		57. Pyganic EC 1.4 (16 - 32oz)
		58. Evergreen EC 60-6 (8 - 16oz)
		59. Actara 25 WG (4.5 - 5.5 oz)
		64. Entrust 80 WP (2 - 2.5 oz) ▲
		66. Warrior 1 CS (3.4 - 5.12 oz)
		Comments:
		*Must maintain coverage for adequate
		performance.
		**Lorsban 4E only
		***Use Lorsban 50 W only

SHUCK FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Bacterial Canker	See Dormant	2. Indar 75 WSP (2 oz)
Leaf Spot	2f-g, 4e*, 5g, 8g, 10f-g, 11g, 17e,	4 . Bravo 720 (3 1/8 - 5 1/2 pt)*
	70e	5. Nova 40W (5 - 6oz)
Brown Rot	2e, 4f-g*, 5p/n, 8e, 10p/n, 11p/n, 17g	8. Elite 45 DF (6 oz)
		or Elite 45 DF (4 oz) plus
		Captan 50 WP (3 - 4 lb)
		10. Rubigan 1 EC (6 - 12 fl oz)
		11. Syllit (dodine) 65 WP (1 - 2 lb)
		17. Flint 50 W (2 - 4 oz)
		70. Pristine (10.5 - 14.7 oz)
		Comments:
		Do not use Bravo after shuck split; may resume
		use after harvest.

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2f-g, 5g, 8g, 10f-g, 11g, 17e, 70e	2. Indar 75 WSP (2 oz)
		5. Nova 40 W (5 - 6 oz)
		8. Elite 45 DF (6 oz) or Elite 45 DF (4 oz) plus
		Captan 50 WP (3 - 4 lb)
		10. Rubigan 1 EC (6 - 12 fl oz)
		11. Syllit (dodine) 65 WP (1 - 2 lb)
		17. Flint 50 W (2 - 4 oz)
		70. Pristine (10.5 - 14.7 oz)
INSECTS		INSECTICIDES
Plum Curculio	See Petal Fall	26. Thiodan 3 EC (1 qt/100 gal)
Peachtree Borer	26g, 32e. See "Special Tart Cherry	32. Lorsban 4 E (3 qt/100 gal)
Lesser Peachtree Borer	Insect Problems and Controls" on	
	page 81	
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	2	
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	Fungicides listed under First Cover	
INSECTS		INSECTICIDES
Scale	5g, 32e, 66g	5. Diazinon 50 WP (3 lb)
Plum Curculio	See Petal Fall	32. Lorsban 50 W (2 - 3 lbs)
Comments:		66. Warrior 1 CS (3.4 - 5.12 oz)
Apply spray for scales wher	n crawlers become active.	

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See First Cover	
INSECTS/MITES		INSECTICIDES
Cherry Fruit Fly	5g, 8e, 9e, 23g, 34f, 35f, 40g, 53e***, 64f, 66g, 67f	1. Omite-CR** 5. Diazinon 50 WP (3 lb)
Plum Nursery Mite	28e	8. Guthion 50 WP (1 1/2 lb)
Rose Chafer	See Petal Fall, 57f, 58g	9. Imidan 70 WP (2 1/4 lb)
Scale	See Second Cover	17. Apollo SC (4 - 8 oz)*
European Red Mite	1g**, 17e*, 28g, 42e*	23. Sevin 50 WP (6 lb)
Twospotted Spider Mite	1g**, 17e*, 28g, 42e*	23. Sevin 80 S (4 lb)
	t code-a-phone or determine from the or cherry fruit fly should be applied.	28. Vendex 50 WP (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) 42. Savey 50 WP (3 - 6 oz)* 42. Savey 50 DF (3 - 6 oz)* 53. Surround WP (25 - 50 lb)*** ▲ 57. Pyganic EC 1.4 (32 - 64 oz) ▲ 58. Evergreen EC 60-6 (8 - 16oz) 64. Entrust 80 WP (2 - 2.5 oz) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz) 67. GF120 NF Fruit Fly Bait (10 - 20 oz) ▲ Comments: *Use is limited to 1 application per season. **For use on non-bearing orchards only. ***Apply as often as needed to maintain coverage.

CHERRY FRUIT FLY AERIAL CONTROL

13e

METHOD

Flat Fan Nozzles

13. Malathion LV Concentrate (12 oz)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2f-g, 5g, 7f, 8g, 10f-g, 11g, 17e, 70e	2 . Indar 75 WSP (2 oz)
Brown Rot	2e, 5p/n, 7e, 8e, 10p/n, 11f, 17g	5 . Nova 40 W (5 - 6 oz)
Comments:		7. Orbit 3.6 EC (4 fl oz)
Make first preharvest applica	tion for brown rot 2 or 3 weeks before harvest	8. Elite 45 DF (6 oz)
and repeat in 5 to 10 days.		or Elite 45 DF (4 oz) plus
		Captan 50 WP (3 - 4 lb)
		10. Rubigan 1 EC (6 - 12 fl oz)
		11. Syllit (dodine) 65 WP (1 1/2 lb), plus Wettable
		sulfur 95 WP (9 lb)
		17. Flint 50 W (2 - 4 oz)
		70. Pristine (10.5 - 14.7 oz)
		Comments:
		Flowable sulfur, liquid sulfur, and less concentrated
	V.	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-
		resistant brown rot and leaf spot are widespread in
		Michigan, Topsin-M is not recommended for
MOLOTO		cherries.
INSECTS Cherry Fruit Fly	See Third Cover	-
Chory Francis		

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot	2f-g, 4e, 5g, 8g, 10f-g, 11g, 17e, 70e	2. Indar 75 WSP (2 oz)
		4. Bravo 720 (4 1/8 pt)
		5. Nova 40 W (5 - 6 oz)
		8. Elite 45 DF (6 oz)
		10. Rubigan 1 EC (6 - 12 ft oz)
		11. Syllit (dodine) 65 W (2 lb)
		17. Flint 50 W (2 - 4 oz)
		70. Pristine (10.5 - 14.7 oz)
INSECTS	8	INSECTICIDES
Peachtree Borer	See page 81	28. Vendex 50 WP (1 - 3 lb)
Twospotted Spider Mite	28g, 45g	45. Pyramite 60 WP (8.8 - 13.3 oz)
Plum Nursery Mite	28e, 45g	1

TART CHERRIES 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.

			Fruit Brown Rot-
•	formation on cherry fungicides ry Thornton and Alan L. Jones and George W.	Elite 45 DF (tebuconazole)	activity very weak Blossom Brown F Protectant Back action
Sundin)			Leaf Spot—Good
Fungicide Cate	gories		 Protectant— Back action (
Anilinopyrimid Vangard (cyprodinil)	 ine a protectant fungicide blossom brown rot control good not effective for leaf spot do not use on sweet cherries 		Maximur for effect when us SI spray Powdery Mildew- Fruit Brown Rot-

Table 1 (continued) Background information on cherry fungicide

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.

Nova 40 W	Blossom Brown Rot—Excellent
(myclobutanil)	 Protectant—3-5 days
	 Back action—24-36 hours,
	dependent on temperature
	Leaf Spot—Good; commonly used
	at 5 oz/acre
	 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
	Powdery Mildew—Good
	 Best control when used on a regular
	schedule
	 Wetting agent should improve
	effectiveness
	Fruit Brown Rot—Not labeled for this use;
	activity very poor
Rubigan 1 EC	Blossom Brown Rot—Not labeled for this
(fenarimol)	use; activity very poor
	Leaf Spot—6 oz/acre—Fair;
	12 oz/acre—Good
	 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
	Powdery Mildew—Good
	Fruit Brown Rot—Not labeled for this use;
	activity very weak
Elite 45 DF	Blossom Brown Rot—Excellent
(tebuconazole)	
	Back action—24-36 hours
	Leaf Spot—Good
	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
	Powdery Mildew—Good
	Fruit Brown Rot—Excellent

Fungicide Categor	ies		
Indar 75 WSP	Blossom Brown Rot—Excellent		
(fenbuconazole)			
	Back action—24-36 hours		
	European Brown Rot—Excellent control on		
	Meteor in 1994		
	Leaf Spot—Good		
	 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 spray Powdery Mildew—Not labeled for this use		
	no data available		
	Fruit Brown Rot—Excellent		
	Wetting agent recommended		
Orbit 3.6 EC	Blossom Brown Rot—Excellent		
(propiconazole)	 Protectant—4-5 days 		
	Back action—24-36 hours		
	Leaf Spot— activity fair		
	Fruit Brown Rot—Excellent		
	 Maximum of two pre-harvest sprays 		
trobilurin			
Flint	Blossom Brown Rot—Not labeled for use		
(trifloxystrobin)	before petal fall		
	Leaf Spot—Good		
	Protectant—7-10 days		
	Back action; no data available		
	Powdery Mildew—Good		
	Protectant—7-10 days Pack actions and data available		
	Back action; no data available Fruit Brown Rot—Weak		
	Protectant-7-10 days		
Pristine	Back action; no data available		
	Leaf spot—Excellent		
(pyraclostrobin and boscalid)	Protectant-7-10 days Pack action, no data available		
and boscand)	Back action, no data available		
	Powdery Mildew—Excellent		
	Protectant—7-10 days Back action: no date swellable		
	Back action; no data available Fruit Brown Rot—Good		
	Protectant-7-10 days		
Cabrio	Back action; no data available Blossom Brown RotWeak		
(pyraclostrobin)	BIOSSOIN BIOWN ROL-Weak		
	Leaf SpotWeak		
	Fruit Brown Rot—Weak		
	Powdery mildew—Good		
enzene Compour			
Bravo 6F	Blossom Brown Rot—Good		
(chlorothalonil)	 Protectant—5-7 days 		
(second of the second of the s	 Back action—None 		
	Leaf Spot—Excellent		
	 Protectant—7-10 days 		
	Back action—None		
	 Do not use after shuck split, except 		
	post-harvest		
	Fruit Brown Rot—Not labeled after shuck		

split

Leaf Spot—Good (where dodine resistance	
does not occur)	
 Protectant—5-7 days 	
Back action—36 hours	
Fruit Brown Rot—Poor; Fair if tank mixed	
with sulfur or Captan	
 Protectant—7-10 days 	
Back action—None	
rbamates	
Leaf Spot—Fair—sweets; Poor—tarts	
 Protectant—4-6 days 	
Back action—None	
Fruit Brown Rot—Fair—sweets; Fair—tarts	
 Protectant—4-6 days 	
Back action—None	
Leaf Spot—Fair—sweets; Poor—tarts	
Fruit Brown Rot—Fair; best tank mixed wit	
Sulfur 95 W or Captan 50 WP	
npounds	
Only use in combination with Topsin-M or	
Syllit due to the low maximum	
labeled rate of 4 lb/acre. IR-4 is attempting	
to increase the label rate.	
이 가장에 가장 가장에 가지 않는 것 같은 것이 가지 않는 것은 것을 가지 않는 것이다. 이 가장에 있는 것은 것은 것은 것은 것은 것은 것은 것을 하는 것은 것을 알고 있는 것을 알고 있다.	
 Maximum of 2 applications per 	
season.	
 Do not apply after petal fall 	
Blossom Brown Rot—Excellent	
Protectant—4-5 days	
 Back action—24 hours 	
Leaf Spot—Fair	
 Protectant—5-7 days 	
 Back action (no data available) 	
Because Benlate/Topsin M-resistant brown	
rot and leaf spot are widespread in Michigar	
Topsin M is not recommended on cherries	
Blossom Brown Rot—Fair when used at 15	
20 lb/A, Poor at lower rates	
Protectant—2-3 days	
Back action—None	
Leaf Spot—Poor	
Fruit Brown Rot—Fair	
Protectant—2-3 days	
Back action—None	
When used at 9 lb/acre in tank mixtures	
with Syllit or Topsin-M, it does not give	
adequate control of fruit brown rot	
 when conditions are highly favorable for 	

Bacterial Canker

Bacterial canker of tart cherries is caused by the bacterium *Pseudomonas syringae* pv. *morspunorum* and sometimes by *P. syringae* pv. *syringae*. 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. This and any other copper treatment will not be effective where copper-resistant *P. syringae* pv. *syringae* are present. Resistant strains are common in Michigan cherry orchards.

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 MXM6O 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

Ave	rage	W	etting Period	(hr) ^b
tempe	erature	Light	Moderate	Heavy
(°F)	(°C)	infection	infection	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	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
a Adapted	from Eigon	amith and las	non 1001 Dian	at Dia

^a Adapted from Eisensmith and Jones, 1981. Plant Dis.

65:955-958 and Phytopathology 71:728-732.

^b The infection period is considered to start when rain begins.

Special Tart 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 4 E 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.

Peachtree 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 peachtree borer show wilting and loss of vigor. Unlike the lesser peachtree borer, the peachtree borer does attack young, healthy trees. While cherry trees can survive many lesser peachtree borers infesting the scaffold limbs, a single peachtree borer can cause serious injury to the root and affect the vigor of the tree. Multiple infestations of peachtree borer in the root kills the tree. Applying Lorsban at petal fall for American plum borer does not control the peachtree borer. Applying Lorsban in late June for lesser peachtree borer, taking special care to spray the base of the trunk and the soil around the trunk, controls peachtree borer. Lorsban 4E will cause foliar and fruit injury on sweet cherry.

Tart Cherry Pest Guide for the Northwest Station

			7	19	21 29	29 2	8	10	12	19	52	-	80	15	22	59	6 1	13 2	20 27	e	10	17
	DD Base 42'	e 42 [.] F	90	148 12	121 21	215 211	277	302	341	441	528	786	957	1125	1328	1503 1	1678 18	1888 2107		2296	2485 2675	2675 2865
•	DD Base 50' F	e 50' F	26 5	55 54	4 83	84	118	133	156	213	259	402	417	627	778	908		1184 1329	59	1467	1606	1606 1735 1863
6	Growth Stage		Dormant	Swc	Swollen Bud	Bud Burst	White t Bud	First Bloom	Full Bloom	Petal Fall	Shuck Split		1 [⊭] Cover		2 nd Cover	<u>ی م</u>	3rd Pr Cover Pr	Preharvest			Post	
Foo Eur	European Red	Adult				-			1 st					N	Monitor populations	popula	tions					
_		Hatch	Hatch Apply oil to control eggs	I to cont	Irol egg:	S		1 st	Peak													
Adult Female & Tw	Two Spotted	Adult												W	Monitor popu	opula	lations					
Immatures Spider Mite	der Mite	Hatch							st													
	Plum Rust	Adult				1 st								W	Monitor popu	opular	ations					
Female (Nu	(Nursery) Mite	Hatch						1 st														
	en	Adult 1st	1 st			۵.	Peak				End					-	st					
	Fruitworm	Larva				st		W	onitor fo	Monitor for Larvae	43	End										
		Adult										Peak	~							2		
Pupa Leafmi	cnerry Leafminer	Hatch				•						1 st		Peak			-			<u>a</u>	Peak	
		Tissue										-	1 st		Peak							
Pupa Che	Cherry Fruit Fly Adult	Adult				-								1 st		Peak	ik				Ē	End
Pupa Blac	Black Cherry Fruit Flv	Adult											1 st	-		Peak		- End				
Adult Plu	Plum Curculio	Adult				1 st				Peak	ak							End				
Adult Ro	Rose Chafer	Adult										No.	Peak		End							21
	erican	Adult					1 st			Peak	X											i.
arva Plu	Plum Borer	Hatch				HB	Hibernacula		-	1 st	Peak						1 st	Peak		End		
	Lesser Peach	Adult									1 st		Peak	ak								End
Larva Tre	Tree Borer	Hatch										15			Peak						End	
Gre	Greater Peach	Adult											ł					Peak			End	
	Tree Borer	Hatch													16						End	
Cherry Leaf Spot	Spot Prevention	Intion								Mo	nitor W	leather	Monitor Weather and Wetting Events	tting Ev	ents						End	
American Brown Rot		Prevention								Mor	Monitor W	sather	and Wetting Events	ting Ev	sine	T	Harvest					2
European Brown Rot		Prevention																				
Powdery Mildew		Prevention								Mor	nitor We	eather	Monitor Weather and Wetting Events	ting Ev	ents							
	Critical Control Period	Perioc																				
Ľ	Principal Monitoring Period	toring F	Period																			
4	Possible Control Period	ol Peric	pc																			

Jim Nugent, District Horticulturist and Station Coordinator, NWMHRS, for reviewing the Guide. Thanks also to Alison Heins, NWMHRS for data preparation. The dates, growth stages, and pest development presented in this guide represent averages for the time period of 1990 – 2001 for the Northwest MI Horticultural Research Station. Actual situations on any farm may differ for a particular year.

Thank you to the MI Cherry Committee And the MSU Center for Integrated Plant Systems for providing funds for this project.

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The rates of materials are based on a standard of 400 gallons per acre dilute spray for mature trees. If rates less than 400 gallons are applied per acre, refer to the rateper-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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

DORMANT		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES Bacterial Canker	57/58f-g	57/58. Copper compounds Copper hydroxide (Champ, Champion, Kocide, many others) – see label. Copper oxychloride (COCS, others) – see label. Basic copper sulfate (Basicop, Blue Shield, many others) – see label. Copper sulfate plus mancozeb Cuprofix Disperse see label. Comments: Apply up to two dormant copper sprays, at 1-2 week intervals.
PRE-BLOOM		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker Crown Gall	57/58f-g See page68	57/58. Copper compounds Copper hydroxide (Champ, Champion, Kocide, many others) – see label. Copper oxychloride (COCS, others) – see label. Basic copper sulfate (Basicop, Blue Shield, many others) – see label. Copper sulfate plus mancozeb Cuprofix Disperss see label. Comments:
		Reduced-rate applications (25-35% of dormant rate) should be applied after trees break dormancy. Apply up to two copper sprays with an interval of one week.
INSECTS/MITES	- 00 F0	
Black Cherry Aphid	5g, 26e, 59e	5. Diazinon 50 WP (4 lb)
Mites Scales	24e 24e, 32e, 52g, 56	24. Superior Oil (1% - 2% v/v) 26. Thiodan 50 WP (4 lb)
		 32. Lorsban 4 E (3 pt) 52. Esteem 35 WP (5 oz) 56. Supracide 2 E (3 - 12 pt) 59. Actara 25 WG (4.5 - 5.5 oz)

WHITE BUD OR POPCORN

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot (blossom blight)	2e, 4f-g*, 5e, 7e, 8e, 14f*, 15f, 17g	2. Indar 75 WSP (2 oz)
		4. Bravo 6F (3 1/8 - 5 1/2 pt)*
		5. Nova 40 W (2.5 - 6.0 oz)
		7. Orbit 3.6 EC (4 fl oz)
		8. Elite 45 DF (8 oz)
		14. Wettable sulfur 95 WP (20 lb) *
		15. Elevate 50 WDG (1 - 1.5 lb)
		17. Flint 50 W (2 – 4 oz)
		Comments:
		*Bravo 82.5% WDG (Bravo Ultrex) formulation
		may cause phytotoxicity on some varieties such as
		Gold. Flowable sulfur, liquid sulfur; and less
		concentrated wettable sulfur should be used as
		rates that will give the same amount of sulfur as
		95% the wettable powder formulation,
		except where prohibited by the product label.
INSECTS		INSECTICIDES
Green Fruitworm	26f, 34e, 35e, 40e, 46e	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)
		46. Spintor 2 SC (6 - 8 oz)

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	d continue at 2- to 4-day intervals if wet, rainy	
weather prevails.		

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 4f-g*, 5e, 7e, 8e, 10p/n, 15f, 17g,	2 . Indar 75 WSP (2 oz)
	50p, 53f*	4. Bravo 6F (4 1/8 - 5 1/2 pt)*
Leaf Spot	2g, 4e*, 5g, 7f, 8g, 10g, 15p, 17g, 50p,	5. Nova 40 W (2.5 - 6.0 oz)
	53f*	7. Orbit 3.6 EC (4 fl oz)
		8. Elite 45 OF (8 oz)
		10. Rubigan 1 EC (6 - 12 fl oz)
		15. Elevate 50 WDG (1 - 1.5 lb)
		17. Flint 50 W (2 - 4 oz)
		50. Captan 50 WP (4 lb)
		53. Carbamate 76 WDG (4 lb), plus
		Wettable sulfur 95 WP (12 lb)*
		Comments:
		* Bravo 82.5% WDG (Bravo Ultrex) formulation
		may cause phytotoxicity on some varieties such
		as Gold. 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, Topsin-M is not
		recommended in cherries past bloom.

PETAL FALL (CONTINUED)

INSECTS		INSECTICIDES						
Black Cherry Aphid	5g, 19e, 26g, 54g, 57, 58, 59e	5. Diazinon 50 WP (3 lb)						
Green Fruitworm	See White Bud	8. Guthion 50 WP (1 1/2 lb)						
Leafrollers	8e, 40e, 46e, 64e, 66e	19. Provado 1.6 EC (4 - 8 fl oz)						
Plum Curculio	5g, 8e, 19f, 34g, 35g, 40g, 53g*, 59e,	26. Thiodan 3 EC (3 qt)						
	66g	32 . Lorsban 4 E (3 qt/100 gal)						
American Plum Borer	32e. See comments on page 81	34. Ambush 25 WP (9.6 oz)						
Oriental Fruit Moth	5g, 8e, 34g, 35g, 40e, 46g, 64g, 66e	35 . Pounce 25 WP (9.6 oz)						
Leafhoppers	8e, 9e, 19e, 32g, 34g, 35g, 40e, 53g*,	40 . Asana XL 0.66 EC (4.8 - 14.5 fl oz)						
	57, 58, 59e, 66e	46 . Spintor 2 SC (6 - 8 oz)						
Comments:		☐ 53. Surround WP (25 - 50 lb)* ▲						
* Must maintain coverage for adequa	ate performance.	54. Neem compounds [AzaDirect (32 fl oz),						
5 I		Ecozin (10 oz)]						
		57. Pyganic EC 1.4 (16 - 32 oz) ▲						
		58. Evergreen EC 60-6 (8 - 16 oz)						
		59. Actara 25 WG (4.5 - 5.5 oz)						
		64. Entrust 80 WP (2 - 2.5 oz) ▲						
		66. Warrior 1 CS (3.4 - 5.12 oz)						
		Comments:						
		*Must maintain coverage for adequate						
		performance.						

SHUCK SPLIT		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 4f-g, 5p/n, 8e, 10p/n, 15f, 17g, 50p*, 53f	2. Indar 75 WSP (2 oz) 4. Bravo 6F (4 1/8 - 5 1/2 pt)
Leaf Spot	2g, 4e, 5g, 8g, 10f-g, 15p, 17g, 50p*, 53f	5. Nova 40 W (5 - 6 oz) 8. Elite 45 DF (8 oz) 10. Rubigan 1 EC (6 - 12 fl oz)
		15. Elevate 50 WDG (1 - 1.5 lb) 17. Flint 50 W (2 – 4 oz)
		 50. Captan 50 WP (4 lb)* 53. Carbamate 76 WDG (4 lb), plus Wettable sulfur 95 WP (12 lb)
		Comments: Do not apply Bravo after shuck split and before harvest. Bravo 82.5% WDG (Bravo Ultrex) formulation may cause phytotoxicity on some varieties such as Gold. *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 Petal Fall	

FIRST COVER

Peachtree Borer

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 5p/n, 8e, 10p/n, 17g, 50p, 53f*	2. Indar 75 WSP (2 oz)
Leaf Spot	2g, 5g, 8g, 10f-g, 17g, 50p, 53f*	5. Nova 40 W (5 - 6 oz)
Bacterial Canker	No chemical controls recommended	8. Elite 45 DF (8 oz)
		10. Rubigan 1 EC (6 - 12 fl oz)
		17 . Flint 50 W (2 – 4 oz)
		50 . Captan 50 WP (4 lb)
		53. 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.
INSECTS		
Black Cherry Aphid	See Petal Fall	-
Leafrollers	See Petal Fall	
Plum Curculio	See Petal Fall	
Rose Chafer	See Third Cover	7
SECOND COVER		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS		Comments:
Black Cherry Aphid	See Petal Fall	Lorsban 4 E trunk sprays for borer control will
Leafrollers	See Petal Fall	cause foliar and fruit injury on sweet cherry if
Rose Chafer	See Third Cover	chemical drifts to the tree canopy.

See "Special Tart Cherry Insect Problems and Controls" on page 81

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THIRD COVER		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS/MITES		INSECTICIDES
Cherry Fruit Fly	5g, 8e, 23g, 34f, 35f, 40g, 53e, 64f, 66g, 67f	5. Diazinon 50 WP (4 lb) 8. Guthion 50 WP (1 1/2 lb)
Rose Chafer	5g, 19g, 23g, 54f***, 53f, 57f****, 58g****, 66g	17. Apollo SC (4 - 8 oz)** 19. Provado 1.6 EC (4 - 8 fl oz)
European Red Mite	28e, 17e**, 42e**	23. Sevin 50 WP (8 lb)
Twospotted Spider Mite	28e, 17e**, 42e**	28. Vendex 50 WP (1 - 3 lb)
Plum Nursery Mite	28e	34. Ambush 25 WP (9.6 oz)
Comments: Call the local pest management agent when sprays for cherry fro *Apply as often as needed to ma		 35. Pounce 25 WP (9.6 fl oz) 40. Asana XL 0.66 EC (4.8 - 14.5 fl oz) 42. Savey 50 WP (3 - 6 oz)** 42. Savey 50 DF (3 - 6 oz)** 53. Surround WP (25 - 50 lb)* ▲ 54. Neem compounds [AzaDirect (32 fl oz) Ecozin (10 oz)]*** ▲ 57. Pyganic EC 1.4 (32 - 64 oz)**** ▲ 58. Evergreen EC 60-6 (8 - 16oz)**** 64. Entrust 80 WP (2 - 2.5 oz) ▲ 66. Warrior 1 CS (3.4 - 5.12 oz) 67. GF120 NF Fruit Fly Bait (10 - 20 oz) ▲ Comments: WARNING:Do not apply Imidan. It causes leaf spotting and defoliation of sweet cherry.
		 *Must maintain coverage for adequate performance. **Use is limited to 1 application per season. ***Primarily a repellent. ****These are short-lived pyrethrums with strong initial knockdown activity.

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Brown Rot	2e, 5p/n, 7e, 8e, 10p, 15f, 17g, 50p, 53f*	2. Indar 75 WSP (2 oz) 5. Nova 40 W (5 - 6 oz)
Leaf Spot	2g, 5g, 7f, 8g, 10f-g, 15p, 17g, 50p, 53f*	 7. Orbit 3.6 EC (4 fl oz) 8. Elite 45 DF (8 oz) 10. Rubigan 1 EC (6 - 12 fl oz) 15. Elevate 50 WDG (1 - 1.5 lb) 17. Flint 50 W (2 - 4 oz) 50. Captan 50 WP (4 lb) 53. 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 Benlate and Topsin-M not recommended for cherries because Benlate-resistant brown rot and leaf spot are widespread in Michigan.
INSECTS		
Cherry Fruit Fly	See Third Cover	
<i>Comments:</i> Make first application 2 or 3 w	veeks before harvest and repeat in 5 to 10 days.	

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES Leaf Spot	2g, 4e, 5g, 8g, 10f-g, 11g, 17g	FUNGICIDES 2. Indar 75 WSP (2 oz) 4. Bravo 720 (4 1/8 pt) 5. Nova 40 W (5 - 6 oz) 8. Elite 45 DF (8 oz) 10. Rubigan 1 EC (6 - 12 fl oz) 11. Syllit (dodine) 65 WP (1 1/2 - 2 lb) 17. Flint 50 W (2 - 4 oz)
INSECTS		INSECTICIDES
Peachtree Borers	See American Plum Borer under "Special Tart Cherry Insect Problems" on page 81	12 . Vendex 50 WP (1 - 3 lb) 45 . Pyramite 60 WP (8.8 - 13.3 oz)
Twospotted Spider Mites	12e, 45g	

	GF120 Fruit Fly Bait 🔺	67	ဖ			P																		S	
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	Entrust ▲	64	Q						ш		O												W	S	W
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	Evergreen	58								U				G									M	S	S
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onap	Diazinon	5	U				O	U		U	Ø	U	Ø				U	_	٩		٩		F	S	H
ness rating	= fair, are ately	Life Stage	Adult	Active	Lana	Active	Larva	Active	Larva	Adult	Lana	Adult	Larva	Adult	Active	Adult	Crawler		Active	Active	Active	Larva			
(Note that a product's effectiveness rating on a pest does not necessarily indicate that it is labeled for that use.	Ratings of control are E = excellent, G = good, F = fair, P = poor Ratings against beneficials are T = highly toxic, M = moderately toxic, S = relatively safe	Insect / Mite	Cherry Fruit Fly	Thrips	Cutworms	European Red Mite	Leafrollers	Aphids	Green Fruitworm	Japanese Beetle	Oriental Fruit Moth	Plum Curculio	Eye-Spotted Bud Moth	Rose Chafer	Plum Nursery Mite	Lecanium Scale	Lecanium Scale		Tamished Plantbug	Two-spotted Spider Mite	White Apple Leafhopper	Borers	Bees	Mite Predators	Insect Predators
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¹ Use only before pre-pink!

Diseases of Grapes in Michigan

For help in diagnosing grape diseases, see "A pocket guide for grape IPM scouting in the north central and eastern US", MSU Extension bulletin E-2889.

Powdery mildew – Uncinula necator

The powdery mildew fungus can infect all green tissues, resulting in a whitish gray, dusty or powdery appearance. Powdery mildew colonies are mostly present on the upper leaf surface. Infections of young, expanding leaves can result in distortion or stunting. Early berry infections can result in splitting of berries, secondary rots, and undesirable flavors in wine. Late infections are largely invisible except for a web-like necrotic pattern on the berry surface, which can still predispose the berries to rots. Severe infections reduce vine growth, yield, fruit quality, and winter-hardiness. In late summer, the fungus produces small golden-brown to black fruiting bodies (cleistothecia) on infected plant parts. The cleistothecia overwinter in bark crevices of the vine and release wind-disseminated ascospores in the spring. Leaves in proximity of the bark tend to get infected first. Powdery mildew is favored by high humidity and moderately high temperatures (68-81°F). Temperatures above 95°F inhibit new infections. Begin -monitoring for the disease early in the season, checking inside the canopy first.

Non-chemical management options: resistant cultivars, create open canopies to reduce humidity build-up, plant rows in direction of prevailing wind.

Downy Mildew – Plasmopara viticola

Downy mildew can infect leaves as well as flower and fruit clusters. Initial leaf symptoms show up as light green or yellow spots. These are termed "oil spots" because of their sometimes greasy appearance. The lesions eventually turn brown as the infected tissue dies. On older leaves, lesions are typically smaller and more angular as they are delimited by leaf veins. Leaf infections may lead to premature defoliation, which can reduce winter hardiness in severe cases. Under warm, humid conditions (>98% humidity and >55°F) at night, white, fluffy sporulation develops on the lower surface of the leaf. White spore masses also develop on infected flower and fruit clusters.' Infected clusters or berries eventually wither and die. The fungus overwinters in leaves on the ground. Spores are spread to new leaves and clusters by wind and rain. The fungus requires a film of water for infection. Lesions appear within 5-17 days after infection. The disease can spread rapidly under warm conditions with frequent rain or dew. Use the 10-10-10 rule to decide when to first start scouting for downy mildew: 10 cm (4 in.) of shoot growth, 10 mm (0.4 in.) rainfall and temperatures of at least 10°C (50°F) during a 24-hour period. Monitor leaves close to the ground as well as in the top of the canopy.

Non-chemical management options: resistant cultivars; create open canopies to reduce humidity and leaf wetness; plant rows in direction of prevailing wind.

Black rot – Guignardia bidwellii

The black rot fungus can attack all new growth, including leaves, petioles, shoots, tendrils, and berries. On the leaves, light brown, roughly circular spots appear in the spring and summer. These can be distinguished from herbicide damage by the presence of a ring of small black fruiting bodies, visible with the naked eye or a hand lens. Even though peak fruit infection occurs around mid-bloom in 'Concord' grapes in Michigan, symptoms only become apparent weeks later. The first symptom of berry infection is a small whitish dot within a rapidly expanding brown area that sometimes contains distinct "growth rings". Within a few days, the berry starts to shrivel and becomes a hard, blue-black mummy, Berries actually become resistant to infection about 3-5 weeks after bloom. If berries are infected close to the time of natural resistance development, lesions remain localized. The fungus overwinters in fruit mummies within the vine or on the ground. Ascospores are released from shortly after bud break until about 2 weeks after bloom, and are dispersed by wind and rain. Leaf spots and newly infected berries can also yield infectious conidia, which are rainsplash-dispersed. The optimum temperature for disease development is 80°F, at which the wetness period required for infection is only 6 hours. At higher or lower temperatures, the wetness requirement increases.

Non-chemical management options: Resistant cultivars; prune out dead canes and fruit mummies; remove fruit mummies from ground; create open canopy to reduce humidity and leaf wetness; plant rows in direction of prevailing wind.

Botrytis bunch rot – Botrytis cinerea

B. cinerea can infect all green parts of the vine, though bunch rot tends to be the biggest problem. In early spring, buds and young shoots may be infected and turn brown. In late spring, V-shaped or irregular brown patches may appear on leaves. Inflorescences may also be blighted and wither away. Some flower infections can remain latent until veraison. From veraison onward, the fungus can infect grape berries directly through the epidermis or through wounds, and may continue to invade the entire cluster. Compact clusters, powdery mildew infection, hail and insect damage (e.g., grape berry moth), can predispose grapes to Botrytis infection. Infected white grapes turn brown and purple grapes become reddish. During dry weather, infected berries dry out; in wet weather, they tend to burst and become covered with a grayish mold, which contains millions of spores. These spores are spread by wind to new infection sites. The disease spreads rapidly during moist periods, especially close to harvest. In certain cultivars,

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slow-developing, late-season infections are termed "noble rot" because they contribute to the production of exceptionally sweet wines. The fungus overwinters as mycelium or sclerotia (small black structures) in mummified fruit and other infected plant parts. The disease is favored by temperatures of 59-68°F and free water or at least 90% humidity.

Non-chemical management options: Resistant cultivars; leaf removal around clusters to reduce humidity and wetness; training systems that help expose the fruit.

Phomopsis cane and leaf spot – Phomopsis viticola

This fungus can infect all green parts of the vine, but infections of the fruit clusters are economically most important. Infected leaf blades show small irregular light green or yellow spots with dark centers and may be puckered. On petioles, shoots, and rachises, chlorotic spots with dark centers develop into elongated black streaks or blotches, which make the tissue brittle and prone to cracking or breakage. Most shoot lesions occur on the basal three to six internodes. Actively growing tissues are most susceptible to infection. Rachis and berry infections become apparent several weeks before harvest and continue to get worse over time. Rachis infections can lead to withering of the rachis, causing berries or sometimes entire clusters to drop prematurely. The fungus can also infect berries, either directly through the skin or through the berry stem. Infected berries turn brown and become soft and rubbery. Pycnidia may appear as numerous small black specks on the berry surface, sometimes oozing cream-colored droplets of spores. The fungus overwinters in bark of infected canes. Bleached areas, sometimes delineated by black lines, on dormant canes are indicative of infection. In spring and early summer, conidia are rain-splash dispersed from pycnidia on the overwintered canes. Prolonged periods of rainy, cold weather in spring promote disease development. At least 6 hours of wetness are needed for infection at the optimum temperature (59-68°F). Flower clusters are susceptible to infection from the moment they are exposed until harvest. Symptoms may appear 21-30 days after infection. Monitor carefully within 3-6 weeks from bud break.

