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Fruit Pesticide Handbook For Commercial Fruit Growers
Michigan State University Extension Service
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*For Commercial
Fruit Growers*

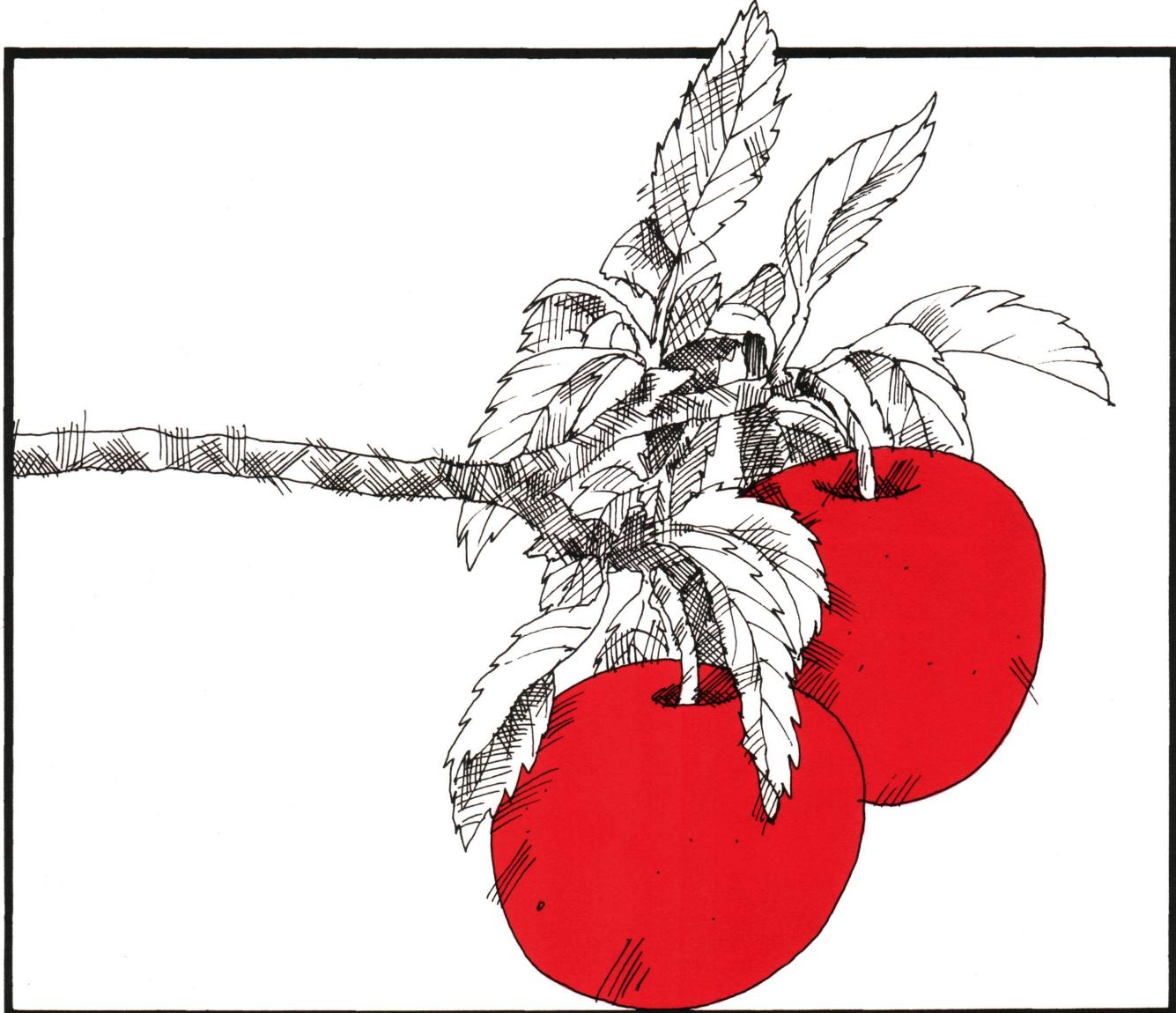
Fruit Spraying Calendar

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Cooperative Extension Service
Michigan State University

1988



Extension Bulletin E-154, Information Current as of December 1, 1987, Revised Annually.