Non-chemical management options: Resistant cultivars, pruning out infected canes (especially older wood), create open canopy to reduce humidity and improve spray coverage of clusters; timely harvesting to reduce losses to fruit drop and fruit rot; avoid hedging or minimal pruning.

Eutypa dieback - Eutypa lata

Eutypa dieback is a progressive disease of the woody tissues of the grapevine commonly found in older vineyards. The disease develops slowly and symptoms may not be visible for several years after infection. Shoot symptoms are best observed in mid-to-late spring.

Symptoms typically show up on one arm. The leaves are smaller than normal, cupped, and chlorotic. As the leaves expand, the edges become tattered. Chlorotic streaks may be present between veins and along margins. Shoots are stunted to varying degrees and have fewer and smaller fruit clusters, sometimes with a mixture of large and small berries. Eventually the affected arm or entire vine will fail to develop shoots and die. Upon close examination of the perennial wood bearing symptomatic shoots, a canker can usually be found surrounding an old pruning wound. Removal of the bark may be necessary to see the canker. When cut across, a wedge-shaped area of dead wood may be present. Shoot symptoms are thought to be induced by a toxin in the sap flowing from the canker. Most Eutypa infections occur through pruning wounds. Spores of the fungus are released from fruiting bodies in old cankers during late winter and early spring when temperatures are above freezing and rainfall of 1/25 inch or more has occurred. Moisture from melting snow may be sufficient. Non-chemical management options: Resistant cultivars; pruning out infected wood well below the discolored area; renewal of infected vines; removal and burning of dead wood from vineyard (vineyard sanitation).

Anthracnose – Elsinoe ampelina, Colletotrichum acutatum

Anthracnose sporadically occurs in Michigan. Table grape varieties are particularly susceptible. This fungal disease affects most above-ground parts of the vine, and actively growing plant parts are most susceptible. On leaves, numerous circular to angular, chocolate brown spots (1/25-1/5 inch diam.) develop. The centers of older lesions become bleached and fall out, leaving a "shot hole" appearance. Lesions along the veins may cause curling and distortion as the leaves expand. On shoots, spots are oval, sunken, and purplish-brown spots with gray centers and raised edges, and can blight entire shoot tips. On older wood, infections look like small craters with raised edges. On berries, purplish brown "bird's-eye" spots form. Depending on the cultivar and possibly the fungus, spots on berries can also look light gray with a dark edge. Lesions may cause berry cracking. The causal fungi overwinter in infected parts of the vine, and conidia are rain-splash dispersed in the spring. Anthracnose is especially severe in years with heavy rainfall early in the season. Start monitoring in the period 2-8 weeks from budburst.

Non-chemical management options: Resistant cultivars; pruning out infected wood; create open canopy to reduce humidity and improve spray coverage.

Sour bunch rot – fungi, yeasts and bacteria

Sour bunch rot is caused by a variety of fungi, yeasts and acetic acid bacteria. Low-grade powdery mildew infections or grape berry moth or fruit fly infestations can predispose clusters to infection. Insects can also spread

the sour rot organisms on their feet and mouthparts. Sour bunch rot is a wet rot which can spread rapidly throughout the cluster and cause the berries to smell like vinegar. Unlike with Botrytis bunch rot, mold is usually absent. Prolonged periods of wetness or high relative humidity are conducive to sour bunch rot development. Some cultivars are more susceptible than others.

Non-chemical management options: avoid wounding and insect infestations; create open canopy to reduce humidity.

Armillaria root rot - Armillaria mellea

While this disease is rare, it should be considered when planting grapes at old orchard sites or in forested areas, as the fungus infects woody plants. Infected grapevines may wilt severely and die quickly. Or they may suffer from a slow decline, characterized by a lack of vigor, stunting, small dark-green foliage, and eventually death. Usually, a number of plants in varying states of decline will be present in pockets within the vineyard. The fungus produces striated white mycelial mats underneath the bark on the trunk or larger roots at or below the soil line. Infected tissues have a distinct mushroom-like odor when moist. Rhizomorphs, black fungus strands that look somewhat like roots, may be present on the outsides of the roots. During the fall, the fungus may produce clumps of golden brown mushrooms (honey mushrooms) with caps that are 2-11 inches in diameter. The more mushrooms in a clump, the smaller they are. The fungus moves from one plant to the next by root contact and tends to move down rows. The fungus can live a long time in old roots in the soil.

Non-chemical management options: don't plant in infested orchard/forest sites; remove old stumps including the roots.

Crown gall – Agrobacterium vitis

Crown gall is a problem in areas where climatic conditions favor freeze injury. It is particularly damaging to Vitis vinifera and interspecific hybrids. The major symptom is fleshy galls on the lower trunk near the soil line. Aerial galls may also form as high as 3 ft up the vine. Young vines may be completely girdled by galls in one season. Young galls are cream colored and fleshy but turn brown and woody with age. Affected vines appear weak and portions of the vines above the galls may die. Crown gall is caused by the bacterium Agrobacterium vitis, which is a different strain from A. tumefaciens, the cause of crown gall on fruit trees and many other plants. The bacterium lives in the soil and enters the plants through wounds caused by mechanical damage, grafting, or freeze injury. The bacterium may also be present on the surface of planting material, which could explain sudden and severe outbreaks of crown gall in young vineyards after frost events. Contaminated pruning or grafting tools may contribute to spread. Removing galls usually does not cure the plant as new galls will continue to form. Sometimes, galls may be confused with abundant callus growth at graft unions. Isolation of the pathogen will be needed to confirm the cause of the galls in this case.

Non-chemical management options: don't plant in previously infested sites; buy plants from reputable nursery (preferably in eastern US); avoid wounding plants; cut out and remove galls as soon as possible; sterilize pruning shears with bleach between vines.

Ringspot virus decline – Tomato ringspot virus

(TomRSV) or Tobacco ringspot virus (TRSV)

This disease occurs sporadically in V. vinifera cultivars and interspecific hybrids. Vitis labrusca cultivars resistant. A typical symptom in older vineyards is missing or dead vines in a roughly circular pattern. In the first year of infection, the disease is difficult to detect. A few shoots may show leaves with mottling or an oak leaf pattern. In the second year, the disease becomes more evident. New growth is generally sparse because many infected buds are prone to winterkill. Diagnostic symptoms are shortened internodes with small distorted leaves, and sparse fruit clusters with uneven ripening of berries. In the third year, growth is very stunted and limited to basal suckers. The vine continues to decline and eventually dies. The disease is caused by either of two nepoviruses (TomRSV and TRSV) which are transmitted by dagger nematodes (Xiphinema spp.). Both can also be transmitted via seed and cuttings. The nematode vectors retain the virus for long periods of time and can acquire it from roots of infected grape or weeds. TomRSV infects a wide range of fruit crops, whereas both TomRSV and TRSV both infect many common weeds in vineyards, including dandelions, sheep sorrel, common chickweed, and red clover. Because of this, is it not uncommon for these viruses to be present in land used to establish new vineyards.

Non-chemical management options: buy virus-tested planting stock; don't plant in previously infested sites; remove and destroy infected vines; including nearby healthy-looking vines, practice good weed control before planting; cultivate infested vineyards last to avoid moving soil.

Peach rosette mosaic virus decline – Peach rosette mosaic virus (PRMV)

This disease occurs on V. labrusca cultivars in Michigan. The cultivars Concord and Catawba are particularly susceptible, whereas Niagara and Delaware are resistant. The disease also affects peaches in Michigan and Ontario, Canada. Infected vines exhibit an umbrellalike growth habit due to shortened and crooked internodes. Leaves are misshapen with a flattened basal sinus. Clusters are scraggly and may shell berries. Other disorders, such as boron deficiency and infection by grapevine fanleaf virus may mimic this disease. Infected grapevines generally lack vigor, are prone to winter injury, and may die after several years. Dead and dying vines are usually found in a slowly spreading, circular pattern. The disease is caused by peach rosette mosaic virus (PRMV), which is vectored by nematodes (Xiphinema and Longidorus spp.). Some perennial

weeds, such as dandelion, Carolina horse nettle, and curly dock are hosts of PRMV, and can be a source of infection. The virus may also be introduced via infected planting stock or spreading grape pomace from fruit of infected plants. About 10% of grape seedlings grown from seed of infected vines have been shown to be infected. The disease spreads about 3 ft per year to new vines in a circular pattern. There is a 3- to 4-year latent period between infection and the first expression of symptoms.

Non-chemical management options: buy virus-tested planting stock; don't plant in previously infested sites; or remove and destroy infected vines including nearby healthy-looking vines; cultivate infested vineyards last to avoid moving soil.

Nematodes – Root knot nematode, dagger nematode, lesion nematode

Plant parasitic nematodes are microscopic roundworms that live in the soil and feed on plant roots. In addition to being directly damaging to grapevine roots, some nematodes are important as vectors of viruses. Nematode damage can also predispose roots to root rots. In newly established vineyards, nematodes may be responsible for poor establishment and weak growth of young vines, especially at sandy sites. Nematodes seldom kill vines, but cause a steady decline in vigor. Symptoms on above-ground plant parts are not very specific, e.g., poor growth, low yields, and "off" color. Infected plants are more susceptible to environmental and other stresses. Symptoms may also resemble certain nutrient deficiencies or virus diseases. Belowground symptoms are poor root development, darkcolored root lesions, and stunting or death of feeder roots. Root knot nematodes characteristically cause small swellings (galls) of the young feeder roots or secondary roots. When the galls are opened, the glistening white bodies of female nematodes can often be seen with a hand lens. Nematodes are spread via infected planting material or movement of soil on farm equipment and in run-off or irrigation water. Once established in a vineyard, nematode infestations tend to be permanent, so care must be taken to prevent new infestations. Nematode infestations can be confirmed by sending root and soil samples to a nematology lab.

Non-chemical management options: don't plant in previously infested sites; cultivate infested vineyards last to avoid moving soil with nematodes; clean cultivating equipment.

The rate of materials for use on grape is 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. To get sufficient spray coverage of fruit clusters within the canopy, it is recommended to use 50 - 100 GPA after bloom. Effectiveness of materials listed below is based primarily on trials using concentrate sprays of 50 GPA (water) on mature grape vines. 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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

BUD SWELL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Phomopsis	14f**, 63f-g**	14. Sulfur [various formulations]
Comments:		(10 lb equivalent)* ▲
A dormant application of s	sulfur or lime sulfur directed at the cordon will help	63. Lime sulfur (10-20 gal) ▲
control Phomopsis, powdery	/ mildew, and mites. Do not apply lime sulfur to	3. 이 가슴에 가슴에 가슴 가슴 감을 수 있는 것을 수 있다.
green foliage. Do not apply	sulfur to leaves of sensitive cultivars, e.g., Concord	d.
INSECTS		INSECTICIDES
Grape Flea Beetle	44g, 57, 58	32. Lorsban 4 E (1 qt)*
Climbing Cutworms	32e*, 44e	44. Danitol 2.4 EC (10.6 oz)
Comments:		57. Pyganic EC 1.4 (16 – 32 oz) ▲
*This is a Special Local Ne	eeds (SLN) label, and growers must possess the	58. Evergreen EC 60-6 (8 – 16 oz)
SLN label at the time of app	lication. Lorsban 4 E will not control flea beetles.	

1- TO 5-INCH SHOOT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Phomopsis	50g, 51g, 59g-e	5. Nova 40 WP (3 - 5 oz)
(cane, leaf, and rachis infection)		8. Elite 45 DF (4 oz)
Powdery Mildew	5e, 8e, 10e, 13e, 14g*, 54e	10. Rubigan 1 EC (4 oz)
Bactericides for Fruit Crops", pages susceptibility and sulfur/copper ser spray decisions. Phomopsis: spores will be release onwards. Start protecting flower clu	nd restrictions in the section "Fungicides and s 11-15. Also consider cultivar disease nsitivity (Table 2, page 103) when making ed during rain events from budbreak usters once they become visible (2-3 leaves	 Bayleton 50 WP (3 - 6 oz) Sulfur [various formulations] (labeled rates)* ▲ Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80WDG (1¼ - 2½ lb) Ziram 76 DF or Ziram Granuflo (3 - 4 lb) Procure 50 WP (4 - 6 oz) Dithane DF or Penncozeb 75 DF or Manzate 200 DF (1½ lb)
susceptible varieties or problem and Black rot: Sprays specifically for b Instead, emphasize protection of th	lack rot at this time are not necessary.	Comments: * Sulfur can provide good management of powdery mildew on sulfur-tolerant grapes (Table 2) but must be applied relatively frequently. Sulfur is much less active at temperatures below 65 °F. Sulfur can cause injury even on tolerant varieties when temperatures are above 85 °F. Do no apply within 14-21 days of an oil application. Sulfur has a detrimental effect on beneficial mites.
INSECTS		INSECTICIDES
Grape Flea Beetle	44g	44. Danitol 2.4 EC (10.6 oz)
Climbing Cutworms	See Bud Swell	

6- TO 12-INCH SHOOT

Pest	Efficiency
DISEASES	
Downy Mildew	12e*, 15e*****, 16e*, 17g*, 50e**, 51g, 57e***, 58e***, 59e, 70e* ****
Powdery Mildew	5e, 8e, 10e, 12g-e*, 13e, 14g*, 16g*, 17e*, 54e, 70e* ****
Phomopsis (cane, leaf, and rachis infection)	5f, 8f, 12e*, 16e*, 17e*, 50g**, 54f, 59g-e, 70e* ****

Comments:

Downy mildew: The downy mildew fungus becomes active at about 10-inch shoot growth and infective spores are released during rainy periods if temperatures are above 50°F. A spray at this time may be important for highly susceptible varieties or if the disease was severe the previous year.

Phomopsis: Rachis infections are possible once the flower clusters become exposed. Rachis lesions do not become visible until 3-4 weeks after infection. Hedged and minimally pruned vineyards are most at risk of infection.

	Suggested Chemicals (Rate/acre)
	FUNGICIDES
1922	5. Nova 40 WP (3 - 5 oz)
	8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz)
,	10. Rubigan 1 EC (4 oz)
	12. Abound 2 F (11 - 15 oz)*
	13 . Bayleton 50 WP (3 - 6 oz)
	14. Sulfur [various formulations]
	(labeled rates)
3	15. Aliette WDG (3-5 lb)*****
	16. Sovran (3.2 - 5.6 oz)*
v	17. Flint (1.5 - 4 oz)*
·	50. Captan 50 WP (4 lb)** or Captec 4 L (2 qt)**
	or Captan 80WDG $(1\frac{1}{4} - 2\frac{1}{2} \text{ lb})^{**}$
	51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb) 54. Procure 50 WP (4 - 6 oz)
	57. Bordeaux mixture (6 lb copper sulfate and 6
	b hydrated lime per 100 gal water)*** ▲
	58. Fixed copper [various formulations]
	(labeled rates)*** ▲
	59. Dithane DF or Penncozeb 75 DF or
	Manzate 200 DF (2 lb)
	70. Pristine (6 - 10.5 oz)* ****
	Comments:
	*To limit the risk of resistance development, do
	not apply more than two consecutive
	applications of strobilurin fungicides.
	**Captan applied here will give control of
	Phomopsis leaf and cane spot disease and
	downy mildew, but is weak against black rot.
	***Copper sensitive varieties (see table 2) can
	be injured by copper. Even non-sensitive
	varieties can be harmed under slow drying, cooling conditions. Fixed copper formulations
	should not be used with Bayleton, Nova,
	Guthion, Imidan, Sevin or Thiodan.
~ ~	****Do not use Pristine on Concord, Worden,
	Fredonia or related cultivars or injury may result.
	*****Do not tank-mix Alliette with copper
	compounds, surfactants or foliar fertilizers. Apply
	on a 21-day schedule; do not apply more than 7
	11

times per season.

IMMEDIATE PRE-BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)		
DISEASES		FUNGICIDES		
Bląck Rot (fruit infection) Downy Mildew	5e, 8e, 10g, 12e*, 13e, 16e*, 17g*, 51g, 53g, 54g, 64g**, 70e* 12e*, 15e, 16e*, 17g*, 50e, 51g, 57e, 58e,	5. Nova 40 WP (3 - 5 oz) 8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz) 10. Rubigan 1 EC (4 oz)		
	59e, 70e*	12. Abound 2 F (11 - 15 oz)*		
Powdery Mildew	5e, 8e, 10e, 12g*, 13e, 14g, 16g*, 17e*, 54e, 64f-g**, 66f-g***, 70e*	13. Bayleton 50 WP (3 - 6 oz)14. Sulfur [various formulations]		
Phomopsis (rachis infection)	5f, 8f, 12e*, 16e*, 17e*, 50g, 54f, 59g-e, 70e*	(labeled rates) ▲ 15. Aliette WDG (3-5 lb) 16. Sovran (3.2 - 5.6 oz)*		
continued until 5 weeks por resistant to infection by th susceptible for a few weel wetness and temperature Elite applied for black rot Rubigan does not provide disease pressure. Tank m needed. Downy mildew: This is an Vineyards should be scoul foliage should be protected disease. Powdery mildew: If powo years, make sure to apply	a against black rot should commence now and be ost-bloom, at which time the berries become naturally the black rot pathogen (some Vinifera cultivars may be ks longer). Infection risk increases with increasing leaf (see Grape Black Rot table on page 104). Nova or will also be highly effective against powdery mildew. a dequate control of black rot under moderate to high nix with a mancozeb product if black rot control is n important time to manage primary infections. the dot for the disease throughout the summer and the ed based on weather conditions and presence of the dery mildew on the fruit was a problem in previous v a spray of an effective fungicide now and maintain throughout fruit development period.	 17. Flint (1.5 - 4 oz)* 50. Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80WDG (1¼- 2½ lb) 51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb) 53. Ferbam Granuflo (4 lb) 54. Procure 50 WP (4 - 6 oz) 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ 59. Dithane DF or Penncozeb 75 DF or Manzate 200 DF (2 lb) 64. Armicarb 100 (2.5 - 5 lb)** 66. JMS Stylet Oil (1 - 2% conc.)*** ▲ 70. Pristine (6 - 10.5 oz)* Comments *To limit the risk of resistance development, do not apply more than two consecutive applications of strobilurin fungicides. **Armicarb is a salt and kills fungi on contact. Apply in at least 50 gpa of water to get adequate coverage. ***JMS Stylet Oil will temporarily remove bloom on grapes. Stylet oil also helps to control mealybugs, mites, and leafhoppers. Do not tank mix Stylet Oil with spreaders-stickers, foliar fertilizers, or Captan. Do not apply sulfur with or 		
INSECTS		INSECTICIDES		
Grape Berry Moth	48f	48. Grape berry moth mating disruption		
before bloom. Pheromone seasonal activity of these applied at the first adult en application may be neces	erwinters as a pupa and adult emergence begins at or e traps are available to detect the presence and moths. Pheromone for mating disruption should be mergence, according to the product label. Re- sary to cover all adult flights. Large acreage vineyards tions are the most appropriate for mating disruption.	products		

BLOOM Efficiency Pest DISEASES Black Rot (fruit infection) 5e, 8g, 10f-g, 12e, 13e***, 16e 17e, 50e, 51g, 53g, 59e, 64g, 70e**** Phomopsis (rachis and fruit 5f, 8f, 12e, 16e, 17e, 50g, 54f, 59g-e, 70e***** infection) **Powdery Mildew** 5e, 8e, 10g, 12g, 13e***, 14g, 16g, 17 27g-e*****, 54e, 58f, 64f-g, 65f*****, 66f-g, 70e***** **Downy Mildew** 12e, 15e, 16e, 17g, 50e, 51g, 53f, 55e****, 57e, 58e, 60e****, 59e, 70e***** 3g*, 6e**, 27e******, 65e***** **Botrytis Bunch Rot** Comments:

Botrytis bunch rot: A spray for Botrytis bunch rot at bloom is only warranted when conditions are extremely favorable (cool and wet) for disease development. The most important times for control of Botrytis bunch rot are from veraison to pre-harvest or when the disease is first spotted in the vineyard.

Phomopsis: Rachis infections can continue at least until bunch closing if inoculum is available and are responsible for berry drop before and at harvest. Berries become infected through the berry stem or directly through the skin. It is important to keep the developing fruit protected, particularly during wet weather. Thorough fungicide coverage of the clusters is essential for control, especially when using protectant fungicides. Increase spray volume or decrease tractor speed and spray every row middle after bloom to obtain sufficient coverage.

North	Suggested Chemicals (Rate/acre)
	FUNGICIDES
	3. Rovral 50 WP (11/2 - 2 lb)*
**	5. Nova 40 WP or DF (3 - 5 oz)
1	6. Vangard 75 WG (10 oz)**
1.1	8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz)
e,	10. Rubigan 1 EC (4 oz)
	12. Abound (11 - 15 oz)
	13. Bayleton 50 WP (3 - 6 oz)***
	 Sulfur [various formulations] (labeled rates)
	15. Aliette WDG (3-5 lb)
	16. Sovran (3.2 - 5.6 oz)*
	17. Flint (1.5 - 4 oz)*
	27. Endura (4.5 - 8 oz)******
	50. Captan 50 WP (4 lb) or Captec 4 L (2 qt)
ed	or Captan 80WDG (1¼– 2½ lb)
cu	51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb)
,	53. Ferbam Granuflo (4 lb)
	54. Procure 50 WP (4 - 6 oz)
	55. Ridomil Gold MZ (2.5 lb)****
	57. Bordeaux mixture (6 lb copper sulfate and 6 lb
-	hydrated lime per 100 gal water) ▲
	58. Fixed copper [various formulations] (labeled
7	rates) ▲
	59. Dithane DF or Penncozeb 75 DF or
al	Manzate 200 DF (2 lb)
	60. Ridomil Gold/Copper (2 lb)****
to	64. Armicarb 100 (2.5 - 5 lb)
	65. Elevate 50 WDG (1 lb)*****
	66. JMS Stylet Oil (1 - 2% conc.) ▲
	70. Pristine (6 - 10.5 oz)*****
	Comments:
	*Add a non-ionic surfactant, e.g. Triton B-1956 or Triton CS-7 at 0.05% or 6 fl oz/100 gal water.
	Where resistant strains of Botrytis occur, Rovral
	may not provide adequate control.
	**Do not make more than 2 applications of
	Vangard per season.
	***If black rot pressure is heavy, increase Bayleton
	rate to 6 oz/acre.

****--Both of these products have a 66-day preharvest interval (PHI). Ridomil Gold MZ provides some black rot control but no powdery mildew control. Ridomil Gold/Copper will not control black rot but provides some control of powdery mildew *****--Do not apply Elevate more than 3x per season.

******--Do not use Pristine on Concord, Worden, Fredonia or related cultivars or injury may result. ******-- Use Endura at 4.5 oz/A for powdery mildew, and 8 oz/A for Botrytis bunch rot control.

BLOOM (CONTINUED)

Pest	Efficiency	Suggested Chemicals (Rate/acre)				
INSECTS Grape Berry Moth Rose Chafer Grape Phylloxera Comments: *Do not use Thiodan 3 EC fo severe injury. Check labels fo **Do not make more than or ***Must maintain coverage f	5g, 8e, 9e, 11e, 23e, 43g, 44e**, 46g, 50e8g, 9g, 11f, 23g, 44g**, 53f***26e*, 44cormulation on Concord grapes to prevent or other variety restrictions. he post-bloom application of Danitol. for adequate performance. oved from the Guthion label. Check the label to	INSECTICIDES 5. Diazinon 50 WP (2 lb) 8. Guthion 50 WP (1½ - 2 lb)**** 9. Imidan 70 WP (1½ lb) 11. Lannate 90 SP (½ - 1 lb) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2½ lb) 23. Sevin 80 S (2½ lb) 26. Thiodan 50 WP (2 lb)* 26. Thiodan 3 EC (1½ - 2 qts)* 43. Bacillus thuringiensis (B.t.) * [Dipel (1.5 lb)] ▲ [Deliver AC (0.5-2.0 lb)] 44. Danitol 2.4 EC (10.6 oz)** 46. SpinTor 2 SC (6 oz) 50. Intrepid 2F (8 oz) 53. Surround WP (25 lb)***				
FIRST COVER (PI	EA-SIZED BERRIES) Efficiency	Suggested Chemicals (Rate/acre)				
DISEASES		FUNGICIDES				
Black Rot	See Bloom	Comments:				
Downy Mildew Powdery Mildew		The time interval between the last spray harvest for EBDC fungicides, Ridomil Go				

Powdery Mildew		harvest for EBDC fungicides, Ridomil Gold MZ and			
Phomopsis (rachis and fruit in	nfection)	Ridomil Gold/Copper is 66 days.			
INSECTS		INSECTICIDES			
Grape Berry Moth	See Bloom	5. Diazinon 50 WP (2 lb)			
Grape Leafhopper	5f, 8f*, 9f, 11g, 19e**, 23g, 44e***,	8. Guthion 50 WP (11/2 - 2 lb)*			
	45g, 53f****, 57, 58, 60e	9. Imidan 70 WP (1.5 lb)			
Potato Leafhopper	5g, 8g*, 9g, 11g, 19g**, 23g,	11. Lannate 90 SP (1/2 - 1 lb)			
	44g***, 60g	19. Provado SoluPak (¾ - 1 oz)**			
Rose Chafer	8g*, 9g, 11f, 23e, 44e***, 57f, 58g,	23. Sevin 50 WP (4 lb)			
	60e	23. Sevin 80 S (2 lb)			
Comments:		44. Danitol 2.4 EC (5.3 - 10.8 oz)***			
Pheromone traps are available	le for monitoring berry moth abundance and	45. Pyramite 60 W (6.6 - 13.2 oz)			
helping to time insecticide ap	plications in vineyards.	53. Surround WP (25 lb)**** ▲ 57. Pyganic EC 1.4 (16 - 32oz) ▲			
		58. Evergreen EC 60-6 (8 - 16oz)			
		60. Assail WSP (1.1 oz)			
		Comments:			
	3	*Guthion is restricted to three applications per			
		year.			
		**Do not apply more than 2.0 oz of Provado per			
		acre per year.			
		***Do not make more than one post-bloom			
		application of Danitol.			
		****Must maintain coverage for adequate			
		performance.			

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot	See Bloom	Comments:
Botrytis Bunch Rot		The time interval between the last spray and
Downy Mildew		harvest for EBDC fungicides, Ridomil Gold MZ
Powdery Mildew		and Ridomil Gold/Copper is 66 days.
Phomopsis	1	
Comments:		a second and a second
	of Botrytis bunch rot is between veraison	
and pre-harvest.		
INSECTS		INSECTICIDES
Grape Berry Moth	See Bloom	
Grape Phylloxera	See Bloom	
Grape Leafhopper	See First Cover	
Rose Chafer	See First Cover	
THIRD COVER (BUNC	the second s	
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot	See Bloom	
Downy Mildew		
Powdery Mildew		
Phomopsis		
Comments:		
	at 4-5 weeks after bloom. Sprays for time for certain Vinifera varieties and veraison. uch reduced at this time because much	
of the inoculum has been exhausted, Downy mildew : Keep monitoring for up later in the season, especially in 'l become naturally resistant to infection	symptoms. The disease tends to show Viagara'. At this time the berries have	
INSECTS		INSECTICIDES
Grape Berry Moth	See Bloom	9. Imidan 70 W (2 lb)
Grape Leafhopper	See First Cover	10. Kelthane 35 WP (1 1/2 - 3 1/2 lb)
Mites	10g, 28g, 41g, 44g, 45g, 61g	23. Sevin 50 WP (4 lb)
Japanese Beetle	9g, 23g, 44g, 53f*, 57f, 58g	23. Sevin 80 S (2 1/2 lb)
		23. Sevin XLR+ (2 qt)
		28. Vendex 50 WP (1 - 2 1/2 lb)
		41. Agri-Mek 0.15 EC (16 oz) plus non-ionic
		surfactant
		44. Danitol 2.4 EC (10.6 oz)
		45. Pyramite 60W (8.8 - 13.2 oz)
		53. Surround WP (25 lb)* ▲
		57 . Pyganic EC 1.4 (16 - 32oz)
		58. Evergreen EC 60-6 (8 - 16oz)
		61. Acramite 50W (0.75 - 1.0lb)
		Comments:
		*Must maintain coverage for adequate performance
		penomiance

FOURTH COVER Suggested Chemicals (Rate/acre) Pest Efficiency DISEASES **FUNGICIDES** Black Rot (fruit infection) See Bloom and Third Cover **Downy Mildew** See Bloom and Third Cover **Powdery Mildew** See Bloom and Third Cover **Botrytis Bunch Rot** See Bloom and Third Cover Comments: Black rot: Sprays may only be needed at this time for certain Vinifera varieties and hybrids that remain susceptible until veraison. **INSECTS/MITES INSECTICIDES** Grape Berry Moth See Bloom Comments: Japanese Beetle See Third Cover Labrusca vines are naturally resistant to feeding See Third Cover by Japanese beetles, and can withstand some leaf Mites area loss without affecting vine growth or fruit Comments: guality. Hybrid and Vinifera vines are at greater The third week of July is a key time to scout high risk vineyards for grape risk from Japanese beetle defoliation. berry moth and grape leafhopper, and to make decisions on their control. **FIFTH COVER** Suggested Chemicals (Rate/acre) Pest Efficiency DISEASES **FUNGICIDES** Black Rot (fruit infection) 5e, 8g, 10f-g, 12g, 13e**, 16e, 17g, 5. Nova 40 WP or DF (3 - 5 oz) 8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz) 50e, 51g***, 64g, 70e 10. Rubigan 1 EC (4 oz) **Powdery Mildew** 5e, 8e, 10e, 12g, 13e**, 14g*, 16g, 27g-e, 51f***, 54e, 64f-g, 66f-g, 70e 12. Abound (11 - 15 oz) 13. Bayleton 50 WP (3 - 6 oz)** **Downy Mildew** 12e, 15e, 16e, 17g, 50e, 51g***, 57e, 14. Sulfur [various formulations] (labeled rates)*▲ 58e, 70e 15. Aliette WDG (3-5 lb) Comments: 16. Sovran (3.2 - 5.6 oz) 17. Flint (1.5 - 4 oz) Downy mildew: On susceptible varieties, downy mildew has the potential for 27. Endura (4.5 - 8 oz) explosive spread during mid- to late summer under the proper conditions (moderate temperatures and wet). The need for a spray here should be based 50. Captan 50 WP (4 lb) or Captec 4 L (2 gt) or Captan 80WDG (11/4-21/2 lb) on the weather conditions and the presence of the disease as determined by 51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb)*** scouting. 54. Procure 50 W (4 - 6 oz) 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) 58. Fixed copper [various formulations] (labeled rates) 64. Armicarb 100 (2.5 - 5 lb) 66. JMS Stylet Oil (1 - 2% conc.) A 70. Pristine (6 - 10.5 oz) Comments: *-- Sulfur should not be sprayed less than a month from harvest, since it may interfere with the winemaking process. **--Bayleton may give superior control of powdery mildew on French hybrid grapes. ***--Do not apply Ziram later than 21 days to harvest.

INSECTS		INSECTICIDES
Japanese Beetle	See Third Cover	
Grape Berry Moth	See Bloom	

SIXTH COVER (VERAISON)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Black Rot (fruit infection)	5e, 8g, 10f-g, 12g, 13e, 16e, 17g, 50e, 51g**, 64g, 70e	3. Rovral 50 WP (1½ - 2 lb) 5. Nova 40 WP or DF (3 - 5 oz)
Powdery Mildew	5e, 8e, 10e, 12g, 13e, 14g*,16g, 27g-e, 51f**, 54e, 64f-g, 66f-g, 70e	6. Vangard 75 WG (10 oz) 8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz)
Downy mildew	12e, 15e, 16e, 17g, 50e, 51g**, 57e, 58e, 70e	10. Rubigan 1 EC (4 oz) 12. Abound (11 - 15 oz)
Botrytis Bunch Rot	3g, 6e, 27e, 65e, 70e	13 . Bayleton 50 WP (3 - 6 oz)
Comments:		14. Sulfur [various formulations] (labeled rates)* ▲
Powdery mildew: On highly sus needed between veraison and h	sceptible varieties, additional sprays may be narvest.	15. Aliette WDG (3-5 lb) 16. Sovran (3.2 - 5.6 oz) 17. Flint (1.5 - 4 oz)
	spray here should be based on the weather the disease as determined by scouting. Additional overaison and harvest.	 27. Endura (4.5 - 8 oz) 50. Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80WDG (1¼- 2½ lb) 51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb)**
Botrytis bunch rot: Veraison is especially in tight-clustered culti	an important timing for Botrytis bunch rot control, ivars.	 54. Procure 50 W (4 - 6 oz) 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ 58. Fixed copper [various formulations] (labeled rates) ▲ 64. Armicarb 100 (2.5 - 5 lb)
		65. Elevate 50 WDG (1 lb)**** 66. JMS Stylet Oil (1 - 2% conc.) ▲ 70. Pristine (6 - 10.5 oz)
		Comments: *Sulfur should not be sprayed less than a month from harvest, since it may interfere with the wine- making process. **Do not apply Ziram later than 21 days to harvest
INSECTS		INSECTICIDES
Grape Berry Moth	9e, 11g, 23f/g, 43f/g, 46g, 50g	9. Imidan 70 WP (1½ lb) 11. Lannate 90 SP (½ - 1 lb)
	ng indicates grape berry moth is present. High risk r infestation at this time. Increase spray volume to rays.	 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2½ lb) 23. Sevin XLR+ (2 qt) 43. Bacillus thuringiensis (B.t.) * [Dipel (1.5 lb)] ▲ [Deliver AC (0.5-2.0 lb)] 46. SpinTor 2 SC (6 oz) 50. Intrepid 2F (8 oz)

PRE-HARVES	
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Pest	Efficiency	Suggested Chemicals (Rate/acre)			
DISEASES		FUNGICIDES			
Botrytis Bunch Rot	3g*, 6e,* 27e**, 65e***	3. Rovral 50 WP (1½ - 2 lb)*			
		6. Vangard 75 WG (10 oz)*			
		27. Endura (8 oz)**			
		65. Elevate 50 WDG (1 lb)***			
		Comments:			
		*Rovral and Vangard have a 7-day PHI			
		**Endura has a 14-day PHI			
		*** Elevate has a 0-day PHI.			

Fungicide	Black Rot	Downy Mildew	Powdery Mildew	Botrytis Rot	Phomopsis
Abound (azoxystrobin)	+++	+++	++	+	+++
Alliette (fosetyl-AL)	?	+++	?	?	?
Armicarb (potassium bicarbonate)	++	0	+ / ++	+	+
Basic Copper Sulfate (copper)	+ *	+++	++	+	+
Bayleton (triadimefon)	+++	0	+++	0	+
Captan (captan)	++	+++	0	+	++
Ferbam (ferbam)	++	+	0	0	0
Copper hydroxide (copper)	+	++	+	+	+
EBDCs (mancozeb)	+++	+++	+/++	0	++/+++
Elevate	0	0	0	+++	0
Elite (tebuconazole)	+++	0	+++	0	++
Endura (boscalid)	?	?	++	+++	?
Flint (trifloxystrobin)	+++	++	+++	+	+++
JMS Stylet Oil (paraffinic oil)	0	0	++	+	0
Kaligreen (potassium bicarbonate)	++	?	+ / ++	?	?
Lime sulfur (calcium polysulfide)	0	0	+	0	++
Messenger (harpin)	?	?	++	+	+
Nova (myclobutanil)	+++	0	+++	0	++
Oxidate (hydrogen peroxide)	?	?	+	+	?
Pristine (pyraclostrobin + boscalid)	+++	+++	+++	+++	+++
Procure (triflumizole)	++	0	+++	+	++
Prophyt (potassium phosphite)	?	?	?	?	++
Quintec (quinoxifen)	++	?	+++	?	?
Ridomil Gold MZ					
(mefenoxam + mancozeb)	++	+++*	0	0	++
Ridomil Gold/Copper					
(mefenoxam + copper)	+	+++	++	+	+
Rubigan (fenarimol)	++	0	+++	0	0
Rovral (iprodione)	+	0	0	++	?
Serenade (Bacillus subtilis)	?	+ / ++	++	+ / ++	+ / ++
Sulfur (elemental sulfur)	0	0	++	0	+
Sovran (kresoxim methyl)	+++	+++	++	+	+++
Topsin M (thiophanate methyl)	++	0	+++**	++	+
Vangard (cyprodinil)	?	?	+	+++	+
Ziram (ziram)	++	++	+	+	++

0 = not effective, + = slightly effective, ++ = moderately effective, +++ = highly effective, ? = effectiveness not known. Ratings are based on published information and modified based on observations in Michigan vineyards.

*Ridomil also has eradicative properties.

**If benzimidazole-resistant strains are present, efficacy will be reduced.

Table 2. Relative susceptibility to disease and sulfur and copper sensitivity of grape varieties. (The ratings apply to an average growing season under conditions favorable for disease development. Any given cultivar may be more severely affected).

	Black Rot	Downy Mildew	Powdery Mildew	Phomopsis	Botrytis	Eutypa	Crown gall	Sulfur Sensitive ³	Copper Sensitive
Aurore	+++'	++2	+++	++	+++	+++	++	No	++
Baco Noir	+++	+	++	+	++	++	++	No	?
Cabernet Franc	+++	+++	+++	?	+	?	+++	No	+
Cabernet Sauvignon	+++	+++	+++	+++	+	+++	+++	No	+
Canadice	+++	++	+	?	++	?	++	No	?
Cascade	+	+	++	++	+	++	+	No	?
Catawba	+++	+++	++ ,	+++	+	+	+	No	++
Cayuga White	+	++	+	+	+	+	++	No	+
Chambourcin	+++	++	+	?	++	?	++	Yes	?
Chancellor	+	+++	+++	+++	+	+	++	Yes	+++
Chardonnel	++	++	++	++	++	?	++	No	?
Chardonnay	+++	+++	+++	+++	+++	++	+++	No	+
Chelois	+	+	+++	+++	+++	+++	++	No	+
Concord	+++	+	++	+++	+	+++	+	Yes	+
DeChaunac	+	++	++	+++	+	+++	++	Yes	+
Delaware	++	+++2	++	+++	+	+	+	No	+
Dutchess	+++	++	++	++	+	+	++	No	?
Elvira	+	++	· ++	+	+++	+	+	No	++
Einset Seedless	+++	+++	++	?	+	?	+	?	?
Foch	++	+	++	?	+	+++	+	Yes	?
Fredonia	++	+++	++	++	+	?	+	No	?
Gewürtztraminer	+++	+++	+++	?	+++	?	+++	No	+
Himrod	++	+	++	?	+	?	?	No	?
lves	+	+++	+	?	+	++	+	Yes	?
Limberger	+++	+++	+++	?	+	+++	+++	No	?
Marechal Foch	++	+	++	?	+	+++	?	Yes	?
Melody	+++		+	?	+	?	+	No	?
Merlot	++	+++	+++	+	++	+++	+++	No	++
Moore's Diamond	+++	+	+++	?	++	++	?	No	?
Muscat Ottonel	+++	+++	+++	?	++	+++	+++	No	?
Niagara	+++	+++	++		+	+	++	No	+
Pinot gris	+++	+++	+++	?	++	+++	+++	No	?
Pinot Meunier	+++	+++	+++	?	+++	+++	+++	No	?
Pinot blanc	+++	+++	+++	?	++	?	+++	No	+
Pinot noir	+++	+++	+++	?	+++	?	+++	No	+
Reliance	+++	+++	++	++	+	?	?	No	+
Riesling	+++	+++	+++	++	+++	۲ ++	· +++	No	+
Rosette	++	++	+++	++	+++	++	++	No	+++
	++			and the second se		++	++	Yes	+++
Rougeon		+++	+++		++	-			
Sauvignon blanc	+++	+++	+++	?	+++	?	+++	No	+
Seyval	++	++	+++	++	+++	+	++	No	+ ?
Steuben	++	+	+	?	+	?	+	No	the second s
Vanessa	+++	++	++	+	+	?	+	?	?
Ventura	++	++	++	+	+	?	++	No	?
Verdelet	+	?	?	?	+	?	?	No	?
Vidal 256	+	++	+++	+	+	+	++	No	+
Vignoles	+	++	+++	+++	+++	++	++	No	?
Villard noir	?	+	+++	?	+	?	?	?	?

¹+ = slightly susceptible or sensitive, ++ = moderately susceptible or sensitive, +++ = very susceptible or sensitive. ? = relative susceptibility not established.

²Berries are not susceptible.

³Sulfur injury can occur on tolerant varieties when temperatures of 85° or higher occur during or immediately after application. ⁴Copper applied under cool, slow-drying conditions is likely to cause injury.

Most of the data in this table were obtained from the New York Cooperative Extension Service.

Average Temperature (°F)	Hours of Wetness
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

 Table 3. Approximate number of hours of wetting required for foliar and fruit infection by the grape black rot fungus at different temperatures.

Source: R.A. Spotts, Ohio State University. Data represent a compilation from several experiments with Concord, Catawba, Aurora and Baco Noir.

Effectiveness of Insecticides and Miticides in Controlling Arthropod Pests of Grapes

(Note that a product's effectiveness rating on a pest does not necessarily indicate that it is labeled for that use.)

Ratings of control are E = excellent, $G = good$, $F = fair$, P = poor Ratings against beneficials are T = highly toxic, $M = moderately toxic$, S = relatively safe			Diazinon	Guthion	Imidan	Kelthane	Lannate	Provado	Sevin	Thiodan	Vendex	Lorsban	Agri-Mek	B.t.'s ▲	Danitol	Pyramite	Spintor	Mating disruption	Intrepid	Surround A	Assail	Pyganic ▲	Evergreen	A
Pests	Insect / Mite	Life Stage	5	8	9	10	11	19	23	26	28	32	41	43	44	45	46	48	50	53	56	57	58	6
	Grape flea beetle	Adult			1										G									
	Climbing cutworm	Larva										Е			E									
	Grape berry moth	Egg/Larva	G	Е	Е		G		Е					G	E		G	F	G			- 1 - 1		
	Rose chafer	Adult		G	G		F	G	Е						E					F	E	F	G	
	Grape phylloxera	Aerial forms								Е														
	Grape leafhopper	Larva/Adult	F	F	F		G	Е	G						Е	G				F	E			
	Potato leafhopper	Larva/Adult	G	G	G		G	G	G						G						G			
	Japanese beetle	Adult	F	G	G		F	G	G						G					F	G	F	G	
	Mites	Motiles				G					G		G		G	G								(
Beneficials	Bees		Т	Т	Т	Ν	т	Т	Т	М	S	Т	Т	s	Т	М	М	S	S	S	М	S	М	
	Predator Mites		М	s	S	М	Т	s	Т	м	S	s	s	s	т	м	s	s	S	м	s	s	s	1
	Insect Predators		Т	М	M	N	Т	М	Т	М	S	S	S	S	Т	М	M	S	S	М	М	S	S	1

DISEASES OF STRAWBERRIES IN MICHIGAN

Common leaf spot- Mycosphaerella fragariae

Common leaf spot, also known as Mycosphaerella leaf spot, is a very common foliar disease. Early lesions are small, round and deep purple. With time, the centers of the spots become tan or gray and eventually almost white, while their margins remain purple. From the underside, the lesions look tan or bluish. The fungus can also infect fruit, petioles, fruit stalks, runners, and berry caps (calyxes). On ripe berries, small superficial black spots may form in humid weather. The fungus overwinters in older infected leaves that remain alive over the winter. The fungus produces two kinds of fruiting bodies that contain spores that are carried by wind and rain splash to new leaves. Infection by both types of spores occurs through the lower leaf surface. The disease is favored by wet weather and temperatures between 65-75°F. Infections may occur throughout the growing season, except during hot, dry weather. Young expanding leaves are the most susceptible to infection.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; reduce leaf wetness and humidity by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods.

Scorch – Diplocarpon earliana

Leaf scorch is characterized by irregular, solid purple to brown spots scattered on the upper leaf surface. Initially, scorch lesions look a lot like common leaf spot, but their centers remain dark. As the spots enlarge, they resemble small drops of tar and the areas between the spots turn purple to bright red. The tar-like appearance is caused by the presence of numerous black fruiting bodies in the lesion. Severely infected leaves turn brown, curl up and appear scorched. The fungus can also attack petioles, runners, fruit stalks, and berry caps (calyx). Calyx infection results in an unattractive browning and curling of the calyx. Lesions may girdle fruit stalks, causing flowers and young fruit to die. Berries are usually not infected. The fungus overwinters on infected leaves that survive the winter. In the spring rain-dispersed conidia are produced on both leaf surfaces. The fungus also produces airborne ascospores in flat disk-shaped fruiting bodies. Both spore types infect new leaves through the underside. Wet conditions and moderate to warm temperatures (59-77°F) favor disease development. The fungus can infect strawberry leaves at all stages of development.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; reduce leaf wetness and humidity by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods.

Phomopsis leaf blight – *Phomopsis obscurans*

Phomopsis leaf blight is most commonly found on leaves later in the season. At first, the lesions are circular or lens-shaped and purplish brown, often situated along leaf veins. Older lesions develop a lighter brown center, and can enlarge to $\frac{1}{2}$ - 1 inch in diameter. Lesions along the leaf edge tend to be V-shaped with the widest part of the "V" at the leaf margin. New lesions appear throughout the summer and fall if weather conditions are favorable. Older leaves become blighted and may die prematurely. The fungus can also cause spots on berry caps as well as an enlarging, soft, pale-pink rot at the stem end of the fruit. The fungus produces conidia in tiny brown fruiting bodies embedded in the centers of old lesions. These conidia ooze out during humid weather and get splashed by rain to new tissues where they germinate in the presence of free water and initiate new infections. The fungus overwinters in living or dead infected leaves. Wet conditions and moderate temperatures favor disease development.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; reduce leaf wetness and humidity by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods.

Powdery mildew – Sphaerotheca macularis

Powdery mildew is characterized by upward curling of the leaves. Dry purplish or brownish patches develop on the lower surface of infected leaves and reddish discoloration may be seen on the upper surface. Patches of white, powdery fungus mycelium may appear on the undersides of leaves as the disease progresses. Infected berries may remain pale with protruding seeds. Powdery mildew is generally not a problem in the Midwest. However, during humid summers, the disease can become serious on highly susceptible cultivars. The strawberry powdery mildew fungus infects only wild and cultivated strawberries. It cannot survive in the absence of a living host and apparently overwinters in infected leaves. Spores are carried by wind to susceptible tissues in the spring. Development and spread of powdery mildew is favored by moderate to high humidity and temperatures of about 60-80°F.

Non-chemical management options: select well-aerated site; plant resistant cultivars; use disease-free transplants; avoid dense canopies resulting from overfertilization.

Angular leaf spot – Xanthomonas fragariae

Angular leaf spot is characterized by small, angular, water-soaked lesions that appear on the underside of the leaf. When viewed from the top, the lesions tend to be a reddish purple, and can be confused with scorch. However, when viewed against the light, they look translucent, unlike fungal leaf spots which are opaque. Heavily infected leaves senesce prematurely. Bacteria may exude under humid conditions, making the lower side of the lesions look shiny. The exudate dries to a whitish, scaly film. The bacteria can also cause calyx blackening, which reduces marketability of the fruit.

STRAWBERRIES

Angular leaf spot can enter the field on planting material and can spread rapidly under cool wet conditions. Development of the disease is favored by moderate daytime temperatures (68°F) and low night-time temperatures (32°F) and prolonged leaf wetness caused by frequent rain, overhead irrigation, and heavy dews. Rain and irrigation can also help spread the bacteria to new leaves.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; reduce leaf wetness by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods; pick and cultivate diseased fields last.

Red stele – *Phytophthora fragariae*

Red stele is a root rot disease that is more prevalent on heavy clay soils and poorly drained areas in fields. Many commercial strawberry cultivars are susceptible to red stele. Infected plants are stunted, look a dull green, and produce few runners. Older leaves turn prematurely yellow or red and younger leaves have a metallic bluishgreen cast. Plants wilt and die rapidly during the first hot, dry weather of summer. Infected plants have very few new roots compared to healthy plants, and the roots may look grayish. When the outside portion of the roots is peeled off, the central portion (stele) is pink to brick red, versus a healthy stele which is vellowish white. The red color may only show near the dead tip of the root or extend the whole length of the root. The red stele fungus is introduced to new sites mainly through infected planting material. The fungus can also spread by infested soil on boots, equipment, and run off. The fungus overseasons in diseased roots and soil as hardy oospores that can remain viable in the soil for over 10 years. The oospores produce motile zoospores which can swim about when soil moisture is high and infect root tips. The optimum temperature for infection and disease development is 55-60°F, although the fungus may be active at temperatures as low as 40°F. Under favorable conditions, plants will show disease symptoms within 10 days of infection.

Non-chemical management options: choose well-drained site; plant resistant cultivars (no variety is resistant to all strains of the fungus, but some varieties have resistance to multiplestrains); use disease-free transplants; remove and destroy infected plants if only a few scattered through the field; plant on raised beds; 10-year crop rotation; pick and cultivate infested fields last; prevent run-off from infested site.

Verticillium wilt – *Verticillium dahliae* and *V. albo-atrum* Verticillium wilt can be a major factor limiting production. In new strawberry plantings, the first symptoms usually appear at the start of runner formation. In older plantings, symptoms are more prevalent at picking time. Symptoms on above-ground parts may resemble those caused by other root diseases. Therefore, isolation of the pathogen from diseased tissues is necessary for a positive disease diagnosis. The outer and older leaves of the plant wilt and become reddish-yellow or dark brown at the margins and between veins. New leaves may be stunted and wilt or curl up along the midvein. Severely infected plants are stunted and flattened with small yellowish leaves. Brown to bluish streaks or blotches may be present on the runners and petioles. New roots that grow from the crown are often stunted with blackened tips. Brownish streaks may occur within affected crowns and roots. The fungus overwinters in soil or plant debris as mycelium or microsclerotia (tiny black survival structures), that can remain alive in soil for at least 25 years. It can be introduced with seeds, farm machinery, tools, and soil from the roots of transplants. Once the fungus invades the roots, it destroys the waterconducting tissues. Over 300 different plants, including solanaceous crops and many weeds, can be infected. Soil temperatures of 70-75°F are optimal for disease development.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; remove and destroy infected plants if only a few scattered through the field; cultivate infested fields last; don't plant after infected crops; have sclerotial count done prior to planting to establish need for control; 3-5 year crop rotation; good weed control prior to planting.

Black root rot - Rhizoctonia spp., Pythium spp., lesion nematode

Black root rot is the most common root ailment of strawberries on lighter soils in Michigan. Diseased plants may be scattered throughout the planting or localized in one or more areas. Characteristic symptoms are blackened structural roots and brown lesions on secondary roots, a small root system with few feeder roots, stunting and wilting during dry periods, and reduced yield and runner plant production. The outer part of the blackened roots sloughs off easily and reveals a yellowish-white stele. However, on older, decaying roots, even the stele will be dark brown to black. Crown tissue is not discolored. Black root rot is a disease complex, because it is caused by multiple factors. The fungi most commonly associated with the disease are: Rhizoctonia fragariae and R. solani, Pythium ultimum, and other Pythium species. Feeding wounds caused by the lesion nematode (Pratylenchus penetrans) are thought to predispose the roots to infection. Abiotic factors that are also implicated in black root rot are lack of rotation, soil compaction, winter injury, drought, and other plant stresses. Most commercial strawberry cultivars are susceptible to black root rot.

Non-chemical management options: 3-5 year rotation; use disease-free transplants from a reputable nursery; don't plant transplants with blackened roots; improve drainage; subsoiling to reduce soil compaction; proper irrigation; mulching to prevent winter inury.

Anthracnose – Colletotrichum spp.

Anthracnose is a disease that can affect the foliage. petioles, runners, crown, and fruit. In the Midwest, the most common form of the disease is fruit rot, caused by the fungus Colletotrichum acutatum and C. dematium. Serious losses can occur where the disease is present. Lesions on the petioles and runners are dark brown to black and sunken. Under humid conditions, salmon-pink spore masses are visible in the lesions. Affected stems are sometimes girdled by lesions. Crown infections are caused by C. gloeosporioides and are more common in the southern U.S. They maylead to rapid wilting and death. When sliced open, the crown tissues are solid or streaked reddish brown. Plants collapsing soon after planting may be indicative of anthracnose crown rot and should be sent in for diagnosis. Fruit infections are characterized by dark sunken lesions that may be covered with salmon pink or gravish spore masses. Fruit can be infected at any stage of development and eventually shrivel up to hard, black mummies. The fungus overwinters in mummified fruit and infected plant debris. Spores produced in the spring are dispersed by rain splash and irrigation water. Anthracnose can also be brought in on planting material. Anthracnose fruit rot is favored by hot, humid weather and rain. The optimum temperature for disease development is 80°F.

Non-chemical management options: use disease-free transplants; do not use plastic mulch; remove and destroy plants with crown rot if only a few scattered through the field; reduce leaf wetness by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods; pick/cultivate diseased fields last; train pickers to avoid diseased fruit.

Gray mold – Botrytis cinerea

Gray mold is one of the most serious and common fruit rots of strawberries. It is named for the abundant graybrown, fluffy fungal growth on infected tissues. The fungus can infect petals, flower stalks, berry caps and fruit. Young blossoms are very susceptible to infection and may turn brown and collapse. The fungus colonized senescing flower parts and from there enters the fruit, where it remains inactive (latent) until the fruit matures. Thus while infection occurs at bloom, symptoms are usually not observed until harvest. After picking, berries are very susceptible to infection, especially if bruised or wounded, possibly becoming rotted mass within 48 hours of picking. The fungus overwinters in mummified fruit and old leaves on the ground. In the spring, the fungus produces numerous spores, which are spread by wind throughout the planting. These spores can germinate in a film of water and infect plant tissues within a few hours. Disease development is favored by temperatures of 70-80°F and prolonged wetness of the foliage due to rain, dew, or irrigation.

Non-chemical management options: plant resistant cultivars; use disease-free transplants; reduce leaf wetness by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods; practice good weed control to reduce humidity; pick fruit frequently and early in the day; train pickers to avoid diseased fruit; minimize fruit injury; pick into clean containers; cool fruit rapidly to near 32°F.

Leather rot – Phytophthora cactorum

Leather rot is most prevalent in poorly drained fields and where standing water is present. Excessive rainfall during May and June may lead to severe fruit losses and quality reduction. The fungus primarily attacks fruit, but may also infect blossoms. Leather rot can infect berries at any stage of development and can kill whole clusters. Infected green berries turn brown and look rough and leathery. When more mature berries get infected they turn pink to light brown and become soft. Infected berries have a distinctive and very unpleasant odor and bitter taste, which is detectable in processed products like jam. Under wet conditions, a white fuzzy growth (mycelium and spores) may be present on these berries. The berries eventually mummify. The leather rot fungus overwinters as oospores in infected, mummified fruit and in the soil. The oospores are very hardy and can survive for long periods of time. In the spring and early summer, the oospores germinate to produce sporangia which can be splashed by rain or blown by wind to healthy fruit. The sporangia release motile zoospores, which can swim in a film of water, and infect the fruit. Under the right conditions, the disease can spread very quickly. At the optimum temperature between 62-77°F, only two hours of wetness are needed for infection.

Non-chemical control options: mulch the strawberries with straw to prevent direct contact of the berries with soil and to keep soil from splashing onto the berries; reducestanding water in the field by improving drainage; limit overhead irrigation; train pickers to avoid diseased fruit.

Minor fruit rots - Gnomonia comari, Phomopsis obscurans, Rhizopus stolonifer, etc.At harvest, various fungi other than the ones mentioned previously can cause fruit rots. Usually these rots are of minor economic importance, but occasionally can be severe on some cultivars and under certain environmental conditions. For instance, Rhizopus rot can be severe on overripe fruit in hot summers. This is a leaky soft rot that causes the berries to literally melt away. The berries become covered with a white to gray fuzzy growth containing spores which spread easily through the air. Stem end rot is caused by Gnomonia comari or Phomopsis obscurans, and is characterized by a brown soft rot moving in from the stem end. Both of these fungi also cause foliar and calyx lesions. Regular fungicide applications for foliar diseases and major fruit rots will generally also provide sufficient control of these fruitrotting fungi.

Non-chemical management options: reduce leaf wetness by avoiding dense canopies; time overhead irrigation to overlap with natural dew periods; control of foliar diseases during the season; timely harvesting and rapid

cooling; pick fruit early in the day; train pickers to avoid diseased fruit; minimize fruit injury; pick into clean containers; cool fruit rapidly to near 32°F.

Virus and virus-like diseases - various viruses and phytoplasmas

There are numerous virus diseases that can infect strawberries. Most do not cause distinct symptoms in commercial cultivars. Often the only indications of infection are loss of vigor and lowered yields. Visible symptoms can include leaf crinkling, mottling or mosaic, cupping, and stunting. Infected plants may be more vulnerable to winterkill. The predominant virus-like disease of strawberries in Michigan is June Yellows. The main symptoms are stunting and yellowing of leaf margins, and a progressive loss of vigor. The cause of this disease is actually not known, but may be genetic or viral in origin. It is transmitted by vegetative propagation. Aphids are the most significant vectors of strawberry viruses, although nematodes, thrips, and leaf hoppers are also important. For some viruses, the vectors are unknown. Often, several viruses are present in plants, which may result in more severe symptoms than if they were present singly.

Non-chemical management options: purchase only certified virus-free strawberry plants; remove and destroy symptomatic plants; practice insect control; renew strawberries every 2-3 years to prevent virus build-up.

Nematodes - lesion nematode, root knot nematode, dagger nematode, sting nematode, etc. Plant parasitic nematodes are microscopic roundworms that feed on plant roots. They are common in soils throughout the Midwest. Lesion and root knot nematodes are probably the most destructive nematodes in strawberry plantings. They cause brown spots on the roots, root stunting, knobby root tips, and "whiskery roots". Root systems may be small with few lateral roots. These abnormal conditions interfere with mineral and water uptake and also make roots more susceptible to root-rotting fungi. Above-ground symptoms resemble mineral deficiencies and water stress, especially during fruiting. Symptoms are typically patchy because nematodes tend to be unevenly distributed in fields. The dagger nematode is the vector of tomato ringspot virus, which it can acquire from common weed hosts such as dandelion. Strawberry plantings in nematode-infested soils are not long-lived. Production will decline rapidly after one or two seasons. Nematode damage is more common and severe in replant situations.

Non-chemical management options: crop rotation; use clean planting material; plant on raised beds.

The rates of materials for use on strawberry are based on a standard of 100 gal/acre dilute spray. If you are concentrate spraying (less than 100 gal of water/acre), use the rate/acre figures, regardless of the amount of water you are spraying/acre. After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control

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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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: \blacktriangle .

Pest	Efficiency	Suggested Chemicals (Rate/acre)				
DISEASES		FUNGICIDES				
Leaf Spot, Leaf Blight, Scorch,	5g, 19g, 56g*	5. Nova 40 W (2.5 - 5 oz)				
Stem End Rot (leaves)		15. Aliette WDG (2.5 - 5 lb)**				
Angular Leaf Spot (bacterial)	57g***, 58g***	19. Thiram Granuflo (4 lb)				
Red Stele	15g**, 61e****	56. Topsin-M 70 WP or Topsin M WSB (¾ lb)*				
		plus Captan 50 WP (5 - 6 lb) or Captec 4 L (2 -				
		21/2 qt) or Captan 80WDG (1 1/6 - 3 3/4 lb)				
		57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water)*** ▲				
		58. Fixed copper [various formulations] (labeled				
		rates)***				
		61. Ridomil Gold EC (1 pt)****				
		Comments:				
		* Repeated use of Topsin-M may result in the build-				
		up of fungicide-resistant pathogen strains. Use with				
		Captan together as a tank mix.				
		**Apply Aliette as a foliar spray in spring when				
		active foliage growth occurs. If disease persists make				
		additional applications at 30 to 60-day intervals. Do				
		not tank mix with copper compounds.				
		***Cool wet conditions can enhance phytotoxicity.				
		Discontinue copper applications if signs of crop injury				
		occur. Add hydrated lime as a safener if formulation				
		does not have lime in it.				
		****Make one application of Ridomil Gold EC in				
		spring after ground thaws and before bloom. A				
		second application may be made in autumn after				
		harvest.				

EARLY GROWTH (CONTINUED)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		INSECTICIDES
Spittlebug	8g*****, 19, 23e, 26e, 44	8. Guthion 50 WP (1 lb)*****
Mites	10g*, 20g*, 28g*, 41g****, 42g*,	10. Kelthane 35 WP (1 - 3 lb)*
	44g*, 59g	10. Kelthane 50 WP (3/4 - 2 lb)*
Strawberry Clipper	32e***	19. Provado 1.6 EC (3.75 fl oz)
Slugs	36g**, 58g	20. Brigade 10 WP (18 - 32 oz)*
		23. Sevin 80 WSP (2 lb)
		23. Sevin XLR+ (1 ¹ / ₂ - 2 qt)
		26. Thiodan 50 WP (2 lb)
		26 . Thiodan 3 EC (1 ¹ / ₃ qt)
		28. Vendex 50 WP (1 - 2 lb)*
		32. Lorsban 4 E (2 pt)***
		36. Deadline (Metaldehyde) (10 - 40 lb)**
		41. Agri-Mek 0.15 EC (1 pt)****
		42. Savey 50 WP (3 - 6 oz)*
		42 . Savey 50 DF (3 - 6 oz)*
		44. Danitol 2.4 EC (16 oz)*
and the first and the second		58. Sluggo (40 lb)
		59. Acramite 50 W (0.75 - 1 lb)
		Comments:
		*Apply as two-spotted spider mites begin to
		increase.
		**Various formulations of Metaldehyde and
		Metaldehyde-Sevin baits have a label for slugs on
		strawberries.
		***For strawberry clipper apply first spray when
		first buds become visible followed by a second
		spray 10 days later.
		****Do not add oil to Agri-Mek applied to
		strawberry. May need back-to-back applications for
		satisfactory mite control. ***** Guthion purchased before April 21, 2003 may
		be used on strawberries as labeled.
		ne useu uli suawbernes as iabereu.

PRE-BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot, Leaf Blight, Scorch, Stem End Rot (leaves)	5g, 19g, 56g	5. Nova 40 W (2.5 - 5 oz) 15. Aliette WDG (2.5 - 5 lb)
Angular Leaf Spot (bacterial)	57g, 58g	19. Thiram Granuflo (4 lb)
Red Stele	15g, 61e*	 56. Topsin-M 70 WP or Topsin M WSB (¾ lb) plus Captan 50 WP (5-6 lb) or Captec 4 L (2 - 2½ qt) or Captan 80 WDG (1 ⅓ - 3 ¾ lb) 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ 58. Fixed copper [various formulations] (labeled rates) ▲ 61. Ridomii Gold EC (1 pt)*
		Comments: *Make one application of Ridomil Gold EC in spring after ground thaws and before bloom. A second application may be made in autumn after harvest.

PRE-BLOOM continued

INSECTS		INSECTICIDES		
Tarnished Plant Bug	20, 23, 26e*, 44e	8. Guthion 50 WP (1 lb)		
Spittlebug	See Early Growth	20. Brigade 10 WP (12 - 32 oz)		
Strawberry Leafroller	8e, 23e, 43g, 44, 46g, 64g	23. Sevin 80 WSP (2 lb)		
Strawberry Clipper	See Early Growth	23. Sevin XLR+ (1½ - 2 qts)		
Mites	See Early Growth	26. Thiodan 50 WP (2 lb)*		
Comments:		26. Thiodan 3 EC (11/3 qt)*		
Tarnished plant bug control	is critical at this time.	 43. Bacillus thuringiensis (B.t.) [Dipel (1.5 lb)] ▲ [Deliver AC (0.5-2.0 lb)] 44. Danitol 2.4 EC (10 - 21.3 oz) 		
		46. SpinTor 2 SC (4 - 6 oz) 64. Entrust 80 WP (1.25 -1.5 oz) ▲		
		Comments: *Best results are obtained with a specific Thiodan		

BLOOM

Pest	Efficiency	Sugg
DISEASES		FUNC
Leaf Spot, Leaf Blight, Scorch, Stem End Rot (leaves/fruit)	5g, 19g, 20g-e***, 56g*, 62g-e***, 70e***	3. Ro Ca
Angular Leaf Spot (bacterial)	57g, 58g	or
Powdery mildew	5e, 14g, 20e***, 62e***, 70e***	5. No
Anthracnose	20e***, 25g*****, 56g*, 62e***, 70e***	14. S
Gray Mold	3g**, 19g, 25e*****, 56g*, 65e*****, 67e******, 70e***	15. Al
Leather Rot	15g, 61e****	20. C
Commontos		25. C

Comments:

Do not apply insecticides during bloom to avoid bee poisoning.

Gray mold: this is an important time to control gray mold, since the fungus gains entry to the fruit via infected flowers.

Angular leaf spot: the bacterium that causes angular leaf spot can also infect the calyx (berry cap) and cause it to become black and shriveled, reducing marketability. Protect berry caps with copper products. Cool wet conditions which favor angular leaf spot may also increase copper injury to foliage, which may show up as faint reddish or purple blotches on the leaves.

Suggested Chemicals (Rate/acre) FUNGICIDES 3. Rovral 50 WP (1 - 2 lb)** plus Captan 50 WP (5 - 6 lb) or Captec 4 L (2 - 2½ qt) 5. Nova 40 W (2.5 - 5 oz) 14. Sulfur [various formulations] (labeled rates) ▲ 15. Aliette WDG (2.5 - 5 lb) 19. Thiram Granuflo (4 lb) 20. Cabrio EG (14 oz)***

application at or before 10% king bloom.

- **25.** Captevate 68 WDG (3½ 5¼ lb)*****
- 56. Topsin-M 70 WP or Topsin M WSB (¾ lb) *plus* Captan 50 WP (5 - 6 lb)* or Captec 4 L (2 - 2½ qt)* or Captan 80 WDG (1 ⁷/₈ – 3 ³⁄₄ lb)*
- 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲
- 58. Fixed copper [various formulations] (labeled rates) ▲
- 61. Ridomil Gold EC (1 pt)****
- 62. Quadris FL (6.2 -15.4 oz)***
- 65. Elevate 50 WDG (1.5 lb)*****
- 67. Switch 62.5WG (11 14 oz)******
- 70. Pristine (18.5 23 oz)***

Comments:

*-- The addition of Captan will also aid in the control of leather rot.

**--If resistant Botrytis strains are present, efficacy of Rovral will be reduced. Only one application of Rovral is allowed per season. Do not apply Rovral after first fruiting flower.

***--Do not apply strobilurins more than two times consecutively, and not more than four times (Quadris) or five times (Cabrio, Pristine) per season.

****--In addition to applications of Ridomil for control of red stele, one additional application may be made for leather rot control at fruit set. Do not apply more than 1.5 qt per acre per year.

*****--Do not apply Elevate or Captevate more than two times consecutively or four times per season. *****--Alternate Switch with other effective fungicides, like Elevate or Captan. Do not exceed 56 oz product per acre per year.

THIMBLE-SIZED BERRIES

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot, Leaf Blight, Scorch,	5g, 19g, 20g-e, 56g, 62g-e, 70e	5. Nova 40 W (2.5 - 5 oz)
Stem End Rot (fruit)		14. Sulfur [various formulations] (labeled rates)
Angular Leaf Spot (bacterial)	57g, 58g	15. Aliette WDG (2.5 - 5 lb)
Powdery mildew	5e, 14g, 20e, 62e, 70e	19. Thiram Granuflo (4 lb)
Anthracnose	20e, 25g, 56g, 62e, 70e	20. Cabrio EG (14 oz)
Gray Mold	19g, 25g, 56g, 65e, 67e, 70e	25. Captevate 68 WDG (3½ - 5¼ lb)
Leather Rot	15g	56. Topsin-M 70 WP or Topsin M WSB (¾ lb) plus Captan 50 WP (5 - 6 lb) or Captec 4 L (2 - 2½
		 qt) or Captan 80WDG (1 ⁷/₈ - 3 ³/₄ lb) 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ 58. Fixed copper [various formulations] (labeled rates) ▲ 62. Quadris FL (6.2 - 15.4 oz 65. Elevate 50 WDG (1.5 lb) 67. Switch 62.5WG (11 - 14 oz) 70. Pristine (18.5 - 23 oz)
INSECTS		
Tarnished Plant Bug	See Pre-Bloom	
Mites	See Early Growth	

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot, Leaf Blight, Scorch,	5g**, 19g***, 20g-e**, 56g*, 62g-e**,	5. Nova 40 W (2.5 - 5 oz)**
Stem End Rot (fruit)	70e**	15. Aliette WDG (21/2 - 5 lb)**
Powdery mildew	5e**, 20e**, 62e**, 70e**	19. Thiram Granuflo (4 lb)***
Anthracnose	20e**, 25g**, 56g*, 62e**, 70e**	20 . Cabrio EG (14 oz)**
Gray Mold	19g***, 25e**, 56g*, 65e**, 67e**,	25. Captevate 68 WDG (3 ¹ / ₂ - 5 ¹ / ₄ lb)**
	70e**	56 . Topsin-M 70 WP or Topsin M WSB (³ / ₄ lb)* plus
Leather Rot	15g**	Captan 50 WP (5 - 6 lb)* or Captec 4 L (2 - 2 ¹ / ₂
		qt)* or Captan 80WDG (1 ½ – 3 ¼ lb)*
		62. Quadris FL (6.2 - 15.4 oz)**
		65. Elevate 50 WDG (1.5 lb)**
		67. Switch 62.5 WG (11 - 14 oz)**
		70. Pristine (18.5 - 23 oz)**
		Comments:
		* Topsin-M has a 1-day PHI, while Captan has a
		0-day PHI.
		** Alliette, Cabrio, Captevate, Elevate, Nova,
		Pristine, Quadris, and Switch have a 0-day PHI.
		***Thiram has a 3-day PHI.
INSECTS		INSECTICIDES
Strawberry Sap Beetle	20g, 44g	20 . Brigade 10 WP (16 - 32 oz)
		44. Danitol 2.4 EC (16 - 21.3 oz)

HARVEST				
Pest	Efficiency	Suggested Chemicals (Rate/acre)		
DISEASES	One Dre Hannet	Comments:		
Leaf Spot, Leaf Blight, Scorch, Stem End Rot (fruit)	See Pre-Harvest	Do not plant rotation crops other than those for which Switch is registered for 12 months following		
Anthracnose	See Pre-Harvest	the last application of Switch.		
Gray Mold	See Pre-Harvest			
Leather Rot	See Pre-Harvest			
INSECTS/MITES		INSECTICIDES		
Cyclamen Mites	10g, 26g	10. Kelthane 35 WP (4 - 6 ³ / ₄ lb)		
Comments:		10. Kelthane 50 WP (³ / ₄ - 2 lb)		
		26 . Thiodan 3 EC (2 ³ / ₃ qt)		
planting. Usually the infestation is lin	nen mites may become established in a mited to small areas in the field. These	26. Thiodan 50 WP (4 lb)		
applied with up to 400 gallons of wa	ted chemical. The material should be ter per acre, so the plants are thoroughly agent will improve control. NOTE: Be and harvest (Thiodan 4 days).			