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For Commercial Fruit Growers

Fruit Spraying Calendar 1988

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1988 Fruit Spraying Calendar

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	Page
Introduction	4
Safe Use of Pesticides in Pest Management (Guidelines)	5
Fungicides	7
Insecticides	9
Monitoring Insects	13
Tree-Row Volume	14
1988 Percent of Standard Chart	16
Tree-Row Volume Insecticide Chart	17
1988 Insecticide-Miticide Rates for Apples	18
How to Use the 1987 Fruit Spray Calendar	19
1988 Fruit Spraying Calendar	
Apples	20
Pears	32
Peaches, Nectarines, Apricots	35
Prunes and Plums	43
Tart Cherries	47
Sweet Cherries	53
Grapes	57
Strawberries	63
Brambles	67
Currants, Gooseberries	70
Blueberries	71
Plant Growth Regulators	77
Herbicides	82
Weed Control Recommendations—Tree Fruits	
Apples, Pears	88
Cherries (Tart and Sweet), Peaches, Plums	90
Weed Control Recommendations—Small Fruits	
Blueberries, Brambles	92
Grapes	93
Strawberries	94
Post-Harvest Disorder Control	95
Nematode Control	97
Vineyards and Small Fruit Plantings	99
Wildlife Damage Control in Orchards	101
Compatibility Chart	105
Days Between Final Spray and Harvest	
Fungicides	106
Insecticides	107
Spray Record Sheet	109

Introduction

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

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

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

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

<i>Apple Grader's Manual (Commercial)</i>	E-0747
<i>Growing Apricots in Michigan</i>	E-0533

<i>Highbush Blueberry Varieties for Michigan</i>	E-1456
<i>Propagating Highbush Blueberries</i>	E-1680
<i>Blueberry Diseases in Michigan</i>	E-1731
<i>Common Blueberry Insect Pests & Their Control</i>	E-1863
<i>Training and Pruning Young Cherry Trees</i>	E-1744
<i>Growing Currants and Gooseberries</i>	E-0856
<i>Fertilizers for Fruit Crops</i>	E-0852
<i>Grape Grader's Manual (Commercial)</i>	E-0897
<i>Common Diseases of the Grapevine in Michigan</i>	E-1732
<i>Peach Culture in Michigan</i>	E-0509
<i>Pear Culture in Michigan</i>	E-0519
<i>Safe, Effective Use of Pesticides</i>	E-1824
<i>Growing Raspberries in Michigan</i>	E-0543
<i>Raspberry Diseases in Michigan</i>	E-1730
<i>Cedar-Apple Rust</i>	E-1441
<i>Tractor-mounted Air Blast Sprayers</i>	E-0840
<i>Increasing Storage and Market Life of Jonathan Apples</i>	E-0627
<i>Controlling Apple Storage Scald</i>	E-1015
<i>Refrigeration & Controlled Atmosphere Storage for Horticultural Crops</i>	E-1914
<i>Commercial Strawberry Culture in Michigan</i>	E-0682
<i>Strawberry Diseases in Michigan</i>	E-1728
<i>Diseases of Tree Fruits</i>	NCR-045
<i>Tree Fruit Insects</i>	NCR-063
<i>Vineyard Preparation for Nematode and Virus Disease Control</i>	E-0806
<i>Common Weed Seedlings of Michigan</i>	E-1363

These additional reference materials are available at any county Cooperative Extension Service office and at the Michigan State University-CES Bulletin Office, P.O. Box 6640, East Lansing, MI 48823-6640.

Safe Use of Pesticides in Pest Management (Guidelines)

Selection of 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. Make certain that your operation will use the pesticide only for the purposes listed and in the manner directed on the label. Select only those pesticides that are 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, and the surrounding environment.

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 reference during any pesticide emergency. Bring the specimen label material along with any person who has become poisoned and needs medical attention.

Closely follow all the warning statements outlined in the PRECAUTIONARY STATEMENTS section on 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 STATEMENT OF PRACTICAL TREATMENT that is given on the front panel of all pesticide labels.

Transporting Pesticides

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

Storage of 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 easily han-

dling pesticide spills and made of materials that will not adsorb 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. Try to store herbicides separate from insecticides and fungicides because volatile materials will cross contaminate other materials. 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. Always read and follow the STORAGE AND DISPOSAL section of all pesticide labels.

Handling and Mixing of Pesticides

Always wear protective clothing and equipment when handling, mixing, and applying pesticides and during the clean up of application equipment. Protective equipment should include full coverage clothing, chemical resistant gloves and boots, eye protection, hard hat, and a MSHA/NIOSH approved respirator with a chemical adsorbent material appropriate for the pesticide being used.

Mix pesticides upwind 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 accidents. Try to use closed handling/mixing systems when appropriate.

Mix only what is required for the area (lb/acre) 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 in which you handle pesticides.

Application of Pesticides

Prior to any application, the equipment used must be thoroughly checked for sound operation and accurately calibrated. Poor maintenance and calibration practices will lead to excessive residues on the crop and could harm humans, animals, crops and the environment. Inspect the application equipment during use to prevent the unintentional release of chemicals. If the equipment needs repair, stop the application operation and fix the problem before completing the spray job. Spray only the

label directed rate to the target area.

Do not spray on days 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.

Warn all unauthorized persons to get out of the target area during the pesticide application. Warn occupants of properties abutting the target area when such precautions are specified by the label of the pesticide being used.