POST-HARVEST AND NEW PLANTING

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Leaf Spot, Leaf Blight, Scorch	1g, 5g, 56g	5 . Nova 40 W (2.5 - 5 oz)
Powdery mildew	1g, 5e, 14g	14. Sulfur [various formulations] (labeled rates)
Red Stele	61e	56. Topsin-M 70 WP or Topsin M WSB (¾ lb) plus
Comments:		Captan 50 WP (5 - 6 lb) or Captec 4 L (2 - 2½ qt) or Captan 80 WDG (1 ⁷ / ₄ - 3 ³ / ₄ lb)
mildew can affect the ability of the	f spot, leaf blight, scorch, and powdery plant to regenerate fully after renovation lantings. Start treatments 10-14 days after	61. Ridomil Gold EC (1 pt)
INSECTS		INSECTICIDES
Strawberry Leafroller	5g, 8e, 20, 23e, 43g, 46g, 64g	5. Diazinon 50 WP (2 lb)
Leafhoppers	23g	8. Guthion 50 WP (1 lb)
		19. Provado 1.6 EC (3.75 fl oz)
Strawberry Aphids	5e, 19e, 26e*	20. Brigade 10 WP (8 - 32 oz)
Slugs	36g**, 58g**	23. Sevin 50 WP (4 lb)
Grubs	32g***	23. Sevin 80 S (21/2 lb)
		26. Thiodan 3 EC (11/3 qt) *
		32. Lorsban 4 E (2 qt)***
		36. Deadline (Metaldehyde bait) (10 - 40 lb) **
		43. Bacillus thuringiensis (B.t.) *
		[Dipel (1.5 lb)]
		[Deliver AC (0.5 - 2.0 lb)]
		46 . SpinTor 2 SC (4 - 6 oz)
		58. Sluggo (40 lb)**
		64. Entrust 80 WP (1.25 - 1.5 oz) ▲
		Comments:
		*See label for restriction of Thiodan use.
		**Fall application can ease slug problems the
		following spring. Bait should be applied during a
		period of clear and dry weather for best results. ***Preplant only for grub control in sufficient water for incorporation.

Fungicide	Anthrac nose	Botrytis gray mold	Angular leaf spot	Common leaf spot	Phomopsis leaf blight and fruit rot	Scorch	Powdery mildew	Leather rot	Rhizopus rot	Red stele	Phytoph- thora crown rot
Aliette	0	0	0	0	0	?	0	+++	0	+++	+++
Armicarb	+	++	0	+++	+	+	++	?	?	?	?
Cabrio	++++	++	?	++++	+++	+++	+++	?	+++	?	?
Captan	+++	+++	0	+++	++	++	0	+	+++	0	0
Captevate	+++	+++	0	++	++	++	?	?	++	?	?
Copper*	+	+	+++	++	++	++'	+	+	++	+	+
Elevate	?	++++	?	?	?	?	?	0	?	0	0
Nova	0	0	0	+++	+++	?	+++	0	?	0	0
Pristine	++++	++++	0	++++	+++	++++	++++	?	+++	?	?
Quadris	++++	+	?	+++	++	+++	+++	?	+++	?	?
Ridomil	0	0	0	0	0	0	0	+++R	0	++++	++++
Rovral	0	++++R	0	0	0	?	0	0	0	0	0
Sulfur*	0	0	0	0	0	?	+++	0	0	0	0
Switch	++	++++	?	?	?	++	?	0	?	0	0
Thiram	+++	+++	0	+	++	++	0	+	0	0	0
Topsin-M	+R	+++R	0	+++	+++	+++	++R	0	++	0	0

Table 1. Effectiveness of Fungicides for Strawberry Disease Control

0 = not effective, + = poor, ++ = moderate, +++ = good, ++++ = excellent, ? = not known. Ratings are based on published information and observations in Michigan and other states.

*Phytotoxicity may occur.

R = Efficacy reduced if fungicide-resistant strains present.

Table 2. Disease resistance of strawberry cultivars commonly grown in the Midwest.

Variety	Red stele	Verticillium wilt	Botrytis gray mold	Common leaf spot	Leaf scorch	Phomopsis leaf blight	Powdery mildew	Angular leaf spot	Black root rot
Allstar	VR	R	S-I	R	R		R	S	S
Annapolis	S	1	S	S	S		VS		
Bounty	S	VS	1	1 1	· · · · · · · · · · · · · · · · · · ·		1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 - 1990 -		-
Cavendish	R	I-R	S	R	R	· · · · · ·	S-I		
Chandler									
Delmarvel	R	R		S-R	T-R		Т	R	
Earliglow	R	T-R	R	S	R	R	S	· · · · · ·	R
Glooscap	S	S	S	S-I	S-I	1	S-I	S	
Gov. Simcoe	S	I I I	1		1		VS		
Guardian	R	I-R	2	S	R				
Honeoye	S	S	1	R	R	S	S-R	1	S
Idea	I-R			S	S			1	
Jewel	S	S	1	R	R.		L		S
Kent	S	S	S	S-I	S-I	S		S	
Lateglow	R	R	1	Т	Т	S	Т	S	
Latestar	R	R	S	S-R	S-R	S	Т		
Lester	R	R		R	R	1	R	S	
Midway	R	S-I	1	VS	S				R
Mira									
Mohawk	R	R		1	1		· 1		
Northeaster	R	R	1	S-R	S-R		S		
Oka				S	1		Т		
Primetime	R	R		Т	Т		Т		
Redchief	R	R	S	S-R	S-R	I	S-R	S	
Scotland		1		T	R		S		
Scott	R	I-R		S-R	R		R		
Selkirk		S		1	S		VS		
Seneca	S	S		R	R			S	VS
Settler	S S	1			1		1		
St. Williams		1		R	R		I-R		
Startyme	S	S			I	1			
Winona	R		S		1	1			1

VR = very resistant, R = resistant, I = intermediate, T = tolerant, S = susceptible, and VS = very susceptible Table prepared by J. Hancock, E. Hanson, M. Ellis, and A.M.C. Schilder.

Resistant to several races of the red stele fungus.

DISEASES OF BRAMBLES IN MICHIGAN

Anthracnose – Elsinoe veneta

This is one of the most common and widespread diseases of brambles. Disease losses can occur from defoliation, stunting and reduced vigor, reduced fruit vield and quality, and cane death. Typical symptoms are round to oval scabby or sunken lesions on the green canes and fruit stems. The lesions are ash-gray with purplish brown, raised margins. Lesions may extend down into the bark, partly girdling the cane. As the canes dry in late summer and early fall, diseased tissue often cracks. In the following year, fruit produced on severely diseased canes may fail to develop to normal size and may shrivel and dry. Leaf lesions are small and often arranged in rows along major veins, and may have a "shot hole" appearance. The fungus overwinters in lesions on infected canes. In the spring, spores are rain-splashed, blown, or carried by insects to young, rapidly growing plant parts that are susceptible to infection. The spores germinate in a film of water, penetrate the plant tissue, and symptoms appear about a week later. As canes age, they become much less susceptible. Cool, wet weather is conducive to disease development.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; prune out and destroy dead and diseased canes.

Spur blight – *Didymella applanata*

Spur blight occurs only on red and purple raspberries. While the disease looks serious, is not clear how damaging the disease really is. Purple to brown blotches appear just below the leaf or bud, usually on the lower portion of the stem in late spring or early summer. The lesions expand and in late summer or early fall, fungal fruiting bodies, appearing as small black specks, develop in the affected areas. The bark splits and takes on a bleached appearance. Leaflets show brown, wedge-shaped diseased areas with yellow borders. Infected leaves may fall off, leaving only petioles without leaf blades attached to the cane. As diseased primocanes become fruiting canes during the next season, the side branches growing from diseased buds are often weak and withered and produce less fruit. The fungus survives the winter in diseased canes. During wet periods the following spring and summer, spores are released and carried by splashing rain and wind to nearby new growth and cause new infections.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; prune out and destroy dead and diseased canes.

Cane blight – Leptosphaeria coniothyrium

Cane blight is one of the more damaging diseases of raspberries and also occurs on blackberries. Cane blight can result in wilting and death of lateral shoots, a general weakening of the cane, and reduced yield. Dark brown to purplish cankers form on new canes, especially at pruning wounds, near the end of the season. The cankers enlarge and extend down the cane or encircle it, causing lateral shoots to wilt and eventually die. On second-year canes, the side branches may suddenly wilt and die, usually between blossoming and fruit ripening. Infected canes commonly become cracked and brittle and break easily. The pathogen overwinters in infected or dead canes. The following spring, spores ooze out of fruiting bodies on the cane and are blown, splashed by rain, or carried by insects to nearby canes. Under moist conditions, the spores germinate and enter the plant through pruning wounds, insect punctures, fruit stem breaks, and other wounds. Dead canes can continue to produce conidia and remain a source of infection for several years. The disease is most severe during wet seasons.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; prune out and destroy dead and diseased canes; avoid wounding by trellising the canes; protect the canes from insect damage; top and prune canes in dry weather; do a second pruning during fall or winter to remove infected stubs.

Raspberry leaf spot - Septoria rubi

This disease is common on raspberries. A very similar disease, caused by a related fungus, also occurs on blackberries. Leaf lesions are round and have a whitish to gray center surrounded by a brown to purple border. Tiny black fruiting bodies form in the center of the spots. Spots on canes and petioles are similar to those on leaves but are generally more elongated. The disease can cause premature defoliation which will produce weak plants that are more susceptible to winter injury. The fungus overwinters in living and dead infected canes. In the spring, spores are released in high numbers and carried to young susceptible leaves and canes by splashing or wind-driven rain. The spores germinate in a film of moisture and infect the plant. The fungus produces spores on leaf lesions throughout the growing season. Periods of rainfall are highly conducive to disease development.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; prune out and destroy dead canes.

Orange rust - Arthuriomyces peckianus

Orange rust is the most important of several rust diseases that attack brambles, but does not affect red raspberries. The orange rust fungus grows systemically throughout the roots, crown and shoots of an infected plant, and is perennial inside the below-ground plant parts. Once a plant is infected by orange rust, it is infected for life. Orange rust does not normally kill plants, but causes them to be so stunted and weakened that they produce little or no fruit. Symptoms are obvious after new growth appears in the spring. Newly formed shoots are weak and spindly and new leaves are stunted or misshapen and pale green to yellowish. Within a few weeks, the lower surface of infected leaves is covered with blister-like pustules that are waxy at first but soon turn powdery and bright orange. Rusted leaves wither and drop in late spring or early summer. In late spring. aeciospores from the pustules on infected leaves are carried by wind and rain to healthy susceptible leaves, which they infect. Secondary spores from these infections penetrate leaf buds. The fungus overwinters within the roots and crown of the host. Orange rust is favored by low temperatures and high humidity. Temperatures from 43-72°F favor disease development. Aeciospores require long periods of leaf wetness for germination and infection.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; remove and destroy infected plants.

Late leaf rust - Pucciniastrum americanum

Late leaf rust is a minor disease that occasionally causes economic losses on red raspberries. It usually occurs late in the season. Small, rather inconspicuous chlorotic or yellow spots may form on the upper leaf surface. Small pustules filled with yellowish powdery spores are formed on the undersides of infected leaves and may also occur on leaf petioles, canes, and even on the fruit. These spores are capable of causing new infections throughout the growing season. Infected fruit are worthless, thus yield of marketable fruit is reduced. Badly infected leaves may drop prematurely, and in years when the disease is severe, canes may be defoliated by September. The late leaf rust fungus is not systemic. While spores from raspberries infect white spruce (the alternate host) it apparently does not need the alternate host to complete its lifecycle and can overwinter on infected raspberry canes. The following season, spores produced on the canes can cause new infections.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind.

Powdery mildew - Sphaerotheca macularis

Powdery mildew affects susceptible raspberry cultivars, but not blackberries or hybrids. Severely infected plants may be stunted and less productive. Infected fruit may be lower in quality or unmarketable as a result of the unsightly covering of mycelial growth. Infected leaves develop light green blotches on the upper surface. Generally, the lower surface of the leaf directly beneath these spots becomes covered by white, mycelial growth. Infected leaves are often mottled, resembling a mosaic virus. When severely infected, the shoots become long and spindly with curled, dwarfed leaves. The fungus overwinters as mycelium in buds on shoot tips. Airborne conidia are abundantly produced on the surface of infected tissue and cause repeated infections throughout the season. The development of this disease is favored by warm weather and moderate to high humidity.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; remove and destroy heavily infected canes.

Botrytis gray mold – Botrytis cinerea

Gray mold is a serious fruit rot disease of brambles and also causes blasting of blossoms. Fruit infections usually don't show up until harvest and appear as soft, light brown, rapidly enlarging areas on the berries. Infected berries become covered with a gray, fluffy growth of the fungus and can infect neighboring healthy berries through contact. Picked berries are extremely susceptible to infection, especially if bruised. Handling of infected fruit during picking may also spread the fungus to healthy berries, which can develop into a rotted mass within 48 hours. The gray mold fungus overwinters on infected dead raspberry leaves and canes. In early spring, it produces large numbers of airborne spores. When moisture is present, the spores germinate and infect susceptible tissues within a few hours. The fungus usually enters the fruit through flower parts, where it remains latent until the fruit ripens. However, a lot of infections also take place on ripe and overripe fruit. Temperatures of 70-80°F and wetness from rain, dew, or irrigation are ideal for disease development. The disease can develop at lower temperatures if foliage remains wet for long periods.

Non-chemical management options: plant resistant cultivars; create open canopies to reduce humidity buildup; plant rows in direction of prevailing wind; harvest frequently; avoid handling infected fruit while picking; avoid bruising of the fruit; cool down fruit rapidly after harvest.

Other fruit rots -Cladosporium spp., Penicillium spp.

Several minor fruit rots can reduce fruit quality of harvested berries. Cladosporium rot appears as dark or olive-green velvety growth on individual drupelets or groups of drupelets. Penicillium rot looks like a powdery, light green or bluish green growth on portions on the fruit. These diseases primarily affect ripe or overripe fruits.

Non-chemical management options: create open canopies to reduce humidity build-up; plant rows in direction of prevailing wind; harvest frequently; avoid handling infected fruit while picking; avoid bruising of the fruit; cool down fruit rapidly after harvest.

Phytopthora root and crown rot – *Phytophthora* spp.

This disease is most prevalent and destructive on red raspberries grown in heavy soils. Several species of Phytophthora, incl. P. megasperma, P. cryptogea, P. citricola ,and P. cactorum, have been isolated from infected plants. Symptoms include a general lack of vigor and a sparse stand. Apparently healthy canes suddenly decline and collapse during the late spring or summer. Infected plants frequently occur in patches. which may spread along the row. Because wilting and collapsing plants may be caused by other factors (winter injury, cane borers, etc.), it is necessary to examine the root system of infected plants. Suspect plants should be dug up and root and crowns cut open. In plants with Phytophthora root rot, this tissue will be a characteristic brick red, eventually turning dark brown as the tissue decays. Sometimes a distinct line can be seen between infected and healthy tissue, especially on the below-ground portion of the crown. The fungi persist primarily as mycelium in infected roots or as dormant oospores in the soil. Oospores germinate under moist conditions, forming sporangia which contain motile zoospores. The zoospores can swim through the water-filled soil pores to susceptible plant parts and cause new infections. Plants subjected to repeated periods of standing water are most susceptible to infection. Spring and fall are particularly favorable periods for infection. However, infection can probably occur throughout the growing season if soil moisture conditions are favorable.

Non-chemical management options: select a site with good drainage; don't plant in previously infested sites; plant resistant cultivars; plant on raised beds; rotate out of raspberries for 5-10 years; cultivate infested fields last; reduce run-off from infested sites to uninfested areas.

Verticillium Wilt – *Verticillium dahliae*

Verticillium wilt is one of the most serious diseases of raspberries, causing wilting, stunting, and eventually death of fruiting canes or the entire plant. It is usually a cool-weather disease and is most severe in poorly drained soils and following cold, wet springs. The appearance of symptoms on new canes frequently coincides with water stress during hot, dry, midsummer weather. Symptoms appear on black raspberries in June to early July, and on red raspberries about a month later. The lower leaves may at first have a dull green cast to them. Starting at the base of the cane and progressing upward, leaves wilt, turn yellow, and drop. Eventually, the cane may be completely defoliated except for a few leaves at the top. Black raspberry and blackberry canes may exhibit a blue or purple streak from the soil line extending up the cane to varying heights. This streak is

often not present or is difficult to detect on red raspberries. In the spring following infection, many of the diseased canes are dead. Others are poorly developed and have shriveled buds. The new leaves are usually vellow and stunted. Infected canes may die before the fruit matures, resulting in withered, small, and tasteless berries. The causal fungus infects more than 160 different kinds of plants, including strawberries, eggplant, tomatoes, potatoes, stone fruits and peppers. The fungus overwinters in plant debris and in the soil as dormant mycelium or small black survival structures called microsclerotia. The fungus can survive in the soil for many years. When conditions are favorable, microsclerotia germinate and infect roots aided by breaks or wounds in the roots. As the infection progresses, the water-conducting tissue (xylem) is clogged up or destroyed.

Non-chemical management options: plant resistant cultivars; don't plant in previously infested sites; have microslerotial count done to determine whether control is needed; rotate out of raspberries and other susceptible crops for 3-5 years.

Crown Gall/Cane Gall – Agrobacterium

tumefaciens/Agrobacterium rubi

Crown gall is a widespread bacterial disease of all brambles. Cane gall affects black and purple raspberries more frequently than other brambles. These diseases are particularly serious in nursery fields where freedom from the disease is essential. The bacteria induce galls or tumors on the roots, crowns, or canes of infected plants. Galls interfere with water and nutrient flow in the plants. Seriously infected plants may become weakened, stunted, and unproductive. Young galls develop in the spring near the soil line or underground and are light in color, spongy, and wart-like. Galls can be formed each season and vary in size from a pinhead to several inches in diameter. Cane galls occur almost exclusively on fruiting canes and usually appear in late spring or early summer. Both crown and cane galls become hard, brown to black, woody knots as they age. Some disintegrate with time and others may remain for the life of the plant. The tops of infected plants may show no symptoms, but plants with numerous galls may be stunted; produce dry, poorly-developed berries; break easily and fall over: or show various deficiency symptoms due to impaired uptake and transport of nutrients and water. Infected canes become more susceptible to winter injury. The bacteria overwinter in galls and in soil and may also be introduced with planting material. They survive in infested soil for years and can invade the roots and crowns of susceptible plants through natural growth cracks, tissue damaged by winter injury, or damage caused by soil insects. Wounds resulting from pruning and cultivation are also important points of entry.

Non-chemical management options: plant resistant cultivars; buy disease-free planting material; protect

canes from winter or other injury; remove and destroy infected plants; disinfect pruning shears between plants.

Virus diseases - raspberry mosaic virus, raspberry leaf curl virus, tomato ringspot virus, raspberry bushy dwarf virus, tobacco streak virus, etc.

Raspberries probably suffer more serious damage from viruses than any other fruit crop in the United States. Virus infection in raspberries can reduce fruit yields by 70% or more. Typical symptoms are stunting, mosaic or streak or ring-like patterns on leaves, leaf curling and distortion, poor fruit set, small crumbly fruit, and plant death. There are at least five severe virus diseases in Michigan. Two of these diseases are raspberry mosaic and raspberry leaf curl. Both are spread by raspberry aphids, which live on diseased wild raspberries and on diseased cultivated raspberries. A third virus disease, tomato ringspot virus, is soilborne 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. Other disorders of raspberries can cause symptoms similar to viruses. Late-spring frosts, mineral deficiencies (such as iron and nitrogen), powdery mildew, pesticide injury, and feeding by leafhoppers, aphids and mites can all cause symptoms similar to those caused by various viruses. Positive identification of a bramble virus cannot be based on foliar symptoms alone. Greenhouse and laboratory tests using specific scientific techniques are required for positive identification of viruses.

Non-chemical control options:1) Prior to planting, sample the planting site thoroughly for nematodes at 6- to 8-inch and 18-inch depths. Send the sample to the MSU Nematology Laboratory for analysis, 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 arowing raspberries is to plant virus-infected 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 within a radius of 500 to 1,200 ft with herbicides: 4) Protect the planting from aphids 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.

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

The rate of materials for use on brambles is 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. To get sufficient spray coverage of fruit clusters and foliage, it is recommended to use 50-100 GPA. Effectiveness of materials listed below is based primarily on trials using concentrate sprays of 50 GPA (water). 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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: \blacktriangle .

DELAYED DORMANT (BUD BREAK)

Pest	Efficiency	Suggested Chemicals (Rate/acre)		
DISEASES		FUNGICIDES		
Anthracnose	64g*	61. Ridomil Gold EC (¼ pt)**		
Spur blight	64g*	or Ridomil Gold GR (5 lb)**		
Cane blight	64g*	64. Lime sulfur solution (10 or 20 gal/100 gal		
Phytophthora Root Rot	61e** See Post-Harvest	water)*		
disease pressure by inactivating	mant application of lime sulfur can help reduce g overwintering inoculum. Good control of nter survival of raspberries like 'Tulameen'.	Comments: *When new leaves are exposed ¼ to ¾ in., use the 20 gal rate; when a few leaves have unfolded, use the 10 gal rate. There is a greater risk of lime- sulfur burn by spraying at the later time. **Ridomil may be applied once in the spring and once in the fall. Apply between bud break and pre- blossom. Do not apply within 45 days of harvest. Application rate is per 1,000 ft of row. Ridomil Gold is registered for raspberries only.		

PRE-BLOSSOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES Anthracnose Spur Blight Cane Blight Phytophthora Root Rot Raspberry Leaf Spot Powdery Mildew Rusts Comments: Cane and leaf diseases: This is diseases. Moderate temperature and severity of these diseases. I can be distinguished from raspb	Efficiency 5g-e*, 20e***, 50g****, 57g, 70g-e*** 5f-g*, 20g***, 50g****, 57g, 70g-e*** 5g*, 20e***, 50g****, 57g, 70e*** 15g**, 61e**** 5g*, 20e***, 70e*** 5e*, 20e***, 70e*** 5e*, 20e***, 70e*** 5e*, 20e***, 70e*** se an important time to control cane and leaf se and frequent rains will increase incidence Leaf spots caused by the anthracnose fungus erry leaf spot by the typical arrangement in ency to take on a "shot hole" appearance.	 Suggested Chemicals (Rate/acre) FUNGICIDES 5. Nova 40 W (1.25 - 2.5 oz)* 15. Aliette 80 WDG (5 lb)** 20. Cabrio EG (14 oz)*** 50. Captan 50 WP (4 lb)**** or Captan 80WDG (2½ lb)**** 57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ 61. Ridomil Gold EC (¼ pt) or Ridomil Gold GR (5 lb)***** 70. Pristine (18.5 - 23 oz)*** Comments: * Do not apply more than 10 oz of Nova per acre per season. **Apply Aliette at 1-3" new growth and continue spraying on a 45-60 day schedule, up to a maximum of 4 sprays per season. Do not apply within 60 days of harvest. Do not tank mix with copper compounds, surfactants or foliar fertilizers. ***Do not apply Cabrio or Pristine more than two times consecutively or four times per season. ****Captan may be used in Michigan under a Special Local Need label. Do not apply more than 20 lb Captan 50WP or 12½ lb Captan 80WDG per acre per season. *****Ridomil may only be applied once in the spring. If already applied at bud break, do not apply now.
INSECTS		INSECTICIDES
Spittlebug Leafrollers Raspberry Sawfly Raspberry Fruit Worm Raspberry Cane Borer* Red-necked cane borer** Comments: To control the raspberry cane b the two rings made by the beetle usually in July. To control the red-necked cane any wild raspberries in the vicini	23g 5g, 8g, 43g*, 49g 13g 13g See Comments See Comments See Comments borer; cut off and destroy injured canes below es. Do this as soon as wilted tips are noticed, borer; cut and burn in the fall or early spring ty since this insect develops on wild ove and burn all canes showing any	 5. Diazinon 50 WP (2 lb) 8. Guthion 50 WP (½ lb) 13. Malathion 50 WP (4 lb) 23. Sevin 50 W (2 - 4 lb) 23. Sevin 80 S (2 - 2½ lb) 23. Sevin XLT (1 - 2 qt) 43. B.t.'s [Dipel DF (1 lb)]* ▲ 49. Confirm 2 F (16 oz) Comments: *B.t's should be timed for early egg hatch and complete coverage is required for control. Two or three applications may be required. B.t. is most effective under warm weather conditions

EARLY BLOOM		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose	5g-e, 20e, 50g*, 70e	3. Rovral 4 F (1 - 2 pt)**
Spur Blight	5f-g, 20g, 50g*, 70g-e	5. Nova 40 W (1.25 - 2.5 oz)
Cane Blight	5g, 20, 50g*, 70e	20. Cabrio EG (14 oz)
Raspberry Leaf Spot	5e, 20e, 50f*, 70e	50. Captan 50 WP (4 lb)* or
Gray Mold (Botrytis rot)	3e**, 5f-g, 20f, 50f-g*, 65e***,	Captan 80WDG (2½ lb)*
-	67e****, 70g	65. Elevate (1.5 lb)***
Powdery Mildew	5e, 20e, 70e	67. Switch 62.5WG (11 - 14 oz)****
Rusts	5e, 20e, 70e	70. Pristine (18.5 - 23 oz)
Comments:		Comments:
		*Captan has a 3-day PHI.
Botrytis gray mold: the gray mold fur		**If resistant Botrytis strains are present, efficacy
invading the blossoms. These infection		of Rovral may be reduced. Do not make more than
ripens. Fruit rots are most severe after		4 applications of Rovral per season.
sprays during bloom can help reduce a	the incidence of pre-narvest rot.	*** Do not apply Elevate more than three times consecutively or four times per season.
Orange rust: this disease become sys	stemic in the plant. Plants that are	****The 14-20 oz. rate is more effective than the
	nd have to be removed and destroyed	11 oz. Rate. Do not apply Switch more than two
to prevent a build-up of inoculum in the		times consecutively or four times per season. Do
disease is by prevention using effectiv	re fungicides.	not plant any other crop for a period of 12 months
	-	unless Switch is registered for that use.

FULL BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose	See Early Bloom	2
Gray mold (Botrytis rot)		
Spur blight		이 것 같은 고양을 가지 않는 것 같은 방법을 받았다. 영상을 했다.
Cane blight		김 씨는 지수는 것은 것이 아파는 것이 같다. 같은 것이 같은 것이 같이
Raspberry Leaf Spot		
Powdery Mildew		
Rusts		

FIRST COVER (PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose	See Early Bloom	f.
Gray mold (Botrytis rot)		
Spur blight		
Cane blight		
Raspberry Leaf Spot		
Powdery Mildew		
Rusts		
INSECTS		INSECTICIDES
Leafrollers	See Pre-Blossom	5. Diazinon 50 WP (2 lb)
Cane Borers	See Pre-Blossom	8. Guthion 50 WP (1/2 lb)
Aphids	See Pre Harvest	23. Sevin 50 WP (4 lb)
Leafhoppers	5g, 8g, 23g	23. Sevin 80 S (21/2 lb)
Tarnished plant bug	23g	23. Sevin XLR+ (2 qt)

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Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Gray mold (Botrytis Rot)	3e*,5f-g* 20f*, 50f-g**, 65e*, 67e*, 70g-e*	3. Rovral 4F (1 - 2 pt)*
Penicillium Rot	5g*, 20g*, 50f**, 70g*	5. Nova 40 W (1.25 - 2.5 oz)*
Cladosporium Rot	5g*, 20g*, 50f**, 70g-e*	20. Cabrio EG (14 oz)*
Comments:		50. Captan 50 WP (4lb)** or Captan 80WDG (2½ lb)**
post-harvest fruit rot. Botryt	ations at this time can help reduce the incidence of is can be distinguished by the grayish, fluffy fungal n looks velvety dark green, and Penicillium looks a	65. Elevate (1.5 lb)* 67. Switch 62.5WG (11 - 14 oz)* 70. Pristine (18.5 - 23 oz)* Comments:
ngntor blaion groon.		*Rovral, Nova, Cabrio, Pristine, Elevate, and Switch have a 0-day PHI **Captan has a 3-day PHI.
INSECTS/MITES		INSECTICIDES
Aphids	5g, 13g, 54g	5. Diazinon 50 WP (2 lb)
Japanese Beetle**	13g, 23g, 40g**, 54f*, 57g***,58g***	13. Aqua Malathion 8 E (1 pt)
Twospotted spider mite	13g, 23g, 54f*, 61e	13. Malathion 25 WP (8 lb)
Comments:		23. Sevin 50 WP (4 lb)
*Primarily a repellent.		23. Sevin 80 S (2½ lb)
	or beetle control when fall bearing varieties are in	23. Sevin XLR+ (2 qt)
bloom risks mortality for pol		40. Asana XL 0.66 EC (4.8 - 14.5 fl oz)
***These are short-lived p	yrethrums with strong initial knockdown activity.	54. Neem [Ecozin (10 oz)]*
		54. Neem [Neemix (1 pt)]* ▲
		54. Neem [AzaDirect (32 oz)]* ▲
		57. Pyganic EC 1.4 (32 - 64oz)***
		58. Evergreen EC 60-6 (8 - 16oz)***
		61. Acramite 50W (0.75 - 1.0 lb)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES	•••••••••••••••••	FUNGICIDES
Phytophthora Root Rot	15g*, 61e***	15. Aliette WDG (5 lb)*
Anthracnose	50g**	50. Captan (4 lb)** or
Spur Blight	50g**	Captan 80WDG (21/2 lb)**
· · · · · · · · · · · · · · · · · · ·		61. Ridomil Gold EC (¼ pt)*** or Ridomil Gold GR (5 lb)***
		Comments: *The last fall application of Aliette should be made at least 30 days prior to leaf drop. **Apply fall spray of Captan after old canes are
		removed. *** Only one application of Ridomil is allowed in the fall.
INSECTS		INSECTICIDES
Aphids	5g*, 54g	5. Diazinon 50 WP (2 lb)*
Raspberry Crown Borer	5e*	54. Neem [Ecozin (10 oz)]* 54. Neem [Neemix (1 pt)]* 54. Neem [AzaDirect (32 oz)]*
		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.

Table 1. Susceptibility of raspberries to various diseases (VR=very resistant, R=resistant, MR=moderately resistant, l=intermediate, MS=moderately susceptible. S=suscentible. S=suscentible. and VS=very suscentible. RMV= Resolvery mosaic virus: RBDV= Resolvery busby dwarf virus: RI CV=Resolverties leaf curd

Summer Raspberries Algonquin R Boyne MR Canby MR Camival MR Camival MR Camival I Camival I Camiva I Camival I Camival I Camival I Camiva		Anthrac- nose	Spur blight	Cane blight	Crown gall	Fire blight	Leaf spot	Powdery mildew	leaf rust	Gray Mold	Viruses
								2		, 1	
			ĸ							MR	R (aphid) R (RBDV)
	S	s	R		-		R			MR	
		s	æ		s		_			-	VR (aphid) R (virus)
											formal vi
			MR		S					s	R (aphid) R (RBDV)
an		MR	MR								
au			s				MS				
au		_	_					_	VS		I (RMV)
			æ							MR	R (aphid)
K81-6			-			s	s			S	S (RLCV)
Killarney MR		s	Я				MR	s			
Latham MR		MR	R	_			Я			_	MR (virus)
Lauren MS		(R				Я				
											R (aphid)
rgh		MR	MR	MR							
Nordic MR		-									
Prelude			Я				Я	5			
Nova S		MS	R			S	VR	MS	æ		S (RLCV)
Regency											
Reveille			æ				æ			_	
Taylor		8					٨S				۸S
Titan VS			MS		s		MR			_	R (aphid)
Tulameen		S	—		ĸ		WS		×	_	MR (RMV) MR (aphid)

MR (aphid) S (RMV) S (RBDV) R (RMV) S (RBDV) R (RMV) I (RBDV) I (RMV) VR (aphid) MR (RMV) Table 1, (continued). Susceptibility of raspberries to various diseases (VR=very resistant, R=resistant, MR=moderately resistant, I=intermediate, MS=moderately susceptible, S=susceptible, and VS=very susceptible; RMV= Raspberry mosaic virus; RBDV= Raspberry bushy dwarf virus; RLCV=Rasoberries leaf curl virus). S (RBDV) R (RBDV) S (aphid) Viruses R (RMV) Gray mold MR S R SSS Late leaf rust S Powdery mildew MR MR R S S Leaf R RR R R Ľ R Fire blight Crown gall S Ľ SS Cane blight MR Spur blight MR VS MR R R Ľ Anthrac-nose MR MR MR Verticillium wilt S 200 Phytophthora root rot MR S S S S **Purple Raspberries Black Raspberries** Fall Raspberries Autumn Cascade Fall Gold (yellow) Golden Harvest Autumn Britten Double Delight Autumn Bliss Anne (yellow) Cumberland Brandywine Black Hawk Allegheny Amethyst Heritage Redwing Caroline Fall Red (yellow) Variety Dinkum Polana Royalty Dundee Amity Ruby Allen Bristol Jewel Haut

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DISEASES OF BLUEBERRY IN MICHIGAN

Mummy berry - Monilinia vaccinii-corymbosi The mummy berry fungus causes blighting of young shoots and flower clusters and a dry rot of blueberry fruit. Under humid conditions, a gravish layer of conidia can be seen on wilted shoots and flower clusters. The fungus overwinters in mummified fruit on the ground and requires a cold period to germinate. In the spring, the mummies form small trumpet-shaped mushrooms that shoot ascospores into the air. These ascospores are spread by wind and infect young shoots causing wilting and death within 2 weeks of infection. At the optimum temperature 57°F, only 4 h of wetness are needed. Frost may enhance susceptibility of the shoots. The conidia are spread by rain, wind, and bees to blossoms, where they grow from the stigma through the style into the ovary. As the fungus colonizes the developing berry, the berry becomes pink to gray, mummifies, and falls to the ground. In spring, after the fruit skin has weathered away, the mummies often look like small black pumpkins. The disease tends to be worse in low-lying moist areas in fields, as well as near the edges of wood lots.