Protect the Bees

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

"Do not spray plants in bloom" is the basic rule in protecting bees. This applies not only to the fruit bloom but also to dandelions and clovers that may be reached by the spray. Mowing dandelions, yellow rocket and clovers in the fruit area helps. Also, do not let puddles of spray accumulate on the ground where bees might drink it. If beekeepers supply fresh water near the bee hives, this hazard is reduced. Where there is a choice, use insecticides least harmful to bees. The table on page 31 rates the toxicity of most of the common insecticides to bees and will serve as a guide to choose the least hazardous material.

Handling and Disposing of Pesticide Containers

All pesticide containers are considered HAZARDOUS WASTE unless they are triple rinsed and the rinsate is used as additional dilution in the spray mixture. After triple rinsing all emptied pesticide containers, perforate both ends so that the container cannot be used. 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 land fill. Dispose of all paper containers in a sanitary land fill or municipal waste incinerator. Do not bury or burn any pesticide containers. Do

not re-use any empty pesticide containers for any purpose.

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

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 label USE directions. If these procedures cannot be met, contact the Michigan Department of Natural Resources Hazardous Waste Division, for instructions on the legal disposal of pesticide waste.

Re-entry into the Application Area

Read and follow the label instructions on re-entry for every pesticide used. Post areas that have been treated to warn others not to enter until the specified re-entry time has elapsed. Take down the postings when the re-entry time is over. Any person who has to go into a treated area prior to the elapse of the re-entry period must wear protective clothing. Farm workers should not work in the treated area until the re-entry time has elapsed. There should be no excuses for farm worker exposure to pesticides during or immediately after a pesticide application.

Fungicides

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Tree Fruit Crops

Bayleton (triadimefon) is particularly effective against apple powdery mildew (*Podosphaera leucotricha*). It is not effective against mildew on cherries caused by *Podosphaera oxyacanthae*. It controls mildew in three ways: 1) by preventing completion of the infection process initiated by spore germination, 2) by preventing symptom development after infection has taken place, and 3) by preventing further symptom expression when applied after symptoms have appeared. When applied on a seasonal basis for existing powdery mildew infection, the level of overwintering inoculum is significantly reduced; therefore, control the following season is much easier. Bayleton is highly effective against cedar apple rust but must be combined with a scab fungicide when apple scab control is also desired.

Bravo (*chlorothalonil*) is registered on cherries for the control of brown rot blossom blight and cherry leaf spot through shuck-split. It is also used as a postharvest treatment for cherry leaf spot. It is a protective fungicide.

Funginex (*triforine*) is registered for use on apples for apple scab, powdery mildew, and rust disease control. Applications are limited to the period from 1/2-inch green tip to petal fall with a limit of 5 applications per season. Funginex is primarily an after-infection fungicide for use in after-infection type scab control programs. Treatments should be made within 72 hr. from the beginning of a wet period suitable for scab infection. It is used at 10 fl. oz. per 100 gallons dilute spray or 36-40 fl. oz. per acre.

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

The use of Funginex on cherries after the bloom period is not registered because of widespread russetting problems experienced in 1982. Injury was more severe on sweet cherry than sour cherry but occurred on both crops. The injury problem occurred in experimental and commercial orchards.

In after-infection studies, triforine has exceeded the after-infection activity of dichlone for brown rot blossom blight. Against cherry leaf spot, triforine applied within 1 to 3 days after infection will prevent typical lesion development, leaf yellowing, or leaf abscission. Although triforine has considerable after-infection activity, it is a

weak protectant and will require frequent applications when rainy periods are extended.

Ronilan (*Vinclozolin*) and **Rovral** (*Iprodione*) are protective fungicides for the control of brown rot blossom and twig blight, and fruit brown rot on stone fruit crops including apricots, cherries, nectarines, peaches, plums and prunes. Both are formulated as a 50% wettable powder and are used at the rate of 1.5 to 2 lb of product per acre. The 2 lb per acre rate is for high disease pressure, and rates should not exceed 2 lb of product per acre. Two applications (minimum) should be made for control of brown rot blossom and twig blight. Begin applications for control of fruit brown rot 21 days before harvest and repeat as needed to within 3 days of harvest for Ronilan and up to and including the day of harvest for Rovral.

Ronilan and Rovral belong to the dicarboximide group of fungicides. They have provided excellent control of brown rot blossom blight in research trials, even when applied 12-24 hours after inoculation. Because of this after-infection activity, a dicarboximide fungicide should be substituted for dichlone in emergency situations during bloom when more than 12 hr. of after-infection control is desired. Browning of blossom petals of the type sometimes observed with dichlone has not been observed with the dicarboximide fungicides. The dicarboximide fungicides do not control cherry leaf spot. Because of their excellent activity against brown rot, the dicarboximide fungicides are particularly important to Michigan stone fruit growers during the preharvest period.

Ridomil (*metalaxyl*) is specific for the control of root and crown rot problems caused by the Oomycete class of fungi (namely, *Phytophthora* spp. and *Pythium* spp.). It is formulated as an emulsifiable concentrate containing 2 lb active ingredient per gallon. It can be used on bearing apples and on all deciduous tree fruits in nurseries and nonbearing field plantings. It is not a substitute for good cultural practices or rootstocks that are most tolerant to the disease. Applications should be made before symptoms appear as it will not revitalize trees showing moderate to severe crown rot symptoms.

Rubigan (*fenarimol*), after 17 years in development, was registered for use on apples on October 23, 1986. It controls apple scab, powdery mildew, and rust diseases. Use Rubigan 1 EC at 6-12 fl oz/acre in either a regular schedule, an extended regular schedule or an after-infection schedule.

On a regular schedule apply 6-12 fl oz at intervals not to exceed 7 days. When using low rates (6-9 fl oz), repeat applications of Rubigan are essential, even when the weather following a scab infection period is unfavorable for new infection. This is because scab lesions are initially suppressed but not eliminated by low rates of Rubigan. Additional sprays of Rubigan are required to eliminate the established but latent infections. Switching to a conventional protectant fungicide may permit the latent infections to develop. Combine Rubigan with a protectant fungicide in the last Rubigan application before switching to another fungicide program.

On an extended regular schedule, combine Rubigan with a protectant fungicide at the recommended use rate for the protectant fungicide. Application intervals should not exceed 10 days. If the rate of the protectant fungicide is reduced, application intervals should not exceed 7 days. In research trials in years with severe pressure, scab control has not been adequate with Rubigan in combination with reduced rates of the protectant fungicide used on 10-day schedules.

In after-infection treatments, use 12 fl oz as the standard rate within 72-96 hr from the beginning of the infection period. Only use the 9 fl oz rate within 72 hr following light infection periods. All after-infection treatments should be followed 7 days later with a second application of Rubigan at 6-12 fl oz.

Small Fruit Crops

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

chemicals. Also, caution should be exercised when adding emulsifiable concentrates.

Funginex (*Triforine, Sapro-N, N'-[1,4-piperazine-diyi-bis-(2,2,2-trichloroethylidene)]-bis-[formamide]*).

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

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

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

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

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

Ridomil (metalaxyl) is a highly active fungicide against *Pythium* and *Phytophthora* (water mold) fungi. It is registered as a 15% granular formulation for soil application to control *Phytophthora* root rot in bearing raspberry.

Rovral (*Iprodione*) is registered for use in grapes for the control of *Botrytis* fruit rot.

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

Insecticides

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Asana is the active isomer of Pydrin. It is used at approximately one-quarter of the rate of Pydrin. Asana will be available as a 1.9 lb per gal EC and only registered for apples.

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

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

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

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 fruitfly and blueberry maggot.

Diazinon ranks intermediate between parathion and malathion in toxicity to humans. It is active against a variety of fruit pests, offering residual activity of 11 to 14 days and has clearance for use on apples, pears, cherries, peaches, plums, prunes, strawberries, grapes and brambles. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer or oblique banded leafroller, which are common in Michigan. Drenching crown treatments of emulsifiable concentrate will kill the overwintering stage of raspberry crown borers when they are a problem.

Dimethoate is marketed as *Cygon* and *De-Fend* for control of a wide range of insects on bearing apples and pears. Sold as a 2.67 lb/gal or 4 EC emulsifiable con-

centrate 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 will also control apple maggot. Compared to many insecticides, it is practically without compatibility problems. While toxic to bees, the product is one of the least poisonous of the organic phosphates to humans and animals.

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

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

Guthion is the most widely used insecticide in Michigan orchards. Available as a 50% wettable powder, a 35 wettable powder or 2 lb/gal spray concentrate, it has provided good broad spectrum control of many primary fruit pests with a residual action of 10 to 14 days. The spray concentrate is not cleared for apples and pears. There have been no phytotoxicity or residue problems when the compound is used properly and in accordance with label directions.

To avoid prohibitive residues, no more than 8 applications of Guthion on deciduous fruit, nor 3 to 4 applications on grapes, strawberries and blueberries are permissible in a season. While Guthion is similar to parathion in toxicity to humans, it is of low toxicity to predaceous orchard mites. Make use of the safety measures reserved for organophosphate insecticides when handling this material. It will not control organic phosphate resistant white apple leafhopper, spotted tentiform

leafminer and oblique banded leafrollers, which are prevalent in Michigan.