Non-chemical control options: Plant resistant cultivars (e.g., Bluecrop) or avoid highly susceptible cultivars; don't plant in heavily wooded and shady areas; remove mummies by raking; cover mummies with 1-2 inches of soil or mulch to prevent spore release; remove wild blueberries from vicinity; apply urea fertilizer on mushrooms in spring; spray Serenade (biological control agent).

Phomopsis twig blight and canker - Phomopsis vaccinii

This disease is characterized by blighted twigs, reddishbrown cankers on canes, and wilting and death ('flagging') of canes in midsummer. Leaves on wilted stems are reddish and remain attached to the stem. The fungus overwinters in infected canes and twigs as well as in dormant buds. Spores ooze out of the pimple-like fruiting bodies under wet conditions throughout the spring and summer and are dispersed by rain splash. Peak spore release occurs around bloom. When a film of water is present, the fungus readily invades succulent floral tissues and moves into the vascular system. The exact conditions required for infection are not known. Drought stress, frost, wounds, and possibly herbicide injury can predispose plants to cane infection. Infected plants may be weakened and more sensitive to winter injury as well. The fungus can also cause reddish-brown spots on leaves and a fruit rot ("soft rot"). The leaf spots or fruit rot are not usually a problem in Michigan.

Non-chemical control options: Plant resistant cultivars or avoid highly susceptible cultivars, prune out and destroy dead and diseased canes, avoid wounding canes, irrigate when needed to reduce plant stress.

Fusicoccum canker - Fusicoccum putrefaciens This disease is more prevalent in northern than in southern Michigan. Fusicoccum canker is a limiting factor to production in the Upper Peninsula. The canker lesions on the canes are reddish brown with a sharp margin, resembling a bull's eye pattern, and are centered around a leaf scar. Most cankers are near ground level, but some can be as high as 3 ft from the ground. In summer, infected canes wilt and die. Leaves remain on infected stems and turn reddish brown. The fungus overwinters in existing cankers. Spores are released during wet weather from bud swell through early leaf drop in October, and are rain-splash dispersed. Peak spore production occurs during bloom. Wounds are not necessary for infection. Infection occurs after as little as 2 hours of wetness at 50-72°F. No infection occurs at 86°F.

Non-chemical control options: Plant resistant cultivars or avoid highly susceptible cultivars; prune out and destroy dead and diseased canes.

Powdery mildew – Microsphaera vaccinii Powderv mildew is common on blueberries in Michigan, especially on 'Jersey'. Damage is generally slight, but defoliation may occur when the disease is severe. Yellowish blotches and puckering on the upper surface, and clusters of water-soaked spots on the lower surface typically show up in midsummer. Sometimes a superficial white fungal growth can also be seen on the infected leaves. Towards the end of the season, the infected areas become reddish and black specks appear: these are the overwintering fruiting bodies (cleistothecia). The fungus overwinters as cleistothecia on fallen leaves and in the bark of the bush. In the spring, the cleistothecia shoot out asco spores, which are carried by wind to the new leaves and cause primary infections. Spores (conidia) are produced on these lesions and cause secondary infections. Powdery mildew is favored by warm, humid weather. Moderate to high humidity is sufficient for infection.

Non-chemical control options: Plant resistant cultivars or avoid highly susceptible cultivars; reduce humidity by creating an open canopy and increasing airflow.

Anthracnose fruit rot - *Colletotrichum acutatum* This disease is characterized by softening of infected berries and slimy orange spore masses. While infections usually occur when the fruit is still green, symptoms do not show up until ripening. The fungus overwinters in old fruiting twigs and dormant buds and sporulates throughout the spring and summer. Peak spore release typically occurs around bloom. Spores are rain-splash dispersed and can infect blossoms and fruit. Sporulation on ripe berries can lead to infection of healthy berries in the same cluster. Spores can also spread to healthy berries at harvest and

in the sorting line, resulting in post-harvest losses. The disease is enhanced by hot and humid weather. The optimum temperature for fungal growth is 68-81°F and about 12 hr of continual wetness are required for infection. High infection rates can also contribute to high mold counts and reduced quality of stored fruit.

Non-chemical control options: Plant resistant cultivars (e.g., Elliott) or avoid highly susceptible cultivars, prune out and destroy old fruiting wood; increase air circulation to reduce humidity; time irrigation to overlap with dew events to reduce fruit wetness duration; timely harvest and rapid cooling of fruit; sanitation of sorting line.

Alternaria fruit rot - Alternaria tenuissima

Alternaria fruit rot is characterized by a dark green velvety mold in a sunken area of the berry, usually at the calyx end. Bluecrop appears particularly susceptible. The fungus overwinters in and is able to sporulate on dead twigs, leaves, and plant debris on the ground. Spores are wind-dispersed and are not usually abundant until early to mid-June. Conditions required for infection are not well understood. Good control of anthracnose fruit rot sometimes results in an increase in Alternaria fruit rot, presumably by taking away the competition. Alternaria can also be a post-harvest problem, causing 'leaky' fruit and a greenish-gray moldy growth on berries, often starting at the stem scar.

Non-chemical control options: prune out and destroy old fruiting wood, create open canopy to increase air circulation and reduce humidity; time irrigation to overlap with dew events to reduce fruit wetness duration; timely harvest and rapid cooling of fruit.

Other fruit rots – Botrytis cinerea, Phomopsis vaccinii, black yeast, etc.

A range of fungi, including yeasts, can cause fruit rots in blueberry. Most of these do not show up until after harvest and are of minor economic importance. Methods that control anthracnose and Alternaria rot will most likely control these rots as well.

Leaf rust - Pucciniastrum vaccinii

This disease is rare but may occur in fields with hemlock trees nearby, as hemlock is the alternate host for this fungus. Yellow leaf spots appear midseason and eventually turn reddish brown. Orange to rusty red pustules on the lower leaf surface contain the uredospores. These spores are dispersed by wind and can re-infect young blueberry leaves. At the end of the season, teliospores are produced in blueberry leaves. These spores are the overwintering structures and germinate in the spring to produce basidiospores which infect hemlock needles. In early summer, the fungus proceeds to produce aeciospores on hemlock needles which re-infect blueberries. Heavy leaf rust infections can lead to premature defoliation of plants.

Non-chemical control options: remove nearby hemlock trees; plant resistant cultivars.

Witches' broom – Pucciniastrum goeppertianum

This is a rare disease in Michigan. Broom-like shoots are malformed with thick spongy stems, shortened internodes, and small leaves. The brooms eventually turn brown and become dry and cracked. The disease is caused by a rust fungus which alternates between blueberries and balsam fir trees. The disease usually does not become apparent until a year after infection. The rust becomes systemic in the plant, so new brooms will keep appearing every year. The fungus overwinters as teliospores which are formed in the swollen stems of the brooms in late summer and fall. The teliospores germinate in spring to produce basidiospores which are carried by wind to fir trees. Within 5 wk of infection, aeciospores are formed on fir needles which re-infect blueberry plants.

Non-chemical control options: Eradicate fir trees within 1500 feet of blueberries; remove or kill infected bushes with an herbicide.

Phytophthora root rot - Phytophthora cinnamomi

This disease is very rare in Michigan. It tends to be associated with heavy soils and poorly drained areas within fields. The fungus infects fine roots, causing them to turn brown or black; larger-diameter roots and the crown may also be discolored. Above-ground symptoms include chlorosis and reddening of the leaves, small leaves, defoliation, cane death, and stunting and death of the entire bush. The fungus overwinters primarily as hardy chlamydospores, which are formed in infected roots and released into the soil as the root tissue breaks down. The chlamydospores germinate to produce sporangia containing zoospores (swimming spores), which swim towards and infect young roots. Abundant soil moisture and temperatures between 68-90°F favor root infection.

Non-chemical control options: select sites with lighter soils and good drainage; improve drainage by tiling; plant on raised beds; plant tolerant cultivars.

Virus and virus-like diseases - blueberry shoestring virus, blueberry leaf mottle virus, tobacco ringspot virus, red ringspot virus, blueberry stunt phytoplasma, etc. These diseases are characterized by various degrees of stunting, leaf malformation, yellowing or reddening of tissues, mottling or ring/mosaic patterns on leaves, poor fruit set or uneven fruit ripening, and plant death. The causal agent of blueberry mosaic is unknown but suspected to be a virus. All of these diseases have in common that they are systemic in the plant and cannot be cured by chemical or other treatments. They are transmitted by vegetative propagation of infected plants, by aphids (blueberry shoestring virus), nematodes (tobacco ringspot virus), pollen (blueberry leaf mottle virus), mealybug (red ringspot virus) or leaf hoppers (blueberry stunt phytoplasma). Symptoms tend to be more obvious in cool growing seasons. Nematodetransmitted viruses tend to spread outward in a roughly

circular pattern, whereas insect-transmitted viruses are more random or spread along the row.

Non-chemical control options: Buy virus-tested planting stock; select resistant or less susceptible cultivars; remove and destroy infected plants; practice good insect control; wash harvesting equipment between fields to remove aphids; fumigate when replanting in areas with nematode-transmitted viruses.

The rate of materials for use blueberries is 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. To get sufficient spray coverage of fruit clusters within the canopy, it is recommended to use at least 50-100 GPA after bloom. Effectiveness of materials listed below is based primarily on trials using concentrate sprays of 50 GPA (water). 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.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation:

GREEN TIP (1/16")

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	4g, 9g**, 50f	2. Indar 75 WSP (2 oz)*
Phomopsis Twig Blight and Canker	2g-e*, 4g, 9g-e**, 15f-g, 29f, 50f,	4. Bravo WeatherStik (3 - 4¼ pt)
	51g***	9. Topsin M WSB (1 lb)** plus:
Mummy Berry (shoot strike phase)	2g-e*, 4f-g, 9g**, 29f-g****	Captan 50 WP (5 lb) or Captec 4 L (2 ¹ / ₂ qt) or
Phytophthora Root Rot	61e****	Captan 80WDG (3 ¹ / ₈ lb) or
Comments:		Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb)
Review fungicide characteristics in the	e section "Fungicides and bactericides	15. Aliette WDG (5 lb)
for Fruit Crops", pages11-15		29. Serenade WP (8 lb)**** ▲
		50 . Captan 50 WP (5 lb) or Captec 4 L (2 ¹ / ₂ qt) or
	resence of mummies with trumpet-like	Captan 80WDG (3 ¹ / ₈ lb)
mushrooms. These tend to be more c		51. Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb)***
	when the opening is about 1/8 inch in	61. Ridomil Gold EC (1/4 pt)*****
	depending on the temperature. Cooler	Comments:
temperatures favor longevity of the me		*Indar is expected to be available under Section 18
	of young leaves and shoots to infection.	(emergency exemption) in 2003. Apply in at least 20
Sprays within 24 h of a frost event ma	ay improve efficacy of fungicides used.	gal water/acre by ground sprayer or in 10 gal
		water/acre by airplane. Make no more than 5
		applications(per acre per season. Efficacy may be
		improved by spraying within 24 h of frost events.
		**Topsin M WSB is expected to have a Section 18
		(emergency exemption) label in 2004. Do not make
		more than three applications per season.
		***Ziram 76 DF can be applied at a higher rate
		under a Special Local Need label. The 4-lb rate is
		generally more effective than the 3-lb rate.
		****Serenade is a biofungicide; thorough coverage
		is essential. Keep pH of spray solution at 4.5 - 8.5.
		*****For established plantings, apply Ridomil as a
		drench at 1/4 pint/1,000 linear ft of row in a 3-ft wide
		band centered on the row. One additional application
		may be made to coincide with periods favorable for
		root rot development. Ridomil will not revitalize plants
		showing moderate to severe root rot symptoms.
GREEN TIP (1/4 - 1/2")		

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummy Berry (shoot strike phase)	See green tip (1/16")	
Phomopsis Twig Blight and Canker		

Suggested Chemicals (Rate/acre) FUNGICIDES 2. Indar 75 WSP (2 oz) ,29f-g, 70g**** 4. Bravo WeatherStik (3 - 4 pt) 9. Topsin M WSB (1 lb)* plus:
2. Indar 75 WSP (2 oz) ,29f-g, 70g**** 4. Bravo WeatherStik (3 - 4 pt) ig, 50f 9. Topsin M WSB (1 lb)* plus:
,29f-g, 70g**** 4. Bravo WeatherStik (3 - 4 pt) ig, 50f 9. Topsin M WSB (1 lb)* plus:
ig, 50f 9. Topsin M WSB (1 lb)* plus:
g-e*, 15f-g,20g****, Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or 1g, 70g-e**** Captan 80WDG (3½ lb) or
12e ****, 15g , 20e ****, 12. Abound FL (6.5-15.4 oz)****
*, 50f, 51f, 65e***, 15. Aliette WDG (5 lb) 20. Cabrio EG (14 oz)**** 25. Captevate (3.5 – 4.7 lb)**
 29. Serenade WP (8 lb) ▲ 50. Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or Captan 80WDG (3½ lb) 51. Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb) 65. Elevate 50WDG (1.5 lb)*** 70. Pristine (18.5-23 oz)**** Comments: *Topsin M WSB is expected to have a Section 18
 (Emergency exemption) label in 2003. Do not make more than three applications per season. **Do not make more than 2 consecutive applications of Captevate and no more than 21 lbs product per season. ***Do not make more than 2 consecutive applications of Elevate or apply more than 6 lbs product per year. ****Do not make more than two consecutive applications and no more than (Abound) or (Cabrio,
Pristine) application.
INSECTICIDES
3g, 46e, 49g 11. Lannate 90 SP (1 lb) or
6g 11. Lannate LV (3 pt)
40. Asana XL 0.66 EC (4.8 - 9.6 fl oz)
43. B.t.'s [Dipel (1.5 lb)] ▲
46. SpinTor 2 SC (4 - 6 oz) 49. Confirm 2 F (16 oz)

25% BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummy Berry (blossom infection	See Pink Bud	
phase)		
Fusicoccum Canker		
Phomopsis Twig Blight and Canker		
Anthracnose		
Phytophthora Root Rot		
Botrytis leaf and blossom blight		

FULL BLOOM (EARLY PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Mummy Berry (blossom infection phase)	2g-e*, ,29f-g, 70g	2. Indar 75 WSP (2 oz)* 4. Bravo WeatherStik (3 - 4 pt)**
Fusicoccum Canker	4g**, 9g, 15g, 50f	9. Topsin M WSB (1 lb) plus:
Phomopsis Twig Blight and Canker	2g-e*, 4g**, 12g, 20g, 25f, 29f, 15f-g, 50f, 51g, 70g-e	Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or Captan 80WDG (3 ¼ lb) or
Anthracnose	4g**, 9g-e, 12e, 15g, 20e, 50g, 51g, 70e	Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb) 12. Abound FL (6.2 - 15.4 oz)
Botrytis leaf and blossom blight	25e, 50f, 51f, 65e, 70e	15. Aliette WDG (5 lb)
		20. Cabrio EG (14 oz) 25 . Captevate (3.5 – 4.7 lb)
		 29. Serenade WP (8 lb) ▲ 50. Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or Captan 80WDG (3 ½ lb) 51. Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb)
		65. Elevate 50WDG (1.5 lb) 70. Pristine (18.5 – 23 oz)
		Comments: *Do not apply Indar within 30 days of harvest. **Do not apply Bravo WeatherStik after early petal fall or fruit spotting may occur. Bravo has a 42-day PHI.
INSECTS		INSECTICIDES
Obliquebanded Leafroller Cranberry Fruitworm Cherry Fruitworm Gypsy Moth	43g*, 49g**, 43g*, 49g**, 52g** 43g*, 49g**, 52g** 43g*, 49g**, ***	 43. Bacillus thuringiensis (B.t.) * [Dipel (1.5 lb)] ▲ Deliver AC (0.5-2.0 lb) 49. Confirm 2F (16 fl oz)**, *** 52. Esteem 35WP (5oz)**
	N	Comments: *Time these insecticides for early egg hatch. B.t. is most effective under warm weather conditions. B.t.'s may need to be reapplied every 4-7 days to maintain control. **Time sprays for start of egg laying. ***Apply Confirm at 4-8 fl. oz for gypsy moth.

FIRST COVER (100% PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	9g, 15g, 50f	2. Indar 75 WSP (2 oz)
Phomopsis Twig Blight and Canker	2g-e, 9g-e, 12g, 15f-g, 20g, 50f,	9. Topsin M WSB (1 lb) plus:
	51g, 70g-e	Captan 50 WP (5 lb) or Captec 4 L (2 ¹ / ₂ qt) or Captan
Anthracnose	4g, 9g-e, 12e, 15g, 20e, 50g, 51g,	80WDG (3 1/8 lb) or
	70e	Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb)
		12. Abound FL (6.2 - 15.4 oz)
		15. Aliette WDG (5 lb)
		20. Cabrio EG (14 oz)
		50. Captan 50 WP (5 lb) or Captec 4 L (21/2 qt) or
		Captan 80WDG (3 1/8 lb)
		51. Ziram 76 DF (3 - 4 lb) or Ziram Granuflo (3 lb
		70. Pristine (18.5 – 23 oz)

FIRST COVER (100% PETAL FALL) (CONTINUED)

INSECTS		INSECTICIDES
Plum Curculio	5g, 8e, 9e, 23g	5. Diazinon 50 WP (2 lb)
Blueberry Tip Borer	5g, 8e, 9e, 23g	8. Guthion 50 WP (1 - 1¼ lb)
Obliquebanded Leafroller	5g, 8e, 9e, 11g* 23g, 43g, 46g,	9. Imidan 70 WP (1 ¹ / ₃ lb)
•	49g, 54g	11. Lannate 90 SP (1 lb)*
Cranberry Fruitworm	5g, 8e, 9e,11g*, 23e, 40e, 43g,	11. Lannate 2.4 LV (3 pt)"
	46g, 49g, 52g**, 64g	23. Sevin 80 WSP (1 ¹ / ₄ - 2 ¹ / ₂ lb)
Cherry Fruitworm	8e, 9e, 23e, 40e, 43f-g, 46g, 49g,	23. Sevin 50 WP (3 - 4 lb)
	52g**, 64g	23. Sevin XLR+ (1½ - 2 qt)
Aphids	5g, 11g*, 40f, 52g, 54g	40. Asana XL 0.66EC (8 oz)
Thrips	5g, 8g, 46g, 64g	43. B.t.'s [Dipel (1.5 lb)] ▲
Comments:		46. SpinTor 2 SC (4 - 6 oz)
For aphid control, sprays should be applied with a ground sprayer to		49. Confirm 2 F (16 oz)
achieve sufficient cover.	5 1 5	52. Esteem 35WP (5 oz)**
		54. Neem compounds [AzaDirect (32 fl oz) ▲,
		[Ecozin 3% (10 oz)]
		[Neemix (1 pt)]
		[AgroNeem (2 qt)]
		64. Entrust 80WP (1.25 - 2 oz) ▲
		Comments:

Comments:

- *--Lannate cannot be used in "U-pick" fields.
- **--Esteem shows greatest activity against fruitworm eggs.

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SECOND	COVER	areen	horry)
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Pest	Efficiency	Suggested Chemicals (Rate/acre)	
DISEASES		FUNGICIDES	
Fusicoccum Canker	9g*, 15g, 50f	9. Topsin M WSB (1 lb) plus:	
Phomopsis Canker	9g-e*, 15f-g, 20g, 50f, 51g*,	Captan 50 WP (5 lb) or Captec 4 L (21/2 qt) or Captan	
	70g-e	80WDG (31/8 lb) or	
Anthracnose	9g-e*, 12e, 15g, 20e, 50g, 51g*,	Ziram 76 DF (3 - 4 lb)* or Ziram Granuflo (3 lb)*	
	67g**, 70e	12. Abound FL (6.2 - 15.4 oz)	
Alternaria Fruit Rot	15g, 51f*, 67g-e**, 70f-g	15. Aliette WDG (5 lb)	
Comments:		20. Cabrio EG (14 oz)	
		50 . Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or Captan 80WDG (3 ½ lb)	
Fruit rots: Bluecrop is partie	cularly susceptible to Alternaria fruit rot.		
· · · · · · · · · · · · · · · · · · ·	,	51. Ziram 76 DF (3 - 4 lb)* or Ziram Granuflo (3 lb)*	
		67. Switch (11 - 14 oz)**	
		70 . Pristine (18.5 – 23 oz)	
		Comments:	
		*Do not apply Ziram Granuflo later than 3 weeks after	
		bloom. Ziram 76 DF has a 14-day PHI.	
		**Do not make more than 2 consecutive applications of	
		Switch or apply more than 56 oz product per season. Do	
		not apply Switch by airplane.	
IN IOF OTO			

INSECTS

See First Cover

THIRD COVER (green berry)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	9g,15g 50f	9. Topsin M WSB (1 lb) plus :
Phomopsis Canker	9g-e, 15f-g, 20g, 50f, 51g, 70g-e	Captan 50 WP (5 lb) or Captec 4 L (2 ¹ / ₂ qt) or Ziram 76
Anthracnose	9g-e, 12e, 15g, 20e, 50g, 51g,	DF (3 - 4 lb)
	67g, 70e	12. Abound FL (6.2 - 15.4 oz)
Alternaria Fruit Rot	15g, 51f, 67g-e, 70f-g	15. Aliette WDG (5 lb)
		20 . Cabrio EG (14 oz)
		50 . Captan 50 WP (5 lb) or Captec 4 L (2 ¹ / ₂ qt) or
		Captan 80WDG (31/8 lb)
		51. Ziram 76 DF (3 - 4 lb)
		67. Switch (11 - 14 oz)
		70 . Pristine (18.5 – 23 oz)
INSECTS	See First Cover	

FOURTH COVER (green berry)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Alternaria Fruit Rot	See Third Cover	
INSECTS		INSECTICIDES
Blueberry Maggot	5g, 8e, 9e, 11g, 13g, 23g, 40g, 46g, 53e*, 54f, 64g, 67g	 5. Diazinon 50 WP (2 lb) 8. Guthion 50 WP (1 – 1½ lb)
Aphids	5g, 11g, 13g, 40f, 54g	9. Imidan 70 WP (1 ¹ / ₃ lb)
Japanese Beetle	8g, 9g, 11f, 13f, 23f, 40g, 53f*, 54f**	 11. Lannate 90 SP (1 lb) 11. Lannate 2.4 LV (3 pt) 13. Malathion LV Concentrate (10 fl oz)
<i>Comments:</i> *Must maintain coverage for adequate performance. **Primarily a repellent on Japanese beetle. Some formulations may affect fruit finish. *** Apply as a concentrated solution by air (see label instructions).		 13. Aqua Malathion 8 EC (1 ½ - 2 ½ pt) 23. Sevin XLR+ (1½ - 2 qt) 40. Asana XL 0.66 EC (4.8 - 9.6 fl oz) 46. SpinTor 2 SC (6 oz) 53. Surround WP (25 lb)* 54. Neem compounds** [AzaDirect (32 fl oz) ▲, [Ecozin 3% (10 oz)] [Neemix (1 pt)] ▲ [AgroNeem (2 qt)] 64. Entrust 80WP (2 oz) ▲ 67. GF120 NF Fruit Fly Bait (10-20 oz)*** ▲

FIFTH COVER (10% blue)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Anthracnose	12e*, 20e*, 50g*, 67g*, 70e*	12. Abound FL (6.2 - 15.4 oz)*
Alternaria Fruit Rot	15g**, 67g-e*, 70f-g	15. Aliette WDG (5 lb)**
		20 . Cabrio EG (14 oz)*
		50. Captan 50 WP (5 lb)* or Captec 4 L (21/2 qt)* or
		Captan 80WDG (3 1/2 lb)*
		67. Switch (11 - 14 oz)*
		70. Pristine (18.5 – 23 oz)*
Comments:		Comments:
Fungicide sprays at this time can help reduce secondary anthracnose		*Abound, Cabrio, Captan, Elevate, Pristine, and Switch
infections from sporulating ripe berries to nearby healthy berries.		have a 0-day PHI; however, the REI of Captan is 72 h.
		**Alliette has a PHI of 12 hours.
INSECTS	See Fourth Cover	

SIXTH COVER	۰.	
Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS	See Fourth Cover	

PRE-HARVEST		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	15g, 50f	12. Abound FL (6.2 - 15.4 oz)
Phomopsis Canker	15f-g, 20g, 50f, 70 g-e	15. Aliette WDG (5 lb)
Anthracnose	12e, 15g, 20e, 50f-g, 67g,	20 . Cabrio EG (14 oz)
	70e	50 . Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or
Alternaria Fruit Rot	15 g, 67g-e, 70f-g	Captan 80WDG (3 1/8 lb)
Comments:		67. Switch (11 - 14 oz)
If canker is a serious problem, and it ha		70 . Pristine (18.5 – 23 oz)
last canker spray, apply a spray at this t	time.	
INSECTS		INSECTICIDES
White Marked Tussock Moth	11e, 23e*	5. Diazinon 50 WP (2 lb)
Obliquebanded Leafroller	11g, 23g*, 40e, 43g, 49g	8. Guthion 50 WP (1-11/2 lb)
Canker Worms	11e, 23e*	9. Imidan 70 WP (11/3 lb)
Japanese Beetle	8g, 9g, 11f, 13f, 23g*, 40g,	11. Lannate 90 SP (1/2 - 1 lb)
	53f**, 54f***, 57f****, 58g****	11. Lannate LV (3 pt)
Blueberry Maggot	5g, 8e, 9e, 13g, 23g*, 40f,	13. Aqua Malathion 8 EC (2 - 2.5 pt)
	46g, 53e**, 54f, 64g, 67g	23 . Sevin 80 S (1 ⁷ / ₈ lb)*
Comments:		23. Sevin XLR+ (1½ - 2 qt)*
*Addition of non-ionic surfactant to gro	ound sprays increases	40. Asana XL 0.66 EC (9.6 fl oz)
knockdown of Japanese beetle.		43. B.t.'s [Dipel (1.5 lb)] ▲
**Must maintain coverage for adequat		46. SpinTor 2SC (6 oz) 49. Confirm 2 F (16 fl oz)
***Primarily a repellent on Japanese b affect fruit finish.	eelle. Some formulations may	53. Surround WP (25 lb)**
****These are short-lived pyrethrums v	with strong initial knockdown	54. Neem compounds*** [Ecozin 3% (10 oz)]
activity.		(Neemix 1pt) \blacktriangle
*****Apply as a concentrated solution	hy air (see label instructions)	[AzaDirect (32 oz)] ▲
hpply de a concentrated control		[AgroNeem (2 qt)]
		57. Pyganic EC 1.4 (32 – 64 oz)**** ▲
		57. Fyganic EC 1.4 (32 – 64 62) ▲ 58. Evergreen EC 60-6 (8 – 16 oz)****
		64. Entrust 80WP (2 oz) ▲
		67. GF120 NF Fruit Fly Bait (10 - 20 oz)***** ▲

PO	ST-	HA	RV	EST	

POST-HARVEST		
Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		FUNGICIDES
Fusicoccum Canker	50f	50 . Captan 50 WP (5 lb) or Captec 4 L (2½ qt) or
Phomopsis Canker	50f	Captan 80WDG (3 ¹ / ₈ lb)
Comments:		
	erious problem and wounds have been nent. Continue spray applications at 3 to 4- rop in the fall	
INSECTS		
Blueberry Bud Mite	26g	26 . Thiodan 3 EC (2 qt)*
		Comments:
		*Apply immediately post harvest with sufficient water to
		achieve thorough penetration of buds scales, followed by
		a second application 2 weeks later.

Dormant applications of lime sulfur:

Dormant or delayed-dormant applications of lime sulfur can help reduce overwintering inoculum of *Phomopsis* and *Fusicoccum*. Applications may be made in the fall after the leaves are off or in the spring before bud break. Lime sulfur is not a stand-alone treatment. A fall application was shown to be as effective or slightly more effective than a spring application in reducing twig blight in New Jersey and Michigan trials. About a 50% reduction in twig blight can be expected using a fall or "fall and spring" application. Some lime sulfur products are OMRI listed for organic production.

Fungicide	Mummy berry		Phomopsis twig blight	Fusicoc- cum	Alternaria fruit rot	Anthracnose fruit rot	Botrytis blight and	Phytoph- thora
	Shoot	Fruit	and canker	canker			fruit rot	Root Rot
Abound	+ / ++	+ / ++	++	?	++	++++	+	?
Aliette	0	0	++ / +++	?	+++	+++	?	+++
Topsin M + Captan or Ziram	+/++	+/++	+++	+++	+	+++	+++	0
Bravo	++	+ .	+++	+++	+	+++	++	0
Cabrio	+ / ++	+ / ++	+++	?	++	++++	+	?
Captan	+	+ / ++	++	+	+	++ / +++	+	0
Captevate	+	++	++	?	?	++	++++	0
Elevate	+	++	+	?	0	0	++++	0
Indar	+++	+++	+++ / ++++	?	+	0	?	0
Lime sulfur	?	?	++*	?	?	?	?	0
Pristine	+++	+++	+++	?	++/+++	++++	+++	?
Rovral	0	0	0	0	0	0	++++	0
Ridomil	0	0	0	0	0	0	0	++++
Serenade	++ / +++	++ / +++	+ / ++	?	?	0	?	?
Switch	+	+	+ / ++	?	+++++	+++	+++	?
Ziram (3 lb)	++	+	++	++	+*	++	+	0
Ziram (4 lb)	++	++	+++	++ / +++	++*	+++	++	0

Table 1. Effectiveness of Fungicides for Blueberry Disease Control.

0 = not effective, + = poor, ++= fair, +++ = good, ++++ = excellent, ? = not known. Ratings are based on published information and observations in Michigan.

* Based on data from New Jersey and Michigan. Fall and spring dormant application used.

Variety	Mummy berry	Phomopsis twig blight and canker	Fusicoccum canker	Powdery mildew	Anthracnose fruit rot	Red ringspot virus	Shoestring virus
Aurora					MR		
Berkeley	S	VS		R			
Bonus							
Bluecrop	MR	MR		MR	VS	MR	VR
Bluegold	S						
Bluehaven	S	S					
Bluejay	R		1				R
Blueray	S				S		
Bluetta	S	R			S	S	
Burlington	R						S
Chippewa							
Collins	S						
Coville	MR		MR	MR			
Darrow	Ŕ						R
Draper					R		
Duke	R						
Earliblue	S	S		R			S
Elliott	R	R			R		S
Jersey	MR	VS		S	S	MR	S
Lateblue	R						
Little Giant					R		
Nelson							
Northblue	R						
Northcountry							
Northland	S						R
Northsky	R						
Patriot							
Polaris							
Rancocas	MS		R	R			MS
Rubel	S	MR	MR		MS		S
Sierra	S						-
St. Cloud							
Spartan	MR		+				S
Sunrise			1				1
Toro			1				
Weymouth	S		T				S

Table 2. Disease resistance in blueberry cultivars commonly grown in the Midwest.

VR=very resistant, R=resistant, MR=moderately resistant, MS=moderately susceptible, and S=susceptible and VS=very susceptible Table prepared by J. Hancock, E. Hanson, D. Trinka, and A.. Schilder.

Effectiveness of Insecticides and Miticides in Controlling Arthropod Pests of Blueberries

(Note that a product's effectiveness rating on a pest does not necessarily indicate that it is labeled for that use.)

E = P = Ra T =	tings of control are excellent, $\mathbf{G} = \text{good}$, $\mathbf{F} = \text{fair}$, poor tings against beneficials are highly toxic, $\mathbf{M} = \text{moderately}$ ic, $\mathbf{S} = \text{relatively safe}$		Diazinon	Guthion	Imidan	Lannate	Malathion	Sevin	Superior Oil	Thiodan	Asana	B.t.'s ▲	Spintor	Confirm	Esteem	Surround A	Neem compounds A	Pyganic ▲	Evergreen	Entrust A	GF120 Fruit Fly Bait 🔺
	Insect / Mite	Life Stage	5	8	9	11	13	23	24	26	40	43	46	49	52	53	54	57	58	64	67
	Blueberry Aphid	Active	G			G					F						G				
	Blueberry Bud Mite	Egg/Active							G	G											
	Blueberry Maggot	Adult	G	Е	Ε	G	G	G			G		F			E	F/G			G	G
	Blueberry Tip Borer	Adult	G	Е	Е			G													
	Canker Worms	Larva				E		Ε			G		G								
	Cherry Fruitworm	Larva/Egg	G	Е	Е			Е			Е	F/G	G	G	G					G	
Pests	Cranberry Fruitworm	Larva/Egg	G	E	Ε	G		Ε			Ε	G	G	G	G					G	
Pe	Gypsy Moth	Larva									1	G	4.0	G							
	Japanese Beetle	Adult		G	G	F	F	G			G					F	F	F	G		
	Obliquebanded leafroller	Larva/Egg		Е	Е	G			1		Е	G	Е	G	G						\square
	Plum Curculio	Adult	G	Ε	E			G	-		G										
	Redbanded leafroller	Larva		Е	Е	G					E	G	Е	Е	G						
	Thrips	Active	G	G									G								
	Tussock Moth	Larva				Е		Е			E		G	G						G	
s	Bees		Т	Т	Т	Т	Т	Т	S	М	Т	S	М	S	S	S	S	S	М	Μ	S
ficia	Predator Mites		М	S	S	Т	М	Т	S	м	Т	S	S	S	S	М	S	S	S	S	S
Beneficials	Insect Predators		т	M	М	Т	М	Т	S	М	т	S	Μ	S	S	М	S	S	S	Μ	s

Plant Growth Regulators G. Lang, J. Nugent, and P. Schwallier

MSU Dept. of Horticulture, Northwest Horticulture Research Station, Clarksville Horticulture Experiment Station

Plant growth regulators (PGRs) are a class of natural and synthetic organic compounds, other than nutrients, that affect growth, development, and maturation of vegetative and reproductive plant structures. The type and degree of plant response varies with the type and concentration of PGR, the crop, and the stage of plant development when applied. Since PGRs subtly or dramatically alter plant growth, it is important to understand their intended and possible side effects, and how to apply them for optimum results.

PGRs must be absorbed into the plant to be effective. Leaves and fruits are the primary sites of absorption, and any factor that influences their wetting and contact time with the PGR may markedly influence plant response. The environment before, during, and/or after application can influence PGR performance by increasing or decreasing absorption, as well as plant activity once the PGR has been absorbed. Use of PGRs on plants low in vigor or under stress requires caution, since such plants may over-respond.

A major challenge with PGR use is results often vary considerably between years and locations, even when apparent climatic and growth conditions are seemingly the same. To minimize variation and improve consistency, consider these application factors:

1. Dosage: PGRs must be applied within a narrow dose range, often given as "parts per million" (ppm), PGR quantity (in oz, lbs, or grams) per 100 gal of spray solution, or PGR quantity applied per acre, to produce a desired response. Since absorption, and hence activity, of most PGRs is affected by drying time, the actual dose to which the plant can respond will depend on climate, the total volume of water applied, and spray particle size and distribution through the canopy.

2. Time of Application: For optimal growth-regulating activity, most PGRs must be applied within a narrow time interval, often only a few days, at a specific stage of plant growth. Missing the window may result in no response or possibly an unintended response.

3. Variety: Varieties often differ in degree of response. Read the product label for specific instructions concerning timing and concentration, and contact your local extension agent for area-specific experiences.

4. Coverage: In general, responses to PGRs are localized, thus all PGRs must be applied with precision. Ensure that the proper amount, with recommended surfactant (if any), is applied uniformly and thoroughly. Calibrate sprayers accurately. When spraying large trees from a non-tower sprayer, direct 2/3 of the spray volume into the upper 1/3 of the tree.

5. Environment: Since weather conditions before, during, and after application may affect PGR performance by influencing absorption and activity, avoid applications whenever weather conditions may approach extremes.

6. Tree Age, Vigor, and Stress: Young trees tend to be easy to thin until they reach full cropping maturity. Highdensity orchards respond as "young" trees until they are about 5 years old. Low-density orchards tend to respond as "young" trees until they are about 7 to 8 years old. Treatment of such "young" trees with PGRs should be conservative to prevent excessive responses, such as overthinning, until they become mature trees bearing full crops. Similarly, trees low in vigor or under stress often respond excessively to PGRs, so special adjustments in dose or application delay may be necessary.

7. Evaluation: There is no substitute for keen observation and routine recording of all PGR application conditions and responses across each orchard block. Always leave several non-treated trees, preferably within the block rather than at the edge, so that the effectiveness of each treatment [application] can be evaluated objectively. With time, future PGR treatments can then be adjusted for site-specific variations based on a record of past experiences.

Apples Chemical Thinning

Chemical thinning of blossoms and fruitlets can reduce the crop load on the tree, promote return bloom and consistent annual production, eliminate small fruitlets, improve fruit size, and improve uniformity of ripening. Chemicals available for apple thinning include: naphthaleneacetic acid (NAA), naphaleneacetamide (NAD), benzyladenine (BA) and carbaryl (Sevin).

Thinning With NAA

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

Listed below are varieties and suggested NAA concentrations to apply 5 to 7 days after petal fall, as a guide when first starting a thinning program. The time of application, relative to bloom or fruit development, influences the response to the thinning application. Applications promote fruitlet abscission most effectively when developing king fruit are approximately 9 to 12 millimeters (mm) in diameter.

If the first application of NAA does not result in enough thinning, increase the concentration 2 to 5 ppm and follow with a second application 7 to 10 days after the first. Very late applications can cause very small sized fruit. **1. Varieties Easy to Thin:** Delicious (non-spur type), Empire, Honeycrisp, Idared, Jerseymac, Jonagold, Jonathan, McIntosh, Northern Spy, and Rhode Island Greening: 4 grams of actual NAA per 100 gallons (10 ppm).

2. Varieties Intermediate to Thin: Cortland, Delicious (spur type), Gala, and Paulared: 6 grams of actual NAA per 100 gallons (15 ppm). Spur type Delicious are harder to thin than regular Delicious and require 3 to 5 more ppm. Note: NAA applied to spur type Delicious after application of Promalin or Accel can result in formation of pygmy fruit.

3. Varieties Hard to Thin: Fuji, Golden Delicious, Rome Beauty, and Wealthy: 8 grams of actual NAA per 100 gallons (20 ppm).

Thinning with NAD

Amid-Thin (NAD) is suggested for use on apples at 50 ppm applied at petal fall. Concentrations lower than this have not given adequate thinning. Applying NAD after petal fall has resulted in poor thinning, as well as causing the fruit to stick fast to the tree so that no "June drop" occurred, resulting in a large crop of valueless, small apples.

NAD is suggested especially for early varieties that ripen before McIntosh, and for varieties likely to be injured by NAA applications. These include Early McIntosh, Northern Spy, Oldenburg (Duchess), Yellow Transparent, and Wealthy. NAD can also be used on most other varieties. While it may not adequately thin some of these other varieties, it seems to make follow-up thinning easier with a subsequent application of another thinning agent. However, NAD sometimes has not thinned Delicious, but instead resulted in a crop with many undersized, distorted apples. *Do not apply* NAD after petal fall on the Delicious variety. Do not combine with Accel.

Thinning with Carbaryl

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 thinning agent, but it has not always produced consistent and adequate results. Unlike most PGRs, 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 activity. Sevin used at second cover following NAA applications can cause overthinning and increase mite problems. Sevin XLR Plus and Sevin 80S can also be used for thinning. Note: Sevin is toxic to bees, so extreme care must be used to prevent exposure to native or commercial bees.

Thinning with Benzyladenine

Benzyladenine (BA, marketed for thinning with the addition of GA₄₊₇ as Accel) has not satisfactorily thinned most varieties, but has been somewhat effective on Empire, Jonathan and McIntosh. BA can thin over a two-week period but developing fruits appear most susceptible to BA applied at the 10-mm 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 target fruit cluster. Warm temperatures at and following application are necessary for effective thinning. A concentration of at least 25 ppm (dilute basis) is necessary for minimum thinning response and 50 ppm is 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. Combine NAA at 1/3 to 1/2 the rate used when applied alone with 1/2 to 1 lb Carbaryl. Apply when fruitlets are 10-12 mm in diameter. Carbaryl may be combined with BA for thinning using the usual rate of Carbaryl with 1/2 to 2/3 rate of BA. This may be helpful on smaller fruited varieties such as Empire and Jonathan. Combination applications are generally dependent on temperatures greater than 70°F for effective thinning.

Guide for Chemical Thinning of Apples in Michigan ¹								
	Chemical Method							
	NAA 5-15 days	NAD at						
	er petal fall (ppm)							
Cortland	15	50						
Delicious, non-spur typ	be 10							
Delicious, spur type	15							
Empire	10	50						
Gala	15	50						
Golden Delicious ²	20							
Honeycrisp	10							
Idared	10	50						
Jerseymac	10	50						
Jonathan	10	50						
McIntosh	10	50						
Northern Spy	10	50						
Paulared	15	50						
Rhode Island Greenin	g 10	50						
Rome Beauty	20							
Wealthy	20	50						
Winesap	10	50						
Other summer varietie	es^3 —	50						

'This table should be used as a guide only. Specific chemical methods, and chemical concentrations may vary depending upon tree vigor, fruit set, environmental conditions, and application techniques (see text).

²Sevin may cause fruit russetting of Golden Delicious.

³Varieties that mature before McIntosh.

Evaluating Results

The results of NAA or NAD thinning sprays may be determined 7 to 10 days after application, as the growth of affected fruits slows and eventually stops; fruits not affected will continue to grow and enlarge. This makes it possible to follow with an additional application of NAA, if the early 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 the sprayer tank, gallons of water applied per acre, previous year's production, and tree response.

Cautions

- As a general rule, apply NAA under fast-drying conditions, when the temperature is between 70° and 75°F. On the other hand, NAD gives best results when applied under slow-drying conditions. NAD is often applied in the evening.
- Weak trees are thinned more readily than vigorous ones. Weak wood in the lower portion of the tree thins more readily than vigorous wood in the top.
- Trees thinned annually have a more predictable response to NAA thinning sprays.
- Thinning with NAA and NAD 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 NAD at 50 ppm 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 readily 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 2-3 ppm 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 rates are too high. When conditions exist that might result in injury or loss of crop from over-thinning with NAA, NAD applied at petal fall using 50 ppm is safer for widespread use. However, these decisions must be made by the grower.
- Uniform coverage is important to avoid over- or underthinning different parts of the tree.
- Thinning is accomplished most effectively with NAA applied 5-15 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 2x concentration is suggested in the beginning, using one-half the spray volume that would be used in conventional spraying.

If higher concentrations are tried, a good starting point is a 3x concentration, but apply only one-fourth the volume of spray solution per tree or per acre that would be used in conventional spraying.

To obtain the amount of thinning desired, each grower must work out the concentration and gallons per tree or per acre that are best suited to their specific orchard conditions.

Defruiting Young Apple Trees

Removing fruit on small trees before they are large enough to produce a commercial 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 Use on Apples

Promalin (N-[phenylmethyl]-IH-purine-6-amine plus GA_{4+7}) is a PGR applied to Red Delicious apples to improve fruit shape by promoting fruit elongation. Apply 16-24 oz/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. Apply when temperature is 70°F or warmer.

Promalin also can be applied to non-bearing apple trees to improve lateral branching. Apply 4-16 oz 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 surfactant. Do not spray trees under stress or after terminal growth ceases. NAA applied for thinning following Promalin application can produce pygmy fruit.

Pro-vide Use on Apples

Pro-vide (GA_{4+7}) is used for suppression of fruit russeting of Golden Delicious apples. Apply 15 ppm (10 oz in 100 gallons) beginning at petal fall and continuing at 7-10 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 7-10 days before anticipated harvest. It becomes effective in about 2 days and controls drop for 6-10 days. A repeat application may be necessary if harvest is delayed. Apply NAA at 10 ppm on McIntosh and earlier ripening varieties, and at 20 ppm on varieties maturing after McIntosh. NAA may stimulate ripening, so treated fruit should be harvested before it becomes overmature.

ReTain (aminoethoxy-vinylglycine, AVG) may be applied to control pre-harvest drop. Apply 4 weeks before anticipated harvest at 50 grams per acre with a nonionic surfactant. Applications of ReTain delay fruit maturity, coloring and softening.

Ethephon Use 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 tree canopies, may limit red color development to the point that applying 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 (4 oz/100 gal) applied 7-10 days prior to normal harvest. On McIntosh and later season varieties, use 150 to 300 ppm (8-16 oz/100 gal) applied 7-21 days before normal harvest. Tree response is influenced by temperature at, and immediately after, application. Cool weather delays response, and warm weather accelerates it. Responses are usually noticeable within 7 days. The timing and rate of application depend upon the apple variety and target market objectives.

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

Apogee Use to Control Shoot Growth and Fireblight Susceptibility on Apples

Apogee (prohexadione-calcium), a gibberellin biosynthesis inhibitor, reduces shoot growth on apple trees, which tends to reduce susceptibility to fireblight (see Fireblight Management section). Shoots treated with Apogee slow shoot extension and some shoots develop early bud set. Factors that increase the vigor of trees, such as heavy pruning, additional nitrogen fertilization, or low crop load, will require additional Apogee applications per acre as will factors such as questionable spray coverage or greater fireblight concerns.

Apogee has a local systemic effect. It needs to be applied with thorough coverage. Therefore, if tops of trees are sprayed, Apogee will only have an effect on the top. This allows growers to use Apogee in problematic areas of trees that need localized control. For example, if the bottoms of trees had frost damage, resulting in a low crop load, an application of Apogee to the bottoms of trees will control excessive growth. Tree vigor, variety (see Table 2), crop load, and application timing impact the efficacy of Apogee and thus the rate needed.

Apogee (27.5% W) should be applied when shoot growth is 1 to 3 inches long, usually at king bloom petal fall on most varieties. Split applications have been shown to provide longer shoot suppression during the summer. When fireblight is a concern, the first application of Apogee should be increased to help control vigor early and reduce fireblight potential. Table 1 lists suggested application rates for fully bearing apple trees at different tree row volume levels. If trees have a light crop load or have high vigor, use a higher rate of Apogee per acre.

The decreased shoot lengthening will become evident about 14 days after the first application. Apogee has been shown to increase fruit set in some years and on some varieties; thus, increased thinning agent rates may be needed to compensate for increased fruit set, as experience dictates.

Apogee requires the addition of non-ionic surfactant such as Regulaid, SS 700 or LI 700. Also, an equal weight of spray grade Ammonium Sulfate (AMS) should be applied with an equal weight of Apogee. Ammonium Sulfate substitutes can be used; follow manufacturer rate recommendations for surfactant and AMS substitutes.

Table 1.	Suggested Apogee rates and timing
(oz/acre)	

Tree Size	1st	2nd	3rd	4 th *Optional	Seasonal Total
Small <200 TRV	5	4	4	4*	17 oz
Medium <200 to 300 TRV	6	5	5	5*	21 oz
Large >300 TRV	7	6	6	6*	25 oz
Timing	King Bloom Petal Fall	2 weeks after King Bloom Petal Fall	3 weeks later	3 weeks later	

Table 2. Sensitivity of Apogee response by applevariety.

Sensitivity to		
Apogee	Variety	Recommendation
Very Sensitive	Cortland, Gala, Gingergold, Northern Spy, Paulared, Rome	Consider reducing rates of later sprays (spray 3 and 4)
Sensitive	Fuji, Golden Delicious, Jonamac, Spartan	
Less Sensitive	Empire, Golden Supreme, Jonagold, Jonathan, Idared, McIntosh	Consider using an additional 1 oz/acre
Special	Red Delicious, Spur Mac	Spur type, Use 4+3+2 for Medium-size trees

Water Sprout and Sucker Control on Apples and Pears

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

To control water sprouts in the vicinity of large pruning cuts, apply 1% NAA to bark in the immediate vicinity of the cut and 2-3 inches below the cut. To control regrowth of sprouts after removal, treat the area where existing sprouts were removed. To control root suckers, remove existing suckers during the dormant season and spray new suckers when 6-8 inches high with 1% NAA solution. To avoid the potential for excessive fruit 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 (naphaleneacetamide) thins Bartlett pears when applied at petal fall. The following rates are given as guides: (1) trees of low vigor, 25 ppm; (b) trees of medium vigor, 35 ppm; (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 of varieties other than Bartlett.

Peaches Chemical Thinning

No reliable chemicals are available for thinning peaches.

Cherries

Ethephon Use on Cherries

Ethephon may be used to promote the loosening of fruit from their stems to facilitate mechanical harvest of tart and sweet cherries, but proper application is important to avoid excessive activity and tree injury. Research and grower experience has shown that lower rates can be used than was first established, in part because of higher activity resulting from higher concentrations in low volume applications (the original research was conducted on a dilute spray basis). Lower rates reduce the likelihood for tree injury. Response varies not only with rate, but also variety, time of application, tree vigor, and the environmental conditions that occur during, and up to 3 days after, application. This creates a challenge to achieve the desired results without experiencing tree injury.

The following points should be considered when preparing to apply ethephon to cherries:

Time of Application: This important factor has two considerations. First, adequate and comparable loosening can be achieved by using either a lower rate if given adequate time for action (10 to 14 days) or a higher rate that will loosen fruit more rapidly over a short timeframe. Therefore, it is possible to substitute time for rate and obtain the same effect, with less potential for tree injury. Second, the chemical should not be applied too early in the season, as the fruit may fail to enlarge further and drop from the tree with the stems attached. Fruit should be in Stage III of growth (enlarging rapidly), with the grass-green color beginning to turn yellow or develop a tinge of red. Consequently, ethephon is generally applied about 7 to 14 days before anticipated harvest.

Temperature: During the 72-hour period following ethephon application, higher temperatures will increase the magnitude of response and lower temperatures will

decrease response. Thus, when temperatures are expected to exceed 85°F (30°C) or remain below 60°F (15°F) for up to 72 hours, applications should be avoided. Within this temperature range, when high temperatures are expected to be only in the 60's, higher than normal rates should be used and when highs are expected in the lower 80's, lower than normal rates should be used.

Tree Size, Vigor, and Stress: Suggested rates/acre are based on full-sized trees. Rates should be reduced when treating blocks having smaller trees. Trees low in vigor or under stress respond to a greater extent, often resulting in gumming and leaf abscission; consequently, such trees should not be treated with ethephon. Trees that exhibited serious gumming the previous year should not be treated.

Concentrate spraying: Applying ethephon with concentrate sprayers (i.e., 80 gal water/acre or less) achieves the same level of loosening at lower rates per acre as dilute applications. Uniform coverage is important.

Tank-mixing: There is little or no research data regarding tank-mixing ethephon. Do **not** tank mix with foliar nutrients or compounds such as fruit-cracking inhibitors, bird repellents, etc. While no problems have been reported by growers for tank-mixing ethephon with the fungicides and insecticides commonly used at this time, it is possible that these materials may act as a buffer to the ethephon, thereby altering activity. This can be overcome by acidifying the tank mixture prior to adding the ethephon.

Re-entry interval (REI) and Pre-harvest interval (PHI):

Ethephon has a 48-hour worker protection REI and a 7 day PHI (thus, do not harvest within 7 days of application).

Tart Cherry Applications

When applied in a concentrate spray (80 gal water/acre or less), use 8-16 oz/acre, applied 8 to 14 days prior to anticipated harvest. When applied dilute, apply no more than 5 oz/100 gal or 1 pt/acre.

Sweet Cherry Applications – Light Varieties

With light sweet cherries, do not apply until fruit on the interior of tree is developing yellow ground color. Ethephon applied prior to this stage of development may cause fruit to drop prematurely with stems attached. When applied in a concentrate spray, use 16-32 oz/acre, applied about 14 days before anticipated harvest. Vary the rates depending on temperatures, days before harvest, tree stress and past experience. Rates up to 2.5 pts/acre may be necessary for promoting harvest in less than 10 days. The full rate of 48 oz/acre will result in tree damage some years. When applied dilute, use no more than 12 oz/100 gallons or 3 pts/acre.

Sweet Cherry Applications – Dark Varieties

When applied in a concentrate spray, use 24-40 oz/acre, applied 12-14 days prior to anticipated harvest. Rates as low as 16 oz/acre have been used successfully by growers, but results have been less consistent. Rates up to 3 pts/acre may be necessary for promoting harvest in less than10 days. The full rate of 64 oz/acre is generally not necessary and will result in tree damage some years. When applied dilute, use no more than 16 oz/100 gallons or 4 pts/acre.

Gibberellic Acid Use on Cherries

Gibberellic acid (GA) may be used to reduce flowering and fruiting of young tart and sweet cherry trees to maximize vegetative growth. GA is used in mature tart cherries to increase fruiting capacity by stimulating the development of lateral shoots and spurs. Application of GA must be made the year prior to the desired result. Applications should be made when temperatures are expected to be above 70°F (21°C) for several days, if possible.

For non-bearing young tart and sweet cherry trees, do not treat the year of planting in the orchard. Apply during the second year to prevent flowering the third season and repeat the third year to prevent flowering the fourth year. Apply a single application of 100 ppm (40 oz/100 gal using 4% ProGibb) at three to four weeks after normal bloom time, when trees have about 5-7 leaves (3-5 fully-expanded leaves) on terminal growth. If tree vigor is low, two applications at 50 ppm (20 oz/100 gal) about 2.5 to 3 weeks apart are more effective than a single application at 100 ppm. Do not treat more than twice in one year.

Following these early year applications of high GA rates, it is very important to bring trees into bearing gradually and not discontinue GA all at once (which may result in oversetting of fruit and stunting of growth). In the fourth year, apply GA at 30-40 ppm if dilute (12-16 oz ProGibb/100 gal) or 20-24 oz/acre if applied as a concentrate spray. In the fifth year, decrease the GA rate to 15-20 ppm if dilute (6-8 oz/100 gal) or 10-12 oz/acre if applied as a concentrate spray. This will allow flowering in years five and six at reasonable levels and avoid the extremely heavy bloom and production that often occurs, and significantly reduces growth, in future years. GA use may then be discontinued or, for weak orchards, repeated annually at 10-15 ppm to promote a more moderate crop level.

In mature tart cherry trees, GA can help maintain and extend high fruiting capacity and reduce the occurrence of blind nodes by stimulating lateral shoots and spurs. Apply about three weeks after full bloom at rates of 10 to 20 ppm (6-12 oz/acre of 4% ProGibb), with lower rates used typically on more vigorous orchards or those with previous successful use of GA. For dilute application, use 4 oz/100 gal for a 10 ppm solution. For concentrate application to full sized tart cherries, use 6 oz/acre for a 10 ppm response. Surfactants and wetting agents are not suggested until more research is completed, as responses have varied from phytotoxicity to no effect.

Promalin Use on Cherries

Promalin can be applied to non-bearing cherry trees to improve lateral branching. Apply one part Promalin per 3 parts dark-colored latex paint by hand to previousseason terminal or scaffold growth where lateral branches are desired. Apply directly to dormant buds that have swollen and begin to show emergence of a green tip. Activity is generally best if temperatures at and following application reach 60°F and higher.

Herbicides 2004

Bernard Zandstra 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 total yield, a result of increased tree size, fruit set, and 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 that 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 that 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 a 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 lambsquarters, 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. Apply napropamide if common groundsel is a major 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.

Preemergence herbicides usually are applied in established orchards after some weeds have emerged in the spring. Include glyphosate or paraquat to kill emerged weeds. A combination of two residual herbicides with different modes of action gives the best weed control.

Herbicides for Fruit Crops

Clopyralid (Stinger) is a postemergence herbicide labeled for several fruit crops. It is very active against all members of the Asteraceae family (composite weeds), including Canada thistle, burdock, dandelion, common groundsel, marestail, mayweed, goldenrod, and ragweeds. It also controls legumes (alfalfa, clover, trefoil, vetch), nightshades, and plantains. It suppresses most members of the Polygonaceae family, including smartweeds, knotweeds, red sorrel, curled dock, wild buckwheat). It will suppress wild carrot. Avoid contact with new growth, which may cup or curl in response to clopyralid.

2.4-D amine (several products) 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 that are growing actively. At this rate of application, the chemical disappears from the soil in 2 to 3 weeks. Two applications are 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. If possible, apply after harvest and before frost. Do not apply during bloom.

Dichlobenil (Casoron) This chemical effectively controls quackgrass in established fruit plantings. 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 active ingredient (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.

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.

Fluazifop-P (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.

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 are less than 8 inches tall and 1.5 lb/acre when weeds are 8 inches or taller. Does not provide residual weed control but can be tank mixed with residual herbicides for broadspectrum control. Avoid contact with green on uncallused bark on young trees and vines. Do not apply within 14 days of harvest.

Glyphosate (Roundup or Touchdown) Glyphosate controls 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 is 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. Direct sprays toward the base of the tree. Glyphosate may be combined with other soilactive herbicides to provide season-long weed control. Apply in a maximum of 20 gal of water per acre. Apply only near trees established for 2 or more years.

Ammonium sulfate increases Roundup efficacy on a broad spectrum of weeds when spraying with hard water. Add 17 lb of ammonium sulfate per 100 gal of spray solution prior to adding the glyphosate.

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 2/3 to 1 1/3 lbs/acre depending upon weeds to be controlled. Combine with Surflan to control annual grasses.

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.

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.

Oryzalin (Surflan) can be used safely 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 is needed to activate the herbicide.

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 directed spray to the base of the trees. It can be applied in combination with paraquat, glyphosate and oryzalin. Include 2 pt/100 gal spray nonionic surfactant.

Paraquat (Gramoxone) 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 nonionic surfactant (NIS) at 1 to 2 pts/100 gal of water. Two or three applications are necessary to maintain weed control through out the season. 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.

Pendimethalin (Prowl) is labeled for use on non-bearing 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. Prowl 3.3 E controls seeds as they germinate but has no effect on established weeds. It can be used in the same manner as oryzalin but has been much less effective in MSU trials.

Pronamide (Kerb) Pronamide acts through the soil to kill quackgrass rhizomes and germinating annual weeds. It is most effective on grasses and controls few broadleaves. 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.

Sethoxydim (Poast) is applied postemergence to actively growing grasses. Rate varies with grass species and stage of growth. It does not control broadleaves. Add crop oil concentrate (COC) or nonionic surfactant (NIS) to the spray solution.

Simazine (Princep) Simazine is effective primarily 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 application exceeds 2 lbs/acre. Simazine does not build up in the soil from annual application of the above rates.

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

Terbacil (Sinbar) This chemical is registered for use only on peaches, pears and apples that 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 venal 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.

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, provides for a wider spectrum of weed control. Where simazine-resistant lambsquarters, pigweed, or foxtails are present, the addition of terbacil or diuron improves 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) knocks down the cover crop effectively.

Herbicides for Strawberries

Clopyralid (Stinger) is a postemergence herbicide labeled for strawberry. It is very active against all members of the Asteraceae family (composite weeds), including Canada thistle, burdock, dandelion, common groundsel, marestail, mayweed, goldenrod, and ragweeds. It also controls legumes (alfalfa, clover, trefoil, vetch), nightshades, and plantains. It suppresses most members of the Polygonaceae family, including smartweeds, knotweeds, red sorrel, curled dock, wild buckwheat). It will suppress wild carrot. Avoid contact with new growth, which may cup or curl in response to clopyralid. Apply clopyralid to established strawberry in spring or fall and to newly planted plants after they are well established.

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

Napropamide (Devrinol) Napropamide is effective on annual grasses and some broadleaf weeds when applied preemergence in strawberries at 2 to 4 lb active ingredient per acre. It is sensitive to light and should be either incorporated 2 inches into the soil before planting, or irrigated in on new or established plantings. It may be applied in spring or fall or at other times of the year after cultivation. It has the potential for inhibition of runner rooting on light sandy soils. Do not apply from bloom through harvest. Fall application will not control weeds the next spring.

Paraquat (Gramoxone) Use paraquat for rapid knockdown of annual and perennial weeds between strawberry rows. Use a shielded sprayer to prevent spray from contacting strawberry plants. Apply when weeds are less than 8 inches tall.

Sethoxydim (Poast) is applied postemergence for grass control when grasses are actively growing. Several applications are needed for quackgrass control. Include COC or NIS in spray solution. Do not apply within 7 days of harvest.

Terbacil (Sinbar) Terbacil is used for pre- and postemergence weed control in strawberries. The safety margin on strawberries is narrow. Apply 2 to 6 oz. of product per acre per application. Do not apply more than 8 oz. of Sinbar 80WP per acre per growing season. Avoid application during periods of active growth. The safest times to apply are after mowing the plants at renovation time or late fall after growth stops and before mulching.

Weed Sprayers

Many types of sprayers are suitable for chemical weed control. 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. It should be able to maintain 50 psi at the nozzles.

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

3. 50-mesh screens for suction line and nozzles. Wettable powders will not go through the 100-mesh screens that 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 per square inch.

6. Flat fan nozzles. The best nozzle size for general use is equivalent to an 8004 Teejet. For most work, a moderate-angle nozzle 80 - 95 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.

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 30 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 80degree 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 Crops^{1,2}

Table 1

Common Name	Trade Name and Manufacturer	Concentration and Commercial Formulations ³
clethodim	SELECT (Valent)	2E
clopyralid	STINGER (DowAgro)	3L
dichlobenil	CASORON (Crompton)	4G
diuron	KARMEX (Griffin)	80 DF
fluazifop-butyl	FUSILADE DX (Syngenta)	2 lb/gal L
glufosinate	RELY (Bayer)	1 lb/gal L
glyphosate	ROUNDUP ULTRA (Monsanto), Touchdown (Syngenta)	4 lb/gal L
hexazinone	VELPAR (DuPont)	2 lb/gal L; 90 SP
isoxaben	GALLERY (DowAgro)	75 DF
napropamide	DEVRINOL (United Phosphorus)	50 DF
norflurazon	SOLICAM (Syngenta)	80 DF
oryzalin	SURFLAN (United Phosphorus)	4 lb/gal L
oxyfluorfen	GOAL (DowAgro)	2 lb/gal Ł
paraquat	GRAMOXONE MAX (Syngenta)	3 lb/gal L
pendimethalin	PROWL (BASF)	3.3 lb/gal L
pronamide	KERB (DowAgro)	50 WP
sethoxydim	POAST (BASF)	1.5 lb/gal L
simazine	PRINCEP (Syngenta)	80 WP; 90 WG, 4L
terbacil	SINBAR (DuPont)	80 WP
2,4-D	FORMULA 40 (Riverdale)	3.7 lb/gal L
	WEEDAR 64 (NuFarm)	3.8 lb/gal L

¹ Trade names and formulations are 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.

²See table in back of bulletin for reentry interval and other information concerning herbicides.

³EC = emulsifiable concentrate; DF = dry flowable; G = granular; L = liquid; SP = soluble powder; WG = wettable granule; WP = wettable powder.

Herbicide Registration for Bearing (B) and Nonbearing (N) Fruit Crops

Table 2

Common Name	Trade Name	Time of Application	Apple	Cherry	Peach	Pear	Plum	Grape	Blue- berry	Bram bles	Straw berry	Cran- berry
clethodim	Select	Post	N	N	N	N	N	N	N	N	B	B
clopyralid	Stinger	Post		B,N	B,N		B,N				B,N	
2,4-D	several	Post	В	В	В	В	B				B	В
dichlobenil	Casoron, Evital	Pre	B, N	B, N		B, N		B, N	B, N	В		В
diuron	Karmex	Pre	B		В	B		В	В	В		
fluazifop-P	Fusilade	Post	N	B, N	B, N	N	B, N	N	N	N	N	
glufosinate	Rely	Post	В					В				
glyphosate	Roundup Touchdown	Post	B, N	B, N	B, N	B, N	B, N	B, N	B, N	B, N		B, N
hexazinone	Velpar	Pre							В			
isoxaben	Gallery	Pre	N	N	N	N	N	N	N	N		
napropamide	Devrinol	Pre	B, N	B, N	B, N	B, N	B, N	B, N	B, N	B, N	B, N	B, N
norflurazon	Solicam	Pre	B, N	В	В	B	В	В	В	В		В
oryzalin	Surflan	Pre	B, N	B, N	B, N	B, N	B, N	B, N	B, N	B, N		
oxyfluorfen	Goal	Pre	В	В	В	В	В	В				
paraquat	Gramoxone	Post	B, N	B, N	B,N	B, N	B,N	В	В	В	В	
pendimethalin	Prowl	Pre	N	N	N	N	N	N				
pronamide	Kerb	Post	B, N	В	В	B, N	В	В	В			
sethoxydim	Poast	Post	B, N	N, N	B, N	N, B	N	В	B, N	B, N	B, N	B, N
simazine	Princep	Pre	В	В	В	В	В	В	В	В		В
terbacil	Sinbar	Pre	В		В				В	В	B,N	

Fruit Plantings
Tree
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Major
Herbicide Effectiveness on

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				Anr	na	br	oac	Annual broadleaf	÷			An	Annual		grasses	ses				2			-	Perennial	nne		weeds	sds						
Herbicide	Application*	Chickweed, Common	Common Lambsquarter	Horseweed (Marestail)	Mustard	Pigweed	Ваджееd	Shepardspurse	Velvet Leaf	Yellow Rocket	Barnyard Grass	Brome Grass	Crabgrass	Fall Panicum	Foxtail	Sandbur	Witchgrass	Bindweed	Canada Thistle	Chickweed, mouseeared	Dandelion	Goldenrod	Grape, Wild	Ground Ivy	wollsM	Milkweed	ebertstrigin	Autsedge	Plantain	Poison Ivy	Quackgrass	Sowthistle	Vetches	Virginia creeper
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Solicam	Pre/Post	U	ш	ш	ш	ш ш	ш	U U	LL (D)	U	U	Ľ.	U	U	ш	ш	U	٩	٩	G	٩	z	z	_ ∠	z	۵.	G	ш	ш	z	ш	ш	٩	z
Fusilade	Post	z	z	z	z	z	z	z z	z	z	ш	ш	U	U	ш	υ	ш	z	z	z	z	z	z	z	z	z	z	z	z	z	U	z	z	z
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2,4-D	Post	٩	ш	٩	U U	U U	U U	ს ს ს	0	U U	z	z	z	z	z	z	z	U	G	٩	ш	۵.	LL LL	<u>с</u>		₽.	ш	٩	ш	ш	z	ш	ш	٩
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*Pre= preemergence; Post=postemergence; ** Repeated applications may provide control of perennial weeds E=Excellent, G=Good, F=Fair, P=Poor, N=No Control

Weed Control Recommendations for Tree Fruit, Grape, and Small Fruit

Bernard Zandstra Department of Horticulture

Herbicide rates given are for amount of commercial product per acre of land actually sprayed. COC=crop oil concentrate NIS=nonionic surfactant

TREE FRUIT

APPLE, PEAR (Year of planting)

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence	oryzalin	2 - 4 qt	Apply to weed-free soil after planting. Delay application until
annuals	(Surflan 4 AS)		ground has settled. Use lower rate on light soil.
	pendimethalin	2.4 - 4.8 qt	Apply after soil has settled in new plantings. Avoid contact with
	(Prowl 3.3 E)	- .	leaves or buds. Use high rate for longer control.
	napropamide	8 lb	Apply to weed-free ground after planting. May be used around
	(Devrinol 50 DF)	-	newly planted trees. Incorporate or water in after application.
	pronamide	2 - 4 lb	Apply in November after harvest before soil freezes. Do not
	(Kerb 50 W)		apply to trees transplanted less than 6 months.
	norflurazon	2.5 - 5 lb	Apples only. Apply in fall or early spring to weed-free soil after
	(Solicam 80 DF)	-	soil settles. Use low rate on sandy soils. 60 day PHI.
	isoxaben	0.7 - 1.3 lb	Nonbearing only. Apply in fall or spring before weeds emerge.
-	(Gallery 75 DF)		
Postemergence	paraquat	1.7 - 2.7 pt	Apply before or after planting trees and again during season as
emerged weeds	(Gramoxone Max 3L)		needed to kill emerged weeds. Do not allow spray to touch
			foliage or green stems of trees.
	glyphosate	1 - 4 qt	Apply to actively growing weeds. See label for rate and
	(Roundup Ultra 4L)		optimum weed size. Use adjuvants as required by label.
	(Touchdown 4L)		
Postemergence	fluazifop-P	1 - 1.5 pt	Apply to actively growing grass 4 to 8 inches tall. Add non-ionic
grasses	(Fusilade DX 2E)	-	surfactant (NIS) or crop oil concentrate (COC).
	sethoxydim	1.5 - 2.5 pt	Apply to actively growing grass. Maximum of 7.5 pt/a/yr. Add
	(Poast 1.5E)		NIS or COC. 14 day PHI.