Imidan is a phosphate chemical with a low toxicity to mammals comparable to Sevin. It is formulated as a 50% wettable powder for pre-bloom and post-bloom application on apples, pears, peaches, cherries, plums, prunes, grapes and apricots. It is phytotoxic on sweet cherries. It provides good broad-spectrum control of many fruit pests in Michigan. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer and oblique banded leafroller, which are common in Michigan.

Lannate (see Methomyl).

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

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

Mesurol is a broad spectrum carbamate insecticide that is an effective bird repellent. It repels grackles, robins, starlings, and cedar waxwings from the treated crop area, and minimizes fruit loss due to bird damage. It is registered on cherries and blueberries. It is highly toxic to bees and predators. A maximum of 4 lb of product may be applied per acre per season.

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

Methomyl is effective in controlling green fruitworm,

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

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

Mitac is a formamidine insecticide-acaricide. It effectively controls pear psylla. Mitac EC will control pear rust mite and pear blister mite on pears. It has proven to be excellent in controlling summer populations of pear psylla that are resistant to other insecticides including pyrethroids. Mitac should be applied when temperatures are 60°F or higher. Mitac will control codling moth on pears.

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

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

Parathion is extremely toxic to man and animals. Along with a complete understanding of the label, adequate

safety precautions include rubber gloves, suitable protective clothing and an approved face mask. It has been widely used since 1949 for control of many fruit pests. No injury from this material has been observed on peaches, plums and cherries. Apples, and occasionally pears, have been injured when parathion was used in excess of suggested dosages.

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

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

Penncap-M is registered for use on cherry, nectarine, plum, prune, peach, pear, apple and grape for control of key pests such as codling moth, oriental fruit moth, plum curculio, leafrollers and grape leafhopper. It will not give control of organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer or oblique banded leafroller, which are prevalent in Michigan.

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

Permethrin (Ambush or Pounce) is a member of the class of insecticides known as the synthetic pyrethroids. These compounds exhibit low mammalian toxicity while having very high insecticidal activity. They act as stomach and contact poisons. Permethrin is cleared for seasonal use on pears, apples, peaches and cherries. It will give control of insects that are resistant to organic phosphates.

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

Phosphamidon warrants the same precautions granted any cholinesterase-inhibiting chemical and it is highly toxic to mite predators.

Pounce (see Permethrin).

Pydrin (see Fenvalerate).

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

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

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

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

Preventive European red mite control programs are designed to control the mites at an early stage in their development to prevent any build-up through the season. Supplemental measures are usually required in mid- to late-season. Eradicate mite control programs, on the other hand, attempt to control mites after they have increased sufficiently in numbers to damage the crop. During the past few seasons the eradication pro-

grams have been expensive but not very successful in controlling established mite populations. Oil applications have no value in controlling the two-spotted mite.

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

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

^aThe following ASTM methods are to be used:

¹D445-61 and D446-53; ²D287-55; ³D483-61T;

⁴D97-57; ⁵D1160-61; ⁶D447-59T.

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

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

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

Vendex is formulated as a 50% wettable powder, and as a 4L non-phosphate miticide with very good activity against a wide range of plant-feeding mites. Since it is

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

Vydate L is a systemic and contact carbamate insecticide-acaricide-nematicide. It is currently labeled as a nematicide and miticide on non-bearing trees, and as an insecticide-miticide on bearing apple trees. It gives excellent control of aphids, leafhoppers, mites and leaf-miner larvae; however, it is highly toxic to bees and predators. **WARNING:** Do not apply within 30 days after bloom at a rate greater than 1/2 pt/100 gal or fruit thinning may occur. Outbreaks of wooly apple aphid may occur from a season-long program of vydate.

Zolone is a non-systemic phosphate insecticide-miticide. Presently registered for use on apples, pears, grapes and the stone fruits, it controls most major fruit pests and suppresses or controls minor pests. It will not control organic phosphate resistant strains of white apple leafhopper, spotted tentiform leafminer or oblique banded leafroller, which are common in Michigan. Marketed as an emulsifiable concentrate containing 3 lb of active ingredient per gallon and a 25% wettable powder, it can be applied to within 14 days of harvest on apples, pears, grapes; and within 7 days of harvest on stone fruits.

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

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

Zolone is recommended in cover spray applications following First Cover.

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

Monitoring Insects

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

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

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

Regular Inspections

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

Leaf Sampling-Brushing

Another monitoring technique used specifically to detect the presence and relative numbers of mite pests is leaf sampling and brushing. A sample of leaves, usually 50 or 100, are picked from trees throughout an orchard. The leaves are then passed through a mite-brushing machine where mites on the surface of the leaf are brushed onto a sticky plate. The mites on a predeter-

mined area of the plate are counted and the average number of mites per leaf calculated. This technique is not only useful in detecting pest mites but also reveals the presence of predator mites and is an important tool in integrated mite control.

Bait-Lure Trap

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

Pheromone Trap

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

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

Tree-Row Volume

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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 × 35 feet.

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

As the gallonage of water is reduced errors become more critical. Sprays applied 3X or higher concentrate levels result in a 20-25% increase in deposit, thus allowing a similar reduction in rate of pesticide application without a reduction in pesticide deposit. From a practical viewpoint the acceptable concentrate level depends on several factors including the pest being controlled, density of foliage, weather conditions, and material being applied. Dilute sprays are preferred for applying growth regulators and control of pests such as scale and 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 × the tree width × lineal feet in an orchard.

Example: Rows are 35 ft apart, with a tree width of 23.3 and a tree ht of 20. The lineal feet in this orchard is $43,560 \div 35 = 1245$ lineal ft. The cubic feet = $1245 \times 23.2 \times 20 = 580,180$. $580,180 \div 400 = 1450$ cubic feet. As stated previously, it takes 1 gallon of spray material for every 1450 cubic feet. To simplify tree-row-volume, a graph is presented on page 17 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 × width figure to the intersection with the row spacing base line. Directly below this point on the horizontal axis is the required gallons per acre figure for dilute spraying. Two examples are shown on the graph. Example 1 illustrates 25 foot row spacing with trees that are 16 feet high and 16 feet wide. Draw a base line from 0 to 25, multiply 16×16 to get 256. Follow a horizontal line from 256 to the base line. Vertically below this is a base gallonage of 313 gpa dilute. Example 2 shows a need of 220 gpa dilute for 20 foot rows and trees that are 12 feet high and 12 feet wide.

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

As with any other production procedure, grower judgement must be used with this method. Where tree size is quite variable, calibration should be done for the average of the largest trees. Since two-thirds of the spray is directed to the top of the trees, excess material should be blown over 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 under estimating could lead to lack of control.

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

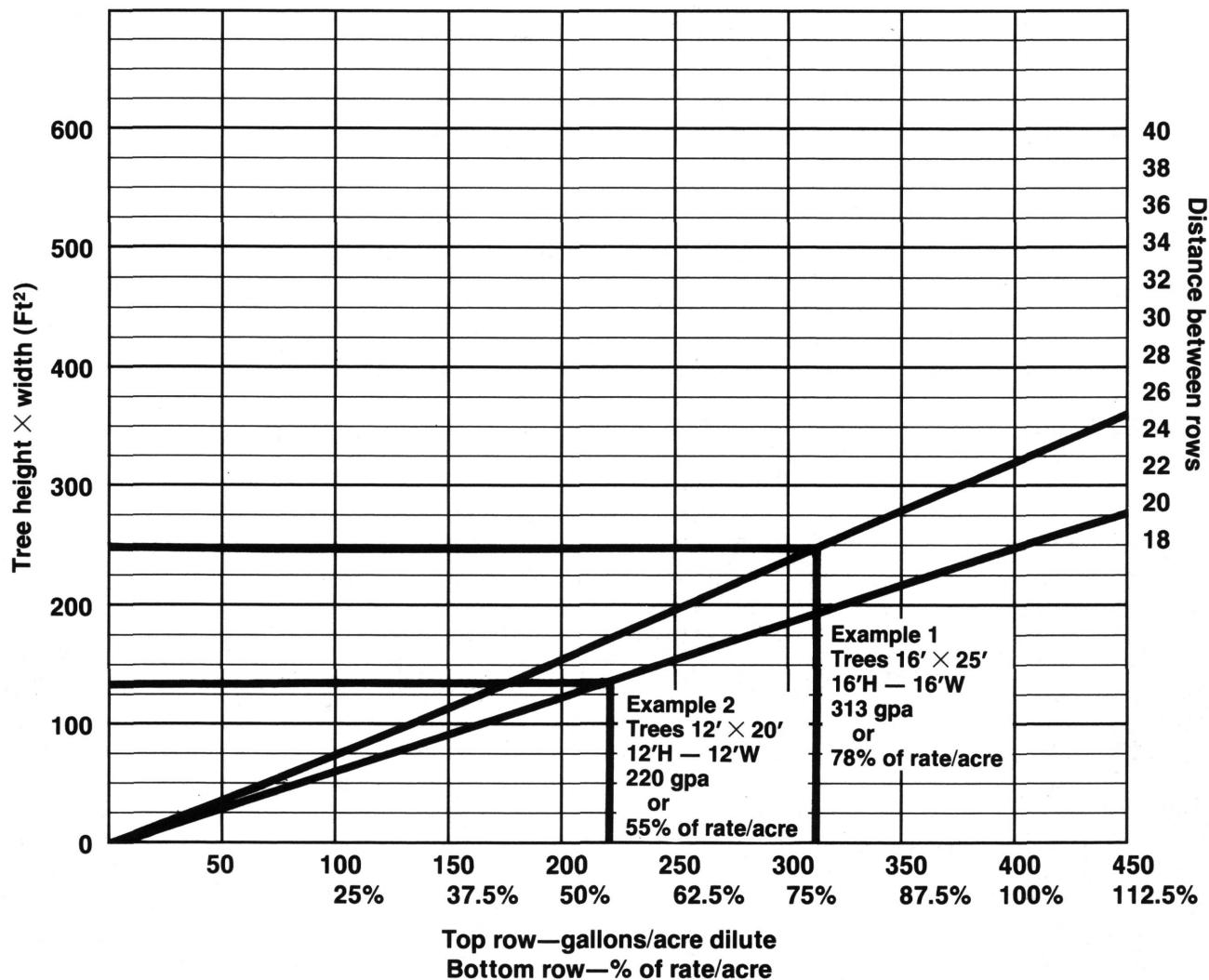
made before spraying blocks of different sized trees.