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APPLE, PEAR (Established One Year or More)

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence annuals	simazine (Princep 90 WG)	2.2 - 4.4 lb	Apply in fall after frost or in spring before weeds emerge. Controls many annual broadleaves and grasses.
	diuron (Karmex 80 DF)	2.5 - 3.8 lb	Apply in spring before weeds emerge. Controls many broadleaves and grasses.
	norflurazon (Solicam 80 DF)	2.5 - 5 lb	Apply in late fall or in spring before weeds emerge. Use lower rates on sandy soils.
	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply in early spring to weed-free soil. Use lower rate on lighter soil. Controls annual grasses.
	oxyfluorfen (Goal XL 2E)	3 - 4 qt	Apply to soil when trees are dormant in the spring. Do not apply after bud swell.
	pronamide (Kerb 50 W)	2 - 4 lb	Apply in November before soil freezes. Suppresses quackgrass.
	terbacil (Sinbar 80 W)	0.6 - 1.2 lb	Apples three years or older only. Apply in late April. Do not use on light, sandy soils.
Postemergence grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Non-bearing only . Apply to actively growing grasses. Add NIS or COC. 14 day PHI.
	sethoxydim (Poast 1.5 E)	2 - 4 pt	Apply to actively growing grasses. Include NIS or COC. 14 day PHI.
Postemergence annual and perennial weeds	paraquat (Gramoxone Max 3L)	1.7 - 2.5 pt	Kills annuals on contact. Apply to small weeds.
	glyphosate (Roundup Ultra 4 L) _(Touchdown 4L)	2 - 4 qt	Kills annual and perennial weeds. Do not allow the spray to contact leaves or green shoots of trees. 1 day PHI.
	2,4-D (Weedar 64 3.8 L)	1 qt	Apply when weeds are growing rapidly. Controls most broadleaves. Spray at low pressure to avoid drift to trees. Do not apply when trees are in bloom. 40 day PHI.
	glufosinate (Rely 1 L)	1 - 1.5 gal	Apples only . Apply to actively growing weeds. Avoid contact with apple foliage. 14 day PHI.

APRICOT, CHERRY (TART, SWEET), PEACH, PLUM (Year of planting)

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence annual weeds	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply in early spring before weeds germinate. Apply to weed-free soil after planting. Use lower rate on light soil. Controls most annual grasses.
	pendimethalin (Prowl 3.3 E)	2.4 - 4.8 qt	Apply after soil has settled in new plantings. Avoid contact with leaves or buds. Use high rate for longer control.
	napropamide (Devrinol 50 DF)	8 lb	Apply to weed-free soil after planting. Safe for use on new plantings. Short residual life.
	isoxaben (Gallery 75 WG)	0.7 - 1.4 lb	Non-bearing only . Apply in fall or spring before weeds emerge. Controls many annual weeds.
Postemergence annuals and perennials	glyphosate (Roundup Ultra 4 L) (Touchdown 4L)	2 - 4 qt	Apply to emerged weeds. Use only wiper applicator in peach and plum orchards. Do not allow the spray to contact leaves or green shoots of trees. Peaches are very sensitive to glyphosate. 17 day PHI.
5	paraquat (Gramoxone Max 3L)	1.7 - 2.7 pt	Apply when weeds are small. Kills annuals. Maximum 3 applications/year. Do not allow herbicide to contact green stems or leaves of cherries. 28 day PHI.
Postemergence grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Apply to actively growing grasses. Add NIS or COC. 14 day PHI.
	sethoxydim (Poast1.5 E)	2 - 4 pt	Apricot, cherry, peach, nonbearing plum. Apply to actively growing grasses. Include NIS or COC. 25 day PHI.
APRICOT,	CHERRY, etc	. (Establ	lished One Year or More)
Preemergence	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply in early spring before weeds emerge. Use low rate on light soil. Controls annual grasses.
	simazine (Princep 90 WG)	2.2 - 4.4 lb	Apply in late fall or early spring. Do not use on light sandy soil. Use lowest rate of simazine on peach and plum.
	norflurazon (Solicam 80 DF)	2.5 - 5 lb	Apply in late fall or spring before weeds emerge. Do not use for cherry on sandy soils. Wait 18 months after planting for use on cherry. 60 day PHI.
	oxyfluorfen (Goal XL 2 E)	3 - 4 qt	Apply in spring to dormant trees. Do not apply after bud swell. Controls many annual weeds.
	dichlobenil (Casoron 4 G)	150 lb	Apply in November before soil freezes. Controls many annual and perennial broadleaves and nutsedge.
	pronamide (Kerb 50 W)	2 - 4 lb	Quackgrass suppression. Apply in fall before soil freezes.
	terbacil (Sinbar 80 W)	2 - 3 lb	FOR USE IN PEACHES ONLY, ESTABLISHED 3 YEARS OR MORE. Apply in April or early May. Use lowest rate on sandy soils. May be tank mixed with Karmex at ½ rate of each. 60 day PHI.
	diuron (Karmex 80 DF)	2 - 4 lb	FOR USE IN PEACHES ONLY, ESTABLISHED 3 YEARS OR MORE. Apply in spring before weeds emerge. May be tank mixed with Sinbar at ½ rate of each. 90 day PHI.

APRICOT, CHERRY PEACH, PLUM (CONTINUED)

		Product	
Weed Problem	Chemical	per acre	Remarks
Postemergence	paraquat	1.7 - 2.7 pt	Kills annuals on contact. Do not allow herbicide to contact
	(Gramoxone Max 3L)		green stems or leaves. 28 day PHI.
	glyphosate	2 - 4 qt	Kills annuals and perennials. Do not allow spray to contact
	(Roundup Ultra 4L)		green leaves or stems of trees. Use only wiper applicator in
	(Touchdown 4L)		peaches and plums. 17 day PHI.
	2,4-D	1 - 1.5 qt	Apply when weeds are small. Do not apply during bloom.
	(Weedar 64 3.8 L)		Controls most broadleaves. Trees must be at least 1 yr. old.
			Avoid contact with green stems or leaves of trees. 40 day PHI.
	clopyralid	.3367 pt	Controls composite weeds, clover, nightshade, plantain,
	(Stinger 3L)		smartweeds. Do not exceed 0.67 pt/a/yr. 30 day PHI.
Postemergence	fluazifop-P	1 - 2 pt	Apply to actively growing grasses. Add NIS or COC. 14 day
grasses	(Fusilade DX 2 E)		PHI.
	sethoxydim	2 - 4 pt	Apricot, cherry, peach, nonbearing plum. Apply to actively
	(Poast 1.5 E)	-	growing grasses. Include NIS or COC. 25 day PHI.

SMALL FRUIT

BLUEBERRY, BRAMBLES (Year of Planting)

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply to weed-free soil after planting. Use lower rate on lighter soil. Must be watered in to be effective.
	isoxaben (Gallery 75 DF)	0.7 - 1.3 lb	Non-bearing only. Apply in fall or spring before weeds emerge. Apply after soil has settled after transplanting. Wait 60 days between applications. Max 4 lb product/a/yr.
	napropamide (Devrinol 50 DF)	8 lb	Apply to weed free soil in the spring. Controls seedling grasses. 4-5 weeks residual life.
Postemergence grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Non-bearing only . Apply to actively growing grasses 4 to 8 inches tall. Add NIS or COC.
	sethoxydim (Poast 1.5 E)	1 - 2 pt	Apply to actively growing grasses. Include NIS or COC.
Postemergence annual and perennial weeds	glyphosate (Roundup Ultra 4 L) (Touchdown 4L)	1 - 2 qt	Apply to actively growing weeds. See label for best rate and timing. Avoid contact with green stems or leaves of blueberry and brambles. 14 day PHI.

BLUEBERRY, BRAMBLES (Established One Year or More)

Preemergence annual weeds	diuron (Karmex 80 DF)	2 - 4 lb	Apply In spring before weeds emerge. Use low rate on young plantings. Less effective on organic soils. Max. 3 lb product per acre on raspberries. 60 day PHI.
	simazine (Princep 90 WG)	2.2 - 4.4 lb	Apply in late fall or spring before growth starts. Use low rate on young plantings. Do not apply when fruit is present.
	napropamide (Devrinol 50 DF)	8 lb	Apply before weeds emerge in spring. Short residual life. Controls seedling grasses.
	dichlobenil (Casoron 4 G)	100 - 150 lb	Apply in November. Do not exceed 100 lb/acre on brambles. Suppresses broadleaves and nutsedge.
	pronamide (Kerb 50 W)	2 - 4 lb	Blueberry only . Apply in November or in early spring before weeds emerge. Not effective on high-organic soils. Suppresses quackgrass.
	terbacil (Sinbar 80 W)	1 - 2 lb	Apply in late fall or early spring. Use only in plantings that have been established at least one year. Apply the low rate on sands and sandy loams and the higher rate on clay loams.
	norflurazon (Solicam 80 DF)	2.5 - 5 lb	Apply in late fall or early spring before weeds emerge. Suppresses many annual weeds and nutsedge. 60 day PHI.
	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply in spring before weeds emerge. Not effective on soils with >5% organic matter. Controls primarily grasses. Max. 12 qt/a/yr. Do not apply to lowbush blueberry.
Postemergence annual and perennial weeds	glyphosate (Roundup Ultra 4 L) (Touchdown 4L)	1 - 2 qt	Apply to actively growing weeds. See label for best rate and timing. Avoid contact with green stems or leaves of blueberry and brambles. 14 day PHI.
Postemergence annual weeds	paraquat (Gramoxone Max 3L)	1.7 - 2.7 pt	Apply as a directed spray to emerged weeds. Avoid contact with new canes or shoots of brambles or blueberries.
Postemergence grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Non-bearing only . Apply to actively growing grasses 4 to 8 inches tall. Add NIS or COC.
	sethoxydim (Poast 1.5 E)	1 - 2 pt	Apply to actively growing grasses. Include NIS or COC. PHI: Blueberry – 30 days. Raspberry - 45 days.
Woody perennials	hexazinone (Velpar 2L)	2 - 4 qt	Blueberry established 3 years or more only. Apply in early spring before bud break. Do not apply on light sandy soils or in successive years. Can injure blueberry. 90 day PHI.

CRANBERRIES

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence	simazine (Princep Caliber 90)	2.2 lb	Apply before growth begins in spring.
	norflurazon (Evital 5G)	80 - 160 lb	Make one application per year. Apply in early spring before weeds emerge, or late fall 2 weeks before winter flood. Use low rate on open, young, sandy bogs, or where sprinkler irrigation is used.
	napropamide (Devrinol 50 DF or 10G)	3 - 15 lb 30 - 150 lb	Apply in late fall or early spring before weeds emerge.
Postemergence	Riverdale 2,4-D granules	10 - 20 lb	Apply in spring after removal of winter flood. Do not use on light sandy soil.
	clethodim (Select 2E)	8 fl oz	Apply to actively growing grasses. Include COC. Do not exceed 32 fl oz/a/yr. 30 day PHI.
	sethoxydim (Poast 1.5 L)	1.5 - 2.5 pt	Apply to actively growing grasses. Add NIS or COC. 60 day PHI.

GRAPES (Year of Planting)

		Product	
Weed Problem	Chemical	per acre	Remarks
Preemergence	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply after soil has settled after planting. Apply to established plantings in spring before weeds emerge. Use the lower rate on sandy soils. Must be watered in for optimum weed control. Suppresses annual grasses.
	pendimethalin (Prowl 3.3 E)	2.4 - 4.8 qt	Nonbearing grapes only. Apply after planting after soil settles. Apply to established plantings before buds swell. Do not apply over plants. Controls annual grasses.
	napropamide (Devrinol 50 DF)	8 lb	Apply to weed-free soil. Apply in early spring. Short residual life. Controls annual grasses and some broadleaves.
Postemergence annual and perennial weeds	glyphosate (Roundup Ultra 4 L) (Touchdown 4L)	1 - 3 qt	See label for appropriate rate and weed size. Do not allow the spray to contact leaves or green shoots. Avoid applications after bloom stage.
	paraquat (Gramoxone Max 3L)	1.7 - 2.7 pt	Apply when sucker growth is less than 8 inch long. Avoid contact with grape leaves or green foliage. Kills emerged annual weeds.
Postemergence Grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Nonbearing grapes only. Apply to actively growing grass 4 to 8 inches tall. Add NIS or COC.
	sethoxydim (Poast 1.5 L)	1.5 - 3 pt	Apply to actively growing grasses. Add NIS or COC. 50 day PHI.

GRAPES	Established on	e year or	more)					
Preemergence	oryzalin (Surflan 4 AS)	2 - 4 qt	Apply after soil has settled after planting. Apply to established plantings in spring before weeds emerge. Use the lower rate on sandy soils. Must be watered in for optimum weed control. Suppresses annual grasses.					
	diuron (Karmex 80 DF)	2 - 5 lb	Grapes established 3 or more years. Apply In spring before weed growth starts. Use lower rate on sandy soils.					
	simazine (Princep 90 WG)	2.2 - 5 lb	Grapes established 3 or more years. Apply In spring before weed growth begins. Use low rates on sandy soils.					
	norflurazon (Solicam 80 DF)	1.5 - 4 lb	Grapes established 2 or more years. Apply in fall or early spring before weeds emerge. Use lower rate on sandy soil. Suppresses annual grasses and nutsedge.					
	dichlobenil (Casoron 4 G)	150 lb	Apply in November before soil freezes. Suppresses annual ar perennial weeds.					
	pronamide (Kerb 50 W)	2 - 4 lb	Grapes established 1 or more years. Apply in November before soil freezes or early spring. Suppresses quackgrass.					
	oxyfluorfen (Goal XL 2 E)	3 - 4 qt	Grapes established 3 or more years and trellised. Apply to soil when grapes are dormant. Avoid plant contact.					
Postemergence annual and perennial weeds	glyphosate (Roundup Ultra 4 L) (Touchdown 4L)	1 - 3 qt	See label for appropriate rate and weed size. Do not allow the spray to contact leaves or green shoots. Avoid applications after bloom stage.					
	glufosinate (Rely 1 L)	3 - 6 qt	Grapes established 1 year or more. Apply to actively growing weeds directed to avoid contact with grapes. Use high rate on large weeds. 14 day PHI.					
	paraquat (Gramoxone Max 3L)	1.7 - 2.7 pt	Apply when sucker growth is less than 8 inches long. Avoid contact with grape leaves or green foliage. Kills emerged annual weeds.					
Postemergence grasses	fluazifop-P (Fusilade DX 2 E)	1 - 2 pt	Nonbearing grapes only. Apply to actively growing grass 4 to 8 inches tall. Add NIS or COC.					
	sethoxydim (Poast 1.5 L)	1.5 - 3 pt	Apply to actively growing grasses. Add NIS or COC. 50 day PHI.					

Weed Control

STRAWBERRY (New Plantings) Product Weed Problem Chemical per acre Remarks Preemergence terbacil 2 - 3 oz Apply 2-3 oz after transplanting but before new runners start (Sinbar 80W) grasses and to root. If plants develop new leaves before application, broadleaves follow immediately with .5-1 inch irrigation or rain to wash Sinbar off of leaves. napropamide 4 - 8 lb Apply before weeds emerge in the spring or in fall following (Devrinol 50 DF) cultivation. May inhibit runner rooting on sandy soils. Must be irrigated or incorporated into the soil 2 inches prior to transplanting new plants. Postemergence clopyralid .33 - .67 pt Apply after July 1 the year of planting. Controls composites, clover, nightshade, plantain, smartweeds. broadleaves (Stinger 3L) 1 - 2 pt Apply to actively growing grasses. Add NIS or COC. 7 day Postemergence sethoxydim grasses (Poast 1.5 L) PHI. clethodim 8 fl oz Apply to actively growing grasses. Add 1% COC to spray (Select 2E) mix. Max. 32 fl oz/a/yr in 4 applications. 4 day PHI.

STRAWBERRY (Established Plantings)

Preemergence grasses and broadleaves	napropamide (Devrinol 50 DF)	4 - 8 lb	Apply before weeds emerge in the spring or in fall following cultivation. May inhibit runner rooting on sandy soils. Must be irrigated or incorporated into the soil 2 inches prior to transplanting new plants.					
Postemergence broadleaves	2,4-D amine (Amine, Formula 40 3.7 L)	1 qt	Apply after harvest at renovation time. Do not apply after August 1 or misshapen fruit may be produced the next season. Controls most broadleaves.					
	terbacil (Sinbar 80 W)	4 - 8 oz	Apply at renovation (after mowing) before new growth begins or in late fall before mulching. Use low rate on sandy soils. Some varieties are sensitive to Sinbar. Do not exceed 8 oz Sinbar per year. 110 day PHI.					
	paraquat (Gramoxone Max 3L)	1.5 pt	Apply to emerged weeds as a directed, shielded spray between rows to prevent contact with strawberry plants. Maximum of 3 applications per season. 21 day PHI.					
	clopyralid .3367 pt (Stinger 3L)		Apply in spring or fall for control of composite weeds, clover, nightshade, plantain, smartweeds. Do not exceed 0.67 pt/a/yr. 30 day PHI.					
Postemergence grasses	sethoxydim (Poast 1.5 L)	1 - 2 pt	Apply to actively growing grasses. Add NIS or COC. 7 day PHI.					
-	clethodim (Select 2E)	8 fl oz	Apply to actively growing grasses. Add 1% COC to spray mix. Max. 32 fl oz/a/yr in 4 applications. 4 day PHI.					

Apple Storage and Disorder Control

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

Fruit treated post-harvest must be labeled properly 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 (Suite 600, Larson Building, Yakima, Washington 98901) offers this information on its website (www.hwhort.org).

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 effective against scald are available for use on apple fruit. Treat susceptible varieties of McIntosh, Cortland, Delicious, Fuji, 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

Storage of fruit in atmospheres having 1.5% oxygen or less reduces the incidence and severity of superficial scald, but may not offer complete control. Improved control has been obtained by initial low oxygen stress at 0.5% O₂ for 2 weeks before CA storage at 1.5% O₂. For chemical 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. Inclusion of a fungicide in the drench water may be necessitated to reduce the incidence of decay.

SUGGESTED CHEMICAL

Diphenylamine (DPA), from Decco and Pace International, 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 many export markets.

Drench solutions should contain a fungicide such as thiabendazole.

Senescence and Internal Breakdown

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

Control

Storage of the fruit in controlled atmospheres as indicated in Table 1 will largely control internal breakdown associated with fruit senescence for several months depending on the susceptibility of the cultivar.

SUGGESTED CHEMICALS

1-Methylcyclopropene (1-MCP, SmartFresh), from AgroFresh, is a vapor under physiological conditions and acts by inhibiting the binding of the hormone

ethylene to its binding site. A single exposure can temporarily render plant material insensitive to ethylene when applied at 1 part-per-million. A single 24-hour exposure to 1 ppm 1-MCP will retard apple ripening and senescence during cold storage for 3 to 6 months if applied before the fruit has begun to ripen significantly. 1-MCP is released from the SmartFresh powdered formulation by adding water. An application unit incorporating an aeration device for the water/SmartFresh solution is used to facilitate and control the release of the 1-MCP from solution. 1-MCP can, in some instances, significantly reduce the incidence of superficial scald.

Calcium Dip or drench the harvested apples in a 2.5% solution of calcium chloride $(CaCl_2)$ 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 russeting, or mite injury in the calyx cavity may be damaged by calcium chloride. Include fungicide in the treatment solution to minimize the occurrence of fruit rots.

Bitter Pit

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 as for internal breakdown. It should be noted, however, that better control of bitter pit is achieved through the use of several preharvest calcium sprays applied throughout the growing season.

Recommended Storage Conditions for Michigan Apples

COLD STORAGE

Cultivar	Temperature (°F)
Jonathan Honeycrisp	36 36 to 38 (Holding 7 to 10 days at >50 °F improves control of soft scald)
All Other Varieties	32

CONTROLLED ATMOSPHERE STORAGE

		Stand	lard CA ^z	Low O ₂	1-MCP	
Cultivar Temp (°F)		%O ₂	%CO2	%O2	%CO ₂	Sensitivity*
Honeycrisp		not curre	ntly advised	not cur	rently advis	ed -
McIntosh						
Most strains	38	2 - 2.5	2.5 1 st mo., then 5	1.5	<3.0	+/-
Marshall Mac	38	3 - 3.5	2.5 1 st mo., then 5	not adv	rised	
Empire ^{wx}	38	1.8 - 2.0	<1	1.5	<1.0	+
Jonathan ^x	32	1.8 - 2.0	3 - 5.0	1.5	<3.0	++
Jonagold	32	1.8 - 2.0	3	1.5	<3.0	++
Gala	32	1.8 - 2.0	3	1.5	<3.0	+
Gingergold	32	1.8 - 2.0	3	1.5	<3.0	++
Cameo [×]	32	1.8 - 2.0	3	1.5	<3.0	+
Red Delicious ^x	32	1.8 - 2.0	3	1.5	<3.0	+
G. Delicious ^x	32	1.8 - 2.0	3	1.5	<3.0	+
Idared ^x	32	1.8 - 2.0	3	1.5	<3.0	+
Rome ^x	32	1.8 - 2.0	3	1.5	<3.0	+/-
Law Rome ^x	32	1.8 - 2.0	3	1.5	<3.0	+/-
N. Spy ^x	32	1.8 - 2.0	3	1.5	<3.0	+
Mutsu ^x	32	1.8 - 2.0	3	1.5	<3.0	+
Fuji ^x	32	1.8 - 2.0	1	1.5	<1.0	+

²For CA storage operations with facilities available, operators should consider CA storage at 2.5% O_2 with up to 3% CO_2 for late harvested apples to extend market quality through December

^yFruits for low oxygen CA should be preclimacteric in ethylene (less than 0.1 ppm). The low oxygen atmosphere should be established within 7 days of beginning to load the room. Accurate and dependable O_2 analyzers must be employed and calibrated with gas standards for CA storage below 2% O_2 .

^xThese varieties have given excellent quality retention for mid-term CA when stored at 1.5% O₂ with up to 3% CO₂ at 38 °F and for long-term CA at 32 °F except Empire, which should be kept at 38 °F.

^wEmpire are prone to low temperature CA injury when stored at 32 °F and they are prone to external and internal CO_2 injury when stored in CA at 32 °F and with CO_2 above 1%.

*Sensitivity to 1-MCP is judged the extent of response and the reliability of response. The indicators ++, +, +/-, - refer to high sensitivity, moderate sensitivity, low or variable sensitivity, and no appreciable benefit, respectively.

NOTE: The CA room can be safely sealed and O_2 pull-down begun when fruit temperature is below 50 °F. Every attempt should be made to have the CA room atmosphere below 5% O_2 within 7 to 10 days after starting to load the room in order to achieve maximum advantage for CA technology.

Nematode Management

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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 nematicide recommendations for nematode management. All other aspects of nematode control in fruit production are covered in MSU Extension Bulletin E2419, "Avoidance and Management of Nematode Problems in Tree Fruit Production in Michigan".

APPLE, CHERRY AND PEACH ORCHARDS

PREPLANT APP	PLICATION	
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.
1,3-D and Chloropicrin (Telone C-35)	Broadcast: 39-50 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.
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 48 inches immediately after application. READ LABEL WARNINGS CAREFULLY.

POST-PLANT	POST-PLANT TREATMENT									
Nematicide	Application rate/acre	Directions and/or Limitations								
Fenamiphos (Nemacur 3)	Band: 1.67-2.5 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 2.5 gallons per acre per site per year. Do not feed cover crops grown in treated orchards to livestock. Avoid contacting tree foliage with the spray mixture.								
Oxamyl (Vydate L)	Foliar Spray: 2-4 pt	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 non-bearing orchards only.								

VINEYARDS AND SMALL FRUIT PLANTINGS

PREPLANT APPL	LICATION	
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.
1,3-D and Chloropicrin (Telone C-35)	Broadcast: 39-50 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)	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-PLAN	TTREATMENT	
Nematicide	Application rate/acre	Directions and/or Limitations
Fenamiphos (Nemacur 3)	Grapes —Band:1-2 gal Brambles —Band: 1-2 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. On bearing grapes, the last application may be made up to 2 days of harvest. On raspberry, do not apply within 180 days of harvest. Do not apply more than once per year. Do not use site for feed or grazing.

Compatibility Chart (Primarily for apples;	may be incomplete for other crops.)		Q Questionable, compatibility not clear W Wettable or soluble powder only	Not compatible	Streptomycin is most favorably applied as a separate annitration atthough it is compatible with Earbam or	Captan when necessary for scab control. Urea formulated	for foliar application is compatible with the commonly used	or Bordeaux.		Compatibilities of some materials may depend upon solvents and emulsifiers used by the manufacturer.	Emulsifiable concentrate formulations are more likely to	cause compatibility problems than wettable powders. If	centrates, incompatibilities may result.		Do not allow spray mixtures to sit overnight.		lian		1 Sulfur (elemental)	Surround WP	Thiodan	1 Vendex	1 Vydate	1 1 Ziram
1 1 Topsin M Q 1 Bordeaux	1 1 1 1 Bravo	1 1 1 1 Carzol	1 1 1 2 Copper (fixed)	1 1 4	W 1 1 2 1 1 1 1 2 1 1 Dinocap (Karathane)	W 1 1 1 Q 1 1 1 Dodine (Syllit)	1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	1 1 1 1 2 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1	1 1 1 1 2 1 1 1 2 2 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1	■ 1 ■ 1 1 ■ 1 1 2 1 2 1 0 ■ 2 ■ 2 ■ 0 Lime	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 WQ 1 1 1 1 W 1 W 1 W 1 1 0	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 2 1 2 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	[1] 1] 1] 1] 1] 1] 1] 1] 1] 1] 1] 1] 1] 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 2 2 0 0 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Days Between Final Spray and Harvest

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

FUNGICIDES/BACTERICIDES

				Plums			-		
Chemical	Apples	Pears	Peaches	and Prunes	Cherries	Grapes	Straw- berries	Brambles	Blue- berries
Abound	Apples	real 5	0	0	0	14	Derries	Diamples	0
Agri-mycin	50	30							
Aliette	14	14	365	365	365		0	60	0
AQ10	0	0	0	0	0	0	0	0	0
Armicarb	0	0	0	0	0	0	0	0	0
Auxigro			0	0	0	0			
Bayleton	45	45				14			
Benlate	14	14	3	3	3	50	1	3	21
Benlate + Captan	14	2.	3	3	3	50	1	3	21
Bravo/Echo			d	d	d				42f
Cabrio					0	,	0	0	0
Captan	0		0c	0	0c	0	0	3	0
Captevate		1.5					0	~	0
Carbamate/Ferbam	7	7	21		0	7		-	
Copper (copper-						11 a			
lime mixtures)	b	b	b		b	b	b	b	
EBDC's	77	77				66			
Elevate		2	0	0	0	0	0	0	0
Elite			0		0	14			
Endura	-					14			
Flint	14	14	1	1	1	14			
Folpet						0		1	0
Indar			0		0				30
JMS Stylet Oil	0	0	0	0	0	Oj	0	0	0
Kaligreen	1	1	1	1	1	1	1	1	1
Messenger	0	0	0	0	0	0	0	0	0
Mycoshield		60	21		1				
Nova	14	85	7		7	14	0	0	-
Orbit			0	0	0				
Oxidate	0	0	0	0	0	0	0	0	0

Legend:

a = No residue if used according to recommendations.

b = Sulfurs and copper plus lime mixtures are exempt if used as recommended, however, the REI is 12-24 hr for Sulfur, 24 hr for Copper, and 48 hr for Lime sulfur.

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.

g = Do not apply after first fruiting flower

h = Do not apply past bloom

i = Do not apply later than 3 weeks past full bloom.

J = Do not apply later than 14 days to harvest on table grapes.

k = REI is 48 hr

m = Non-bearing only

n = Bearing and non-bearing.

Days Between Final Spray and Harvest, continued.

FUNGICIDES/BACTERICIDES (continued)

				Plums and		γ.	Straw-		Blue-
Chemical	Apples	Pears	Peaches	Prunes	Cherries	Grapes	berries	Brambles	berries
Pristine			0	0	0	14	0	0	0
Procure	14	14				7			
Prophyt						0			
Quadris							0		
Ridomil Gold MZ/Cu						66			
Ridomil Gold EC	n	m	n	n	n		0ek	45	0k
Ridomil Gold GR	m	m	m	m	m			45	
Rovral			f	f	f	7	g	0	0
Rubigan	30	30			0	30			
Serenade					0	0			0
Sovran	30	30				14			
Sulfur/Lime Sulfur	b		b	b	b	b		b	b
Switch							0	0	0
Syllit	7		15		0		14		
Thiram	0		7				3a		
Topsin-M	0		1	1	1	14	1		7
Vangard	72	72	h	h	h(tart)	7			
Ziram 76 DF	14	14	14		14	21			14
Ziram Granuflo	14	14	14		14	21			i

Legend:

a = No residue if used according to recommendations.

b = Sulfurs and copper plus lime mixtures are exempt if used as recommended, however, the REI is 12-24 hr for Sulfur, 24 hr for Copper, and 48 hr for Lime sulfur.

c = May be used as post-harvest treatment—See label.

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i = Do not apply later than 3 weeks past full bloom.

J = Do not apply later than 14 days to harvest on table grapes.

k = REI is 48 hr

m = Non-bearing only

n = Bearing and non-bearing.

Days Between Final Spray and Harvest, continued.

INSECTICIDES/MITICIDES

				Plums					
Chemical	Apples	Pears	Peaches	and Prunes	Cherries	Granas	Straw- berries	Brambles	Blue- berries
Acramite	7	7	3	3	Chemes	<u>14</u>	1	Digitibles	Derries
Actara	14j	14j	14	14	14	14	I		
Agri-Mek	28	21	14	14	14	28	3		
Ambush	a	14i	14		3	20	J		
Apollo	45	141	21	21	21				
Asana	21	28	14	14	14			7	14
Assail	7	7	14	17	7		·····	•	
Avaunt	28	28							
Aza-Direct	0	0	0	0	0	0	0	0	0
Biobit	. 0	0	0	0	0	0	0	0	0
Brigade			Ŭ			<u> </u>	0	Ŭ	
Calypso	30	30					.		
Capture		14						3	
Carzol	а	a	а					ŭ	******
Confirm	14	14	~~~~~~					14	14
Crymax	0	0	0	0	0	0	0	0	0
Cythion ULV					1	7			0
Danitol	14	14				21	2		
Diazinon	21	21	21	21	21	28	5	7	7
Dimethoate (Cygon)	28	28							
Dipel	0	0	0	0	0	0	0	0	0
Ecozin	0	0				0	0	0	0
Entrust	7	7	14	7	7		1		3
Esteem	45	45	14	14	14			7	7
Evergreen	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs
Guthion	14f	14	21	15	15	21	5	14	7
Imidan	7b	7b	14b	7	7	14			3
Intrepid	14	14	7	7	7	30			
Javelin	0	0	0	0	0	0	0	0	0
Kelthane	7	7				7	2	/	
Lannate	14b		4			14e	3h		3
Lorsban (foliar)	i	i	i	i	i,14g	35	21i		
Lorsban (trunk)	28		14		6				
Malathion	3	1	7	3	3	3	3	1	0-1b
Methoxychlor	7	7	21	7	7	14		3	14
Mitac		7							
Neemix	0	0				0	0	0	0
Legend:									

a = Do not apply after petal fall

b= See label restrictions on use.

c= No residue if used according to recommendations.

d = 21 days if only 2 sprays are applied.

e = Lannate phi is 1 day for fresh grapes.

f = 21 day PHI on apple if last application > 2 lb/acre.

g= Lorsban 50 W on tart cherry only

h= 10 day PHI for processed strawberries

i= pre-bloom only

j= 35 day PHI if use rates exceed 2.75 oz/A

Days Between Final Spray and Harvest, continued. **INSECTICIDES/MITICIDES** (continued)

				Plums and			Straw-		Blue-
Chemical	Apples	Pears	Peaches	Prunes	Cherries	Grapes	berries	Brambles	berries
Phosphamidon	30				b				
Pounce	а	b	14		3				
Provado	7	7	0	7	7	0	0		
PyGanic	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs	12hrs
Pyramite	25	7	7	7	300	7			
Savey	28	28	28	28	28		3		
Sevin	3	3	3	3	3	7	7	7	7
SpinTor	7		14	7	7	7	1	1	3
Superior Oil	С	С	С	С	С	С	С	С	С
Supracide	i	i							
Surround	0	0				0			
Thiodan	21b	7d	30b	7b	21b	7	4b		b
Vendex	14b	14b	14	14	14	28	1		
Vydate L	14	14							
Warrior	21	21	14	14	14				
Legend:									

Legend:

a = Do not apply after petal fall

b= See label restrictions on use.

c= No residue if used according to recommendations.

d = 21 days if only 2 sprays are applied.

e = Lannate phi is 1 day for fresh grapes. f = 21 day PHI on apple if last application > 2 lb/acre.

g= Lorsban 50 W on tart cherry only

h= 10 day PHI for processed strawberries

i= pre-bloom only

j= 35 day PHI if use rates exceed 2.75 oz/A

Record Keeping Requirements for Production Chemicals

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 is 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.