Until a grower gains experience with this method, it is suggested that a grower experiment with one or two blocks before committing 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 the Virginia Experiment Station, 2500 Valley Ave., Winchester, Virginia 22601. The cost is \$3.00 each.

Tree-Row Volume Graph

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



1988 Percent of Standard Chart

(Standard is 400 gal/A)

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

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

1988 Tree-Row Volume Insecticide Chart

Percent of Standard		20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0
Gallons of Water/Acre (Dilute)		80.0	120.0	160.0	200.0	240.0	280.0	320.0	360.0	400.0	440.0
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
	75 WP	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2
Azinphos-Methyl	50 WP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Carzol	92 SP	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4
Cygon	25 WP	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
	2.67 EC	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
Defend	25 WP	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
	2.67 EC	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
Diazinon	50 WP	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Dimethoate	See Cygon and Defend										
Ethion	8 E	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Guthion	50 WP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Imidan	50 WP	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Lannate	1.8 EC	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
	90 SP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Lorsban	50 WP	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3
	4 EC	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Methomyl	See Lannate										
Morestan	25 WP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Nudrin	1.8 EC	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
	90 SP	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Superior Oil		1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
Omite	6 F	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0	39.6
	30 WP	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Parathion	15 WP	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
	8 F	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Payoff	2.5 EC	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Penncap-M	2 FM	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Phosphamidon		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Plictran	50 WP	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4
Pounce	3.2 EC	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
Pydrin	2.4 EC	2.1	3.2	4.3	5.3	6.4	7.5	8.6	9.6	10.7	11.8
Sevin	50 WP	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8
	80 S	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Supriicide	2 E	0.9	1.4	1.8	2.2	2.7	3.1	3.6	4.0	4.5	5.0
Thiodan	50 WP	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
	3 EC	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9
Vendex	50 WP	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.6
Vydate	2L	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Zolone	25 WP	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
	3 EC	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4

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

1988 Insecticide-Miticide Rates for Apples

E-154 No.	Material	Formulation	Recommended		Days to Re-entry
			Per 100 Gallons	Full Rate Per Acre	
34	Ambush	2 EC 25 WP	3.2 oz 3.25 oz	12.8 oz 13 oz	0 0
8	Azinphos-methyl	50 WP	0.5 lb	2 lb	1
3	Carzol	92 SP	5 oz	1.25 lb	0
6	Cygon	25 WP 2.67 EC	2 lb 1.5 pt	8 lb 6 pt	0 0
6	Defend	25 WP 2.67 EC	2 lb 1.5 pt	8 lb 6 pt	0 0
5	Diazinon	50 WP	1 lb	4 lb	0
6	Dimethoate	See Cygon and Defend			
7	Ethion	8 E	0.5 pt	2 pt	1
8	Guthion	50 WP	0.5 lb	2 lb	1
8	Guthion	35 WP	12 oz	3 lb	
9	Imidan	50 WP	1 lb	4 lb	0
11	Lannate	1.8 EC 90 SP	2 pt 0.5 lb	8 pt 2 lb	0
32	Lorsban	50 WP 4 EC	12 oz 2 pt	3 lb 4 pt	0
11	Methomyl	See Lannate			
15	Morestan	25 WP	0.5 lb	2 lb	0
24	Superior Oil		2 gal	8 gal	0
16	Omite	6 F 30 WP	8-10 oz 1.25 lb	32-40 oz 5 lb	0 0
17	Parathion	15 WP 8 F	1.5 lb 0.25 pt	6 lb 1 pt	2 2
37	Payoff	2.5 EC	1 oz	4 oz	0
18	Penncap-M	2 FM	1 pt	4 pt	0
20	Phosphamidon		0.25 pt	1 pt	0
35	Pounce	3.2 EC	2 oz	8 oz	0
31	Pydrin	2.4 EC	2.7 oz	10.7 oz	0
23	Sevin	50 WP 80 S	2 lb 1.25 lb	8 lb 5 lb	0 0
33	Supracide	2 E	1 qt	3-6 qt	
26	Thiodan	50 WP 3 EC	1 lb 2/3 qt	4 lb 2 2/3 qt	0 0
28	Vendex	50 WP	4-8 oz	1-2 lb	0
28	Vendex	4 L	4-8 fl oz	1-2 pt	
30	Vydate	2 L	1 pt	4 pt	0
29	Zolone	25 WP 3 EC	1.5 lb 1 pt	6 lb 4 pt	1 1