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		FUNGIC	IDES/BACTEF	RICIDES				
					Runoff/			
Trade Name	Common Name	Manufacturer	EPA Reg #		Leach Potential ²	Oral LD50	Dermal LD50	Class ³
	azoxystrobin	Syngenta	100-1098	4 hrs	1/3	>5000	>4000	strobilurin
	streptomycin ve a	Syngenta	100-899	12 hrs	-/-	>5000	>2000	antibiotic
	fosetyl-Al	Aventis	264-516	12 hrs	3/3	2860	>2000	phosphonate
Armicarb 100	potassium bicarbonate	Church & Dwight	10772-4	4 hrs	-/-	2700	>5000	salt/inorganic
Auxigro	GABA+L-Glutamic Acid	Emerald Bio	70810-1	4 hrs	-/-	>5000	>5000	organic
0	triadimefon	Bayer	3125-320	12 hrs	3/2	812-1470	>2000	triazole
Botran 75 W	dicloran	Gowan	10163-189	12 hrs	2/3	>4640	>6320	aromatic
Bravo WeatherStik	chlorothalonil	Zeneca	50534-188-10182	48 hrs	2/3	9000	>2000	aromatic
	lime sulfur	BSP	66196-3	48 hrs	-/-	820	>2000	inorganic
Cabrio	pyraclostrobin	BASF	7969-187	12-24 hrs	-/-	>2000	>2000	strobilurin
Captan 50 WP	captan	Micro-Flo	51036-166	24 hrs-4 days	3/3	>5000	>2000	dicarboximide
Captan 80 WP	captan	Micro-Flo	51036-168	24 hrs-4 days	3/3	>5000	>2000	dicarboximide
Captan 80 WDG	captan	Arvesta	66330-29	24-72 hrs	3/3	>2000	>5000	dicarboximide
Captan 80 WDG	captan	Micro Flo	66222-58	24-72 hrs	3/3	>2000	>5000	dicarboximide
Captec 4 FL	captan	Micro-Flo	51036-181	24 hrs-4 days	3/3	>5000	>2000	dicarboximide
Captevate	fenhexamid+captan	Arvesta	66330-48	24-72 hrs	-/-	>2000	>5000	hydroxy analide dicarboximide
Champ Formula 2	copper hydroxide	Agtrol/NuFarm	55146-64	24 hrs	-/-	1630	>5000	copper
Champ DP	copper hydroxide	Agtrol/NuFarm	55146-57	24 hrs	-/-	1346	>5000	copper
Copper Sulfate	copper sulfate	Griffin	1812-313	24 hrs	3/3	472	-	copper
Cuprofix Disperss	basic copper sulfate	Cerexagri	4581-396	24 hrs	3/3	>2000	>4000	copper
Dithane M-45	mancozeb	DowAgrosciences	707-78	24 hrs	1/3	>5000	>5000	dithiocarbamate
Elevate	fenhexamid	Arvesta	66330-35	12 hrs	-/-	>2000	>2000	hydroxy analide
Elite 45 DF	tebuconazole	Bayer	3125-388	12 hrs	-/-	2593-8465	>2000	triazole
Endura	boscalid	BASF	7969-197	12 hrs	-/-	>2000	>2000	carboxamide
Ferbam Granuflo	ferbam	Taminco, Inc.	45728-7	24 hrs	2/3	>5000	>4000	dithiocarbamate
Flint	trifloxystrobin	Bayer	3125-559	12 hrs	2/3	>5050	>2000	strobilurin
Indar	fenbuconazole	DowAgrosciences	62719-421	12 hrs	1/3	4000	>2000	triazole
JMS Stylet Oil	paraffinic oil	JMS Flower Farms	65554-1	4 hrs	-/-	10000	-	organic
	copper hydroxide	Griffin	1812-288	24 hrs	-1	833	>5000	inorganic
	lime sulfur	Miller	72-19	48 hrs	-/-	820	>2000	inorganic
Kumulus DF	sulfur	BASF	7969-61	24 hrs	-/-	>2200	>2000	inorganic
	maneb	Cerexagri	4581-371	24 hrs	1/3	>5000	>2000	dithiocarbamate
	maneb	Cerexagri	4581-255	24 hrs	1/3	>5000	>2000	dithiocarbamate
	thiabendazole	Syngenta	100-889	12 hrs	1/3	3100	-	benzimidazole
	harpin protein	Eden Bioscience	69834-2	4 hrs	-/-	>5000	>6000	organic
	sulfur	Cerexagri	4581-373	24 hrs	-/- -/-	>2000	>2000	inorganic
	oytetracycline	Syngenta	100-900	12 hrs	2/2	>5000	>2000	organic
	myclobutanil	DowAgrosciences	62719-411	24 hrs	1/2	1870-2090	>5000	triazole
	propiconazole	Syngenta	100-702	24 hrs	-/-	1310	>5000	triazole
	hydrogen dioxide	Biosafe Systems	70299-2	0 hrs	1/3	330 >5000	1410	organic
	mancozeb	Cerexagri	4581-358 4581-370	24 hrs 24 hrs	1/3	>4470	>2000 >2000	dithiocarbamate dithiocarbamate
	mancozeb metiram	Cerexagri UAP Platte	7969-105-34704	24 hrs	2/3	>5000	>2000	dithiocarbamate
Pristine	boscalid+pyraclostrobin	BASF	7969-105-34704	24 hrs	-/-	-5000	2000	strobilurin/carboxamide
Procure 50 WS	triflumizole	Uniroyal	400-431	24 hrs	3/2	2230	2000	triazole
	mefenoxam	Syngenta	100-798	48 hrs	2/1	>5000	>2000	phenylamide
territorial contraction of the second	mefenoxam	Syngenta	100-801	48 hrs	2/1	1172	>2020	phenylamide
	mefenoxam/mancozeb	Syngenta	100-803	48 hrs	1/1	>5000	>2000	phenylamide/dithiocarbamate
	mefenoxam/copper	Syngenta	100-804	48 hrs	2/1	550	>2020	phenylamide/copper
Rovral 50 WP	iprodione	Aventis	264-453	24-48 hrs	3/3	>5000	>2000	dicarboximide
	iprodione	Aventis	264-482	24-48 hrs	3/3	1170	>2000	dicarboximide
	fenarimol	DowAgrosciences	62719-134	12 hrs	2/1		>2000	triazole
Serenade	Bacillus subtilis	Agraquest	69592-7	4 hrs	-/-	>5000	<2000	-
	kresoxim-methyl	BASF	7969-1 54	12 hrs	3/3	>5000	>2000	strobilurin
Switch	cvprodinil+fludioxonil	Syngenta	100-953	12 hrs	-/-	>5000	>2000	anilopyrimidine/phenylpyrrole
Syllit 65 W	dodine	Platte	264-508-34704	48 hrs	2/3	2330	>5000	guanidine
	thiram	Taminco, Inc.	45728-21	24 hrs	3/3	2400	>2000	dithiocarbamate
	thiophanate-methyl	Cerexagri	4581-403	12 hrs	2/3	>5000	>2000	benzimidazole/carbamate
Vangard WG	cyprodinil	Syngenta	100-828	12 hrs	1/3	>5000	>2000	anilinopyridimine
	sulfur	Micro-Flo	51036-14	24 hrs	-1-	>5000	>2000	inorganic
and a second secon	ziram	Cerexagri	4581-140	48 hrs	3/2	1889	>5000	dithiocarbamate
	ziram	Taminco, Inc.	45728-12	48 hrs	3/2	2700	>2000	dithiocarbamate

* = Restricted Use Pesticide

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

²1= high, 2=intermediate, 3=low. These leaching/runoff potential ratings are from the NRCS WIN-PST Pesticide Properties Database at

http://www.wcc.nrcs.usda.gov/pestmgt/sp2_main.html. C = carbamate, FA = fatty acid, IGR = insect growth regulator, K = clay, NA = naturalyte, NM = neem extract, NI = neonicotinoids, OP = organophosphate, OX = oxadiazine, SP =

synthetic pyrethroid.

(continued on next page)

Record Keeping Requirements for Production Chemicals (continued).

			HERBICIDE	5				
rade Name	Common Name	Manufacturer	EPA Registration #	REI ¹	Runoff /Leach Potential ²	Oral LD50	Dermal LD50	Class
Casoron 4 G	dichlobenil	Uniroyal	400-168	12 hrs	2/2	>5000	>2000	Nitrile
Devrinol 50 DF	napropamide	United Phosphorus	10182-258-70506	12 hrs	2/2	>5000	>2000	amide
vital 5G	norflurazon	Syngenta	100-840	12 hrs	2/2	>5000	>2000	pyridazinone
ormula 40	2,4-D	Riverdale	228-357	48 hrs	3/2	866-1058	>2000	phenoxy
usilade DX	fluazifop-P	Syngenta	100-1070	12 hrs	2/3	>5000	>2000	phenoxy
Sallery 75 DF	isoxaben	DowAgrosciences	62719-145	12 hrs	1/3	>5000	>5000	amide
Soal 2XL	oxyfluorfen	DowAgrosciences	62719-424	24 hrs	2/3	>2000	>2999	diphenyl ether
Gramoxone Extra	paraquat	Zeneca	10182-280	12-24 hrs	1/3	283	>2000	quaternary ainmo
armex 80 DF	diuron	Griffin	1812-362	12 hrs	2/2	6100	>5000	urea
Kerb 50 WP	pronamide	DowAgrosciences	62719-392	24 hrs	2/1	>5000	>2000	-
oast	sethoxydim	BASF	7969-58	12 hrs	3/3	4100	>5000	cyclohexine oxime
Princep 90 WDG	simazine	Syngenta	100-603	12 hrs	2/1	>5000	>2000	triazine
Princep 4 L	simazine	Syngenta BASF	100-526 241 –337	12 hrs	2/1 1/3	>5000 3956	>2500 >2200	triazine
rowl 3.3 EC	pendimethalin		264-652	24 hrs	3/3		>2000	dinitroanaline
Rely	glufosinate	Bayer		12 hrs		3570	>5000	organophosphate
Roundup	glyphosate	Monsanto	524-445 524-475	12 hrs	1/3 1/3	>5000 5108	>5000	organophosphate
Roundup Ultra	glyphosate	Monsanto		4 hrs 24 hrs				organophosphate
elect 2EC	clethodim	Valent	59639-3		3/3	2920-3610	>5000	Cyclohexene oxir
inbar 80 WP	terbacil	DuPont	352-317	12 hrs	2/1	5000-7500	>5000	uracil
napshot 80 DF	isoxaben + oryzalin	DowAgrosciences	62719-174	12 hrs	1/3	>5000	-	amide+ dinitroana
olicam 80 DF	norfiurazon	Syngenta	100-849	12 hrs	2/2	1140	>2000	pyridazinone
urflan AS	oryzalin	DowAgrosciences	627 19-112	24 hrs	3/3	5000	>5000	dinitroanaline
itinger	clopyralid	DowAgrosciences	62719-73	12 hrs	3/1	>5000	>5000	-
ouchdown 6 F	sulfosate	Syngenta	100-1117	12 hrs	1/3	>5000	>5000	organophosphate
elpar L	hexazinone	DuPont	352-392	24 hrs	2/1	1100	>5000	triazinone
Veedar 64	2,4-D	Nufarm	71368-1	48 hrs	3/2	1161	1544	phenoxy
	1.1		ECTICIDES/MIT			1.5000	. 5000	
cramite 50WS	bifenazate	UniRoyai	400-503	1-5 days	2/3	>5000	>5000	-
ctara 25WG	thiamethoxam	Syngenta	100-938	12 hrs	2/1	>5000	>2000	nicotinoid
Agri-Mek 0.15 EC	avermectin B1	Syngenta	100-898	12 hrs	1/3	300	>1800	antibiotic
Ambush 2 EC	permethrin	Syngenta	100-985	12 hrs	2/3	2305	1912	pyrethroid
Ambush 25 WP	permethrin	Amvac	5481-502	12 hrs	2/3	>5000	>2000	pyrethroid
pollo SC	clofentezine	Aventis	264-623	12 hrs	1/3	>5000	>2400	-
Asana XL	esfenvalerate	DuPont	352-515	12 hrs	2/3	458	>2000	pyrethroid
ssail 70WP	acetamiprid	Aventis	264-609	12 hrs	-/-	1064	>2000	nicotinoid
vaunt 30WG	indoxacarb	DuPont	352-597	12 hrs	-/-	687-1867	>5000	oxadiazine
za-Direct	azadirachtin	Gowan	71908-1-10163	4 hrs	2/1	>5000	>2000	botanical
Azinphos-Methyl 50	azinphos-methyl	Micro-Flo	51036-1 64	2-21days	2/3	14	>2000	organophospha
iobit HPWP	Bt var kurstaki	Valent	73049-54	4 hrs	-/-	>5000	>2500	biological
Brigade WSB	bifenthrin	FMC	279-3108	12 hrs	2/3	335	>2000	pyrethroid
Calypso	thiocloprid	Bayer	264-806	12 hrs	-/-	-	-	-
arbaryl 4 L	carbaryl	Platte	34704-447	12 hrs	3/3	590	2000	carbamate
arbaryl 80	carbaryl	Drexel	19713-50	12 hrs	3/3	281	>2000	carbamate
arzol 92 SP	formetanate	Aventis	264-635	4-16days	1/3	15-26	>10000	formamidine
Confirm 2F	benzoic acid	DowAgro	62719-420	4 hrs	-/-	>5000	>5000	-
Danitol 2.4 EC	fenpropathrin	Valent	59639-35	24 hrs	2/3	66	>2000	pyrethroid
eliver	Bt Kurstaki	Certis	70051-69	4 hrs	-	>5000	-	biological
Diazinon 50 WP	diazinon	Platte	100-460-34704	24 hrs	1/3	1960	>2020	organophospha
Diazinon AG 600	diazinon	Platte	100-784-34704	24 hrs	1/3	1600	>2020	organophospha
Diazinon 50 W	diazinon	Micro-Flo	51036-108	24 hrs	1/3	>2000	>2000	organophospha
imethoate 400	dimethoate	Platte	34704-207	48 hrs	3/2	425	2020	organophospha
imethoate 267 EC	dimethoate	Micro-Flo	51036-198	48 hrs	3/2	750	>2000	organophospha
ipel	Bt var kurstaki	Valent	73049-17	4 hrs	-/-	8100	7200	biological
cozin	azadirachtin	Amvac	5481-476	12 hrs	2/1	>5050	>5050	botanical
ntrust	Spinosad	DowAgrosciences	62719-282	4 hrs	2/3	>5000	>2000	antibiotic
ndosulfan 50 WSB	endosulfan	Microflo	51036-91	24 hrs	1/3	50	150	organochloride
steem 35 WP	pyripioxyfen	Valent	59639-115	12 hrs	-/-	>5000	>5000	IGR
vergreen	pyrethrin + piperonyl	MGK	1021-1770	12 hrs	2/3	>5000	>2000	pyrethroid
F-120 NF	spinosad	DowAgrosciences	62719-498	4 hrs	2/3	>5000	>5000	antibiotic
Guthion 2 L	azinphos-methyl	Bayer	3125-102	2-21days	2/3	55-75	350	organophospha
GuthionSolupak50W	azinphos-methyl	Bayer	3125-301	2-21days	2/3	12.3-24.7	>2000	organophospha
nidan 70 WP	phosmet	Gowan	10163-169	24 hrs	3/3	126-681	>4.64	organophospha
ntrepid 2F	benzoic acid	DowAgrosciences	62719-442	4 hrs	-/-	>5000	>2000	-
	Bt	Certis	70051-66	4 hrs	-/-	>5100	>5000	-
avelin WG	dicofol	DowAgrosciences	62719-405	12 hrs	1/3	1835-5022	>5000	-
elthane MF		DuPont	352-342	2-7 days	3/1	30-34	>2000	carbamate
elthane MF annate 90 SP	methomyl	DuPont	352-384	2-7 days	3/1	160	>2016	carbamate
elthane MF .annate 90 SP .annate 2.4 LV	methomyl methomyl	Duron	62719-221-10163	1-4 days	2/3	382	>2000	organophospha
elthane MF .annate 90 SP .annate 2.4 LV	methomyl chlorpyrifos	Gowan	02/19-221-10103	1 1 1 1 1	2/3	300-776	>5000	organophospha
elthane MF .annate 90 SP .annate 2.4 LV orsban 50 WP	methomyl		62719-220	1-4 days	2/3	000-110	-5000	
elthane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 4 EC	methomyl chlorpyrifos	Gowan		12-24 hrs	3/3	370	4100	organophospha
avelin WG elthane MF _annate 90 SP _annate 2.4 LV orsban 50 WP _orsban 4 EC lalathion 8 Flowable lalathion 57EC	methomyl chlorpyrifos chlorpyrifos	Gowan DowAgrosciences	62719-220					
elthane MF .annate 90 SP .annate 2.4 LV orsban 50 WP .orsban 4 EC lalathion 8 Flowable lalathion 57EC	methomyl chlorpyrifos chlorpyrifos malathion	Gowan DowAgrosciences Gowan	62719-220 10163-21	12-24 hrs	3/3	370	4100	
elthane MF Lannate 90 SP Lannate 2.4 LV orsban 50 WP Lorsban 4 EC Ialathion 8 Flowable Ialathion 57EC M-Pede	methomyl chlorpyrifos chlorpyrifos malathion malathion fatty acids	Gowan DowAgrosciences Gowan UAP Platte	62719-220 10163-21 34704-108	12-24 hrs 12 hrs 12 hrs	3/3 3/3	370 3946	4100 >2000	organophospha
eithane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 4 EC alathion 8 Flowable alathion 57EC 4-Pede fethoxychlor 2 EC	methomyl chlorpyrifos chlorpyrifos malathion malathion fatty acids methoxychlor	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte	62719-220 10163-21 34704-108 53219-6 34704-102	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs	3/3 3/3 -/- 1/3	370 3946 >5000 5000-6000	4100 >2000 >2000	organophospha - organochlorine
elthane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 4 EC lalathion 8 Flowable lalathion 57EC <i>A</i> -Pede <i>A</i> ethoxychlor 2 EC eemix 4.5	methomyl chlorpyrifos chlorpyrifos malathion fatty acids methoxychlor azadirachtin	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte Certis	62719-220 10163-21 34704-108 53219-6 34704-102 70051-9	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs	3/3 3/3 -/- 1/3 2/1	370 3946 >5000 5000-6000 >5000	4100 >2000 >2000	organophospha - organochlorine botanical
elthane MF annate 90 SP annate 2.4 LV orsban 50 WP oorsban 4 EC alathion 8 Flowable alathion 57EC 1-Pede Methoxychlor 2 EC eemix 4.5	methomyl chlorpyrifos chlorpyrifos malathion fatty acids methoxychlor azadirachtin azadirachtin	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte Certis Thermo Trilogy	62719-220 10163-21 34704-108 53219-6 34704-102 70051-9 70051-5	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs 4 hrs	3/3 3/3 -/- 1/3 2/1 2/1	370 3946 >5000 5000-6000 >5000 >5000	4100 >2000 >2000 >2820 - -	organophospha - organochlorine botanical botanical
eithane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 4 EC alathion 8 Flowable alathion 57EC 1-Pede Methoxychlor 2 EC eemix 4.5 eemix Pounce 25 WP	methomyl chlorpyrifos chlorpyrifos malathion fatty acids methoxychlor azadirachtin azadirachtin permethrin	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte Certis Thermo Trilogy FMC	62719-220 10163-21 34704-108 53219-6 34704-102 70051-9 70051-5 279-3051	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs 4 hrs 12 hrs	3/3 3/3 -/- 1/3 2/1 2/1 2/3	370 3946 >5000 5000-6000 >5000 >5000 1100	4100 >2000 >2000 >2820 - - >2000	organophospha - organochlorine botanical botanical pyrethroid
elthane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 50 WP orsban 4 EC alathion 57EC A-Pede Methoxychlor 2 EC eemix 4.5 eemix Pounce 25 WP Pounce 3.2 EC	methomyl chlorpyrifos malathion malathion fatty acids methoxychlor azadirachtin permethrin permethrin	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte Certis Thermo Trilogy FMC FMC	62719-220 10183-21 34704-108 53219-6 34704-102 70051-9 70051-5 279-3051 279-3051	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs 4 hrs 12 hrs 12 hrs 12 hrs	3/3 3/3 -/- 1/3 2/1 2/1 2/3 2/3	370 3946 >5000 5000-6000 >5000 >5000 1100 1030	4100 >2000 >2000 >2820 - - >2000 >2000	organophospha - organochlorine botanical botanical pyrethroid pyrethroid
elthane MF annate 90 SP annate 2.4 LV orsban 50 WP orsban 4 EC lalathion 8 Flowable lalathion 57EC	methomyl chlorpyrifos chlorpyrifos malathion fatty acids methoxychlor azadirachtin azadirachtin permethrin	Gowan DowAgrosciences Gowan UAP Platte Mycogen Platte Certis Thermo Trilogy FMC	62719-220 10163-21 34704-108 53219-6 34704-102 70051-9 70051-5 279-3051	12-24 hrs 12 hrs 12 hrs 12 hrs 12 hrs 12 hrs 4 hrs 12 hrs	3/3 3/3 -/- 1/3 2/1 2/1 2/3	370 3946 >5000 5000-6000 >5000 >5000 1100	4100 >2000 >2000 >2820 - - >2000	botanical pyrethroid

* = Restricted Use Pesticide
¹REI = Restricted Entry Interval, SL = See Label. Some REIs vary by crop, *always check the label.*²1= high, 2=intermediate, 3=low. These leaching/runoff potential ratings are from the NRCS WIN-PST Pesticide Properties Database at

 $\frac{1}{3}$ C = carbamate, FA = fatty acid, IGR = insect growth regulator, K = clay, NA = naturalyte, NM = neem extract, NI = neonicotinoids, OP = organophosphate, OX = oxadiazine, SP = synthetic pyrethroid.

INSECTICIDES/MITICIDES (continued)

		* ²			Runoff			
			EPA		/Leach	Oral	Dermal	
Trade Name	Common Name	Manufacturer	Registration #	REI ¹	Potential ²	LD50	LD50	Class
Savey 50 DF	hexythiazox	Gowan	10163-250	12 hrs	2/3	>5000	>5000	-
Sevin 80 S	carbaryl	Aventis	264-316	12 hrs	3/3	281	>2000	carbamate
Sevin XLR Plus	carbaryl	Aventis	264-333	12 hrs	3/3	649	>2000	carbamate
Sevin 4 F	carbaryl	Aventis	264-349	12 hrs	3/3	590	>2000	carbamate
Spintor 2 SC	spinosad	DowAgrosciences	62719-294	4 hrs	2/3	>5000	>5000	antibiotic
Sunspray Ultra-fine	superior oil	Security	862-28-270	4 hrs	-/-	>15000	-	-
*Supracide 25 WP	methidathion	Gowan	10163-244	2-14	3/3	53	>2020	organophosphate
Surround WP	kaolin	Engelhard	70060-14	4 hrs	-/-	-	-	clay
Thiodan 3 EC	endosulfan	FMC	279-2924	24 hrs	1/3	45	256	Organochlorine
Thiodan 50 WP	endosulfan	FMC	279-1380	24 hrs	1/3	41	>2000	organochlorine
*Vendex 50 WP	fenbutatin-oxide	Griffin	1812-413	48 hrs	1/3	>5000	>2000	-
*Vydate L	oxamyl	DuPont	352-372	48 hrs	3/3	37	2960	carbamate
Warrior	lambda-cyhalothrin	Syngenta	100-1112	24 hrs	2/3	351	>2000	pyrethroid

PLANT GROWTH REGULATORS

					Runoff			
			EPA		/Leach	Oral	Dermal	
Trade Name	Common Name	Manufacturer	Registration #	REI ¹	Potential ²	LD50	LD50	Class
Accel	6BA + GA4+7	Valent	73049-29	12 hrs	-/-	4900	2900	cytokinin+gibberellin
Apogee	Prohexadione-Ca	BASF	7969-188	12 hrs	3/2	>5000	>2000	Unclassified
Arnid-Thin-W	NAD	Amvac	5481-426	48 hrs	3/2	>10000	>5000	auxin
Ethrel	ethephon	Aventis	264-267	48 hrs	2/3	>5000	>2000	ethylene releaser
Fruitone N	NAD	Amvac	5481-427	48 hrs	3/3	>10000	>5000	auxin
K-Salt Fruit Fix 800	NAD	Amvac	5481-413	24 hrs	3/3	>5050	>2020	auxin
K-Salt Fruit Fix 200	NAD	Amvac	5481-414	24 hrs	3/3	>5050	>2020	auxin
Pro-Gibb	gibberellic acid (GA3)	Valent	73049-15	12 hrs	-/-	>5000	>2000	gibberellin
Pro-Vide	gibberellic acid	Valent	73049-3	12 hrs	-/-	2100	>2000	gibberellin
Promalin	6BA+GA4+7	Valent	73049-41	4 hrs	-/-	3160-4900	>2000	cytokinin+gibberellin
ReTain	AVG	Valent	73049-45	12 hrs	-/-	>7000	>5000	ethylene releaser
Tre-Hold	NAD	Amvac	548 1-429	12 hrs	3/2	5585	>5000	auxin
			NEMATICIDE	S				
*Nemacur 3 S	fenaminhos	Bayer	3 125-283	48 bre	2/1	10 6-24 8	71 5-75 7	organophosphate

*Nemacur 3 S	fenamiphos	Bayer	3 125-283	48 hrs	2/1	10.6-24.8	71.5-75.7	organophosphate
* Nemacur 15G	fenamiphos	Bayer	3125-236	48 hrs	2/1	10-14	>2000	organophosphate
* Telone II	dichloropropene	DowAgrosciences	627 19-32	5 days	3/2	200-300	333	unclassified
* Telone C-17	dichloropropene	-		-				unclassified
	and chloropicrin	DowAgrosciences	62719-12	5 days	3/2	300-500	200-500	unclassified
Vapam	metam-sodium	Amvac	5481-466	48 hrs	3/2	812	>2020	unclassified
*Vydate L	oxamyl	DuPont	352-372	48 hrs	3/3	37	2960	carbamate
= Restricted Use Pesticid	e	2 G					(continu	ed on next page)

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The Fruit Crop Advisory Team Alert Newsletter

Dependable pest management information from MSU Extension

We send updates about growing tree and small fruit under current weather and pest conditions.	No one knows what the weather or pest situation will be this spring and summer. The Fruit Crop Advisory Team (CAT) is structured to respond to the conditions with timely advice for growers and consultants. Members of the team are Extension field staff and campus faculty who meet weekly through conference phone calls to discuss current pest and crop conditions. Team members write newsletter articles and regional reports on crop development and pest management tactics for local conditions.
Timing matters, so we offer prompt delivery to you by mail or Internet	Our newsletters are written, formatted, printed and mailed within 48 hours. With Internet access, you can view the newsletter even faster within 8 hours of the start of production. We look at conditions in surrounding states, data on trends from past years, insects trap catches, forecasting tools and the reports of our agricultural meteorologist to predict what your pest management needs will be.
Both immediate and long-term pest management tactics are provided	 The newsletter articles respond to current outbreaks and recommend long-term preventative actions. Our recommendations include resistance management and protecting beneficial organisms. The following subjects are covered: Managing insects, nematodes, and diseases on tree and small fruit Tree and plant health as well as orchard and vineyard management Pesticide regulations and registration changes including emergency registrations Weather conditions, growing degree days, precipitation totals, and production implications Insect trap catches and other scouting advice
How to read us on the Internet	See issues and archives of the CAT Alert at our IPM Web site: http://www.msue.msu.edu/ipm/fruitCAT.htm The CAT Alert program is coordinated by the MSU IPM Program. With grant funding, we are able to offer this free Internet service and keep subscription costs down for our mail recipients.

Subscribe for 18 issues throughout 2004 _ _ _ _ _ _ .

Our season begins March 2004. Most issues arrive during the growing season, but pre- and post- season issues address preventative measures and harvest or storage concerns. Send your subscription in any time during the year. We'll send back issues from the current publishing year, if you subscribe before July 1. After July 1, the price is \$15 and does not include back issues. Editions of the CAT Alert are also available for vegetables, landscape, greenhouse, and field crops.

Name	County
Company	Phone _()
Address	Check the edition(s) you would like to receive:
City/State	Fruit Vegetable Field Crop Landscape
Zip Code (9-digit if available)	Enclose \$35 for each edition. The total amount you have enclosed is: \$

Make your check payable to: Michigan State University. Send your check and this form to: CAT Alerts, B18 Food Safety & Toxicology Building, Michigan State University, East Lansing, MI 48824 (Phone: 517-353-4703)

How to submit a sample to the MSU Diagnostics Center for diagnosis

SAMPLE SUBMISSION

Accurate diagnosis depends on the rapid receipt of fresh and representative samples along with pertinent information relating to the problem and client objectives. Diagnostic Services forms are available at the MSU Center for Integrated Plant Systems, at your local Extension office, or can be downloaded from http://www.cips.msu.edu/diagnostics/services/form.html.

Plant Samples:

Herbaceous Plants: Send whole plants, including roots and soil. Roots and soil should be in a plastic bag to prevent soil from touching foliage. Be sure to check out Jan's graphic guide (internet instructions) for submitting whole plants. Its packed full of handy tips that will help us get the most out of your sample.

Tree Decline / Wilt: Send 6 to 12 branch sections 1/2 inch to 1 inch diameter and 8 inches long. Branches should be taken from live areas of tree with symptoms, not from completely dead branches. Seal branches in plastic to retain moisture.

Seedlings: Leave plants in plug sheets or trays if possible, send a minimum of 12 seedlings.

Leaf Spot and Fruit Rot: Send several affected samples representing the early and moderate stages of the symptom progression.

Insects/Arthropod Samples:

Precise identification of insects or other arthropods requires specimens to be undamaged upon arrival to the laboratory. It is very important to kill and ship the specimens in a manner that will not damage the delicate structures that facilitate their identification. Peeling a squashed bug from a flyswatter or from the bottom of your shoe and putting it in an envelope for mailing is not recommended. Dried and unprotected insects are easily crumbled during mail processing. Attaching the specimen to scotch tape is not recommended. Killing and shipping specimens in a small, leak proof vial filled with rubbing alcohol is usually best.

Moths / Butterflies: Wing coloration is the most important characteristic in identifying these insects and precautions need to be taken to reduce the loss of the tiny scales that give moths and butterflies their distinctive wing patterns. Place them in the freezer for half an hour to kill them and then gently pack them in a small box or vial with tissue paper.

Ants: Specimens should only include worker ants (i.e. those without wings.) It is very difficult and in many cases, impossible to identify winged ants. Please submit these in alcohol. Other adult and hard bodied specimens: Submit in alcohol.

Larvae (Caterpillar, grub, maggot, etc.): Whenever possible, soft bodied larvae should be lightly boiled for a few minutes before placing them in alcohol. Boiling helps prevent the specimens from shriveling and becoming discolored, however, this only works if the larvae are alive when dropped into boiling water.

Nematode Samples:

Refer to MSU Extension Bulletin E-2199, "Detecting and Avoiding Nematode Problems." Always store nematode samples in plastic bags or other containers that retain moisture. Submit a pint to a quart of soil.

Problem Diagnosis: Collect soil and roots (or foliage) from the margins of diseased areas. Submit samples of diseased plants and apparently healthy ones.

Problem Avoidance: Collect soil & roots (if available) by walking a zig-zag or w-shaped pattern. The more sub-samples (soil, cores, probes, etc.) collected, the "better" the sample.

Soil & Plant Nutrient Samples: Mail or deliver to A-81 Plant & Soil Science Building (PSSB) or drop off at Diagnostic Services, 101 Center for Integrated Plant Systems.

Services and Fees for MSU Diagnostics Services

Plant Health Analysis

Plant health analysis: visual inspection for infectious and non-infectious diseases, pathogen culturing, insect injury, pH and soluble salts	\$15.00
INSV/TSWV ELISA test	\$15.00
Bacterial identification (Biology)	\$20.00
Special laboratory analysis	Variable costs requiring client approval.
	Diagnostic fees for out of state samples are double.

Insects/Arthropods

Common Insect ID	No charge
Keyout Insect ID	\$10.00
Special identification/diagnosis	\$50.00 per hour

Diagnostic fees for out of state samples are double.

Weeds / Plants

Common Plant ID		No charge
Keyout Plant ID		\$10.00
Herbicide Resistance in	Weeds	
Standard Tes	t	\$20.00
Extensive Te	st	\$30.00
Special identification/dia	agnosis	\$50.00 per hour
		Diagnostic fees for out of state samples are double.
Nematodes		Diagnostic fees for out of state samples are double.
Nematodes Basic nematode analys		Diagnostic fees for out of state samples are double. \$15.00
	is:	
Basic nematode analys	is:	\$15.00
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Soil & Plant Nutrient Lab Fees

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Dilution plating

Contact the Soil & Plant Nutrient Lab at: Ph. 517-355-0218 Fax 517-355-1732

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101 Cen Eas Office: 517	AGNOSTIC S nter for Integrat at Lansing, MI 7-355-4536 F w.cips.msu.edu	ed Plant Syste 48824-1311 FAX: 517-432	UN	HIGAN ST i v e r s i TENSIC	T Y Amount Pa	aid: ceipt No.:	
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					CONFIDENTIAL Email:	Fax: ()	
SAMPLE 7	ГҮРЕ (plant typ	pe and variety, if	f known):				
GENERAL INF PLANT PARTS Entire Plant Leaves/Needles Roots Fruit NATURE OF 7 Poor or Abnormal Spots Wilting Plant Death Leaf/Needle Drop Chewing Rot SOIL 7 Sandy Muck INSECT / ART Where was the ins How many insects	FORMATION (in SAFFECTED Stems Twigs/Limbs Trunk Flowers THE INJURY Growth Yellowing Boring Cupping Dieback Galls/Cankers TYPE Clay Silt Loam HROPOD ID SA sect found?	ndicate all that a TYPE OI Field Nursery Greenhouse Orchard Turf/Lawn PREV Entire Planting Single Localize Several Localize Several Localize Few Scattered DRA Good MPLES ONLY Few Severa	pply) F PLANTING Garden House Plant Pasture Natural Area City/Recreation VALENCE Ed Area red Areas Plants F THE DAMAGE oderate Severe AINAGE Fair Poor V (indicate all that a provident of the second V (indicate all that a provident of the second	PROBLEM Upland Slopes Low Areas OTHER B How long at sin Height of plant How many pla How often wat How fertilized Sunny or Shad	DISTRIBUTION Near Drive/Road Edge of Field Near a Residence ACKGROUND te? :? nts affected? ered? ? ed?	HERBICIDE H This year: Last year: INSECTICIDE This year: FUNGICIDE F This year: CROP HIST Last year: Next year: Next year:	HISTORY HISTORY FORY
PLANT TY Tree Grou	ndcover Heigh accous Width	PLANT SIZE	GROWT Upright/Ere Prostrate/Lo		FLOWERS Color: Size: List any unique featur	Annual: Perennial:	T AGE

NEMATODE SAMPLES ONLY (indicate type of analysis requested)

□ Soil and root analysis for root-feeding nematodes (\$15/sample)

□ Foliar nematode analysis (\$15/sample)

□ Total nematode community structure analysis (\$50/sample)

Verticillium dahliae analysis Dilution (\$10/sample)

□ Wet-sieving (\$15/sample)

□ Both (\$25/sample)

No. of samples:

Sample/Field ID:

MATION on centers for assistance.			S Pesticide Disposal	Information	Michigan Clean Sweep, Michigan Department of Agriculture Environmental Stewardship Division. Monday – Friday: 8 a.m.–5 p.m.	(211) 241-0235	National Pesticide Information Center Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Oregon State University 7 days a week; excluding holidays	6:30 a.m 4:30 p.m. Pacific Time Zone 1-800-858-7378 FAX: 1-541-737-0761
CY INFOR he following emergency informati ril 2003	e Poisoning	NTROL ited States, call 2 - 1 2 2	Emergencie Environmental	Pollution	District Michigan Department of Environmental Quality (MDEQ) Office Phone No.	Phone No.	MDEQ Pollution Emergency Alerting System (PEAS): *1-800-292-4706 also *1-800-405-0101 Michigan Department of Agriculture Spill Response	ю
PESTICIDE EMERGENCY INFORMATION For any type of an emergency involving a pesticide, immediately contact the following emergency information centers for assistance. Current as of April 2003	ıman Pesticide Poisoning	POISON CONTROL From anywhere in the United States, call 8 0 0 - 2 2 2 - 1 2 2 2 8 0 0 - 2 2 2 - 1 2 2 2	cial Pesticide Emergencies Traffic Environmental	Accident	Local police department or sheriff's department:	Phone No.	Operations Division, Michigan State Police: *(517) 336-6605	chigan State University Extensi
PESTICIDE For any type of an emergency involving	Hun	-	Speci Pesticide	Fire	Local fire department:	Phone No.	*911 Aperated 24 Hours	sticide Education Program, M
For al			Animal	Poisoning	Your veterinarian:	Phone No.	National Animal Poison Control Center (\$45 consultation fee per case) *1-800-548-2423 *911 * Telephone Number Operated 24 Hours	Revised by Carolyn J. Randall, Pesticide Education Program, Michigan State University Extension

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Fungicides-Bactericides
Insecticides-Miticides
Tree Fruit
Apples
Pears
Peaches-Nectarines
Prunes–Plums
Red Tart Cherries
Sweet Cherries
Small Fruit
Grapes
Strawberries
Brambles
Blueberries
Growth Regulators
Herbicides

Weed Control

Nematicides

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