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

How to Use the 1988 Fruit Spray Calendar

The evaluation of how well certain insecticides control specific insects found in the 1987 Fruit Pesticide Manual was obtained from research data gathered during the past several years. The ratings can help growers determine which materials to use to control certain pests. The ratings may not be accurate in all orchards, as orchards differ due to past chemical application (which may lead to resistance), population levels at time of application and environmental conditions affecting insect susceptibility and pesticide activity or persistence.

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

example, Methomyl is excellent, Thiodan is fair and Zolone is good in controlling green fruitworm.

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

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

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

Guide to Abbreviations Used in This Bulletin

B = bait
D = dust
DF = dry flowable
EC = emulsifiable concentrate or emulsion
F = flowable
G = granule

L or LC = liquid concentrate
LS = liquid solution
S = sprayable
SC = suspension concentrate
SP = soluble powder
W or WP = wettable powder

APPLES

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

After each pest name appears a series of numbers

and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number corresponds to the number of the pesticide in the column headed "Suggested Chemicals." The letter p = poor for the pesticide controlling the pest.

Apple Scab Control (see page 26 for details)

SILVER TIP

Fungicides	Rate/acre	Comments
Dichlone 50% WP plus protectant	1 lb 1/2 strength	Do not use beyond early pink. Do not use with oil or near oil applications.
Funginex 18.2% EC	36-40 fl oz	For use from 1/2-inch green tip to petal fall in after-infection type programs.
Captan 50% WP	8 lb	Because dodine- and Benlate-resistant apple scab are widespread in Michigan, dodine (Cyprex), Benlate and Topsin-M are not recommended for general use on apples.
Dikar 80% WP	8 lb	
Polyram 80% WP	8 lb	
Difolatan 80% DG	25 lb	Single application only of Difolatan 80% DG—see item 4 on page 27.
Difolatan 80% DG	15 lb	Where conditions for scab are severe, use a regular program of Rubigan following Difolatan.
Rubigan 1 EC	6-12 fl oz	Use in regular or after-infection schedules. Tank mix with a protectant fungicide when spray intervals exceed 7 days. Do not apply after second cover spray or after 1/2 in. diameter fruit, whichever occurs first. (Registration of Rubigan after second cover is pending.)

TIGHT CLUSTER—PRE-PINK

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 26	INSECTICIDES
Powdery Mildew	See "Special Apple Disease Controls," page 27	3. Carzol 92 SP (1 lb) 24. Superior Oil (8 gal) 26. Thiodan 50 WP (4 lb) 26. Thiodan 3 EC (2 ^{2/3} qt) 31. Pydrin 2.4 EC (10.8 fl oz) 32. Lorsban 4 EC (4 pt) 33. Supracide 2E (4 qt) 34. Ambush 2 EC (12.8 oz) 34. Ambush 25 WP (12.8 oz) 35. Pounce 3.2 EC (8 fl oz) 35. Pounce 25 WP (12.8 oz) 37. Pay-off 2.5 EC (4 fl oz) 40. Asana 1.9 EC (3.5 fl oz)
INSECTS/MITES		
European Red Mite	24e	
San Jose Scale	24e, 32e, 33e	
Spotted Tentiform Leaf Miner (adult and eggs)	3g, 26f, **31e, **34e, **35e, **37e	
Comments: Tight cluster and pre-pink sprays are needed for control of spotted tentiform leaf miner adults and eggs.		
Comments: Double asterisk (**)—Pydrin, Pounce, Ambush and Payoff are adulticides and ovicides and should be applied before the eggs hatch.		

APPLES

PINK

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Comments: <i>Mildew control is critical at this time. If a severe problem exists, start at green tip.</i>		
INSECTS/MITES		
European Red Mite	3e, 15e, 30f	
Aphids	6e, 11g, 20e, 26e, 29g, 30g	
Tarnished Plantbug	3g, 6e, 11g, 26f, 29g, 31e, 34e, 35e, 37e	
Green Fruitworm	11g, 26f, 31e, 34e, 35e	
Resistant Oblique Banded Leafroller	11e, 31e, 34e, 35e, 37e	
Non-Resistant Oblique Banded Leafroller	8e, 9e, 11e, 29e, 31e, 34e, 35e, 37e	
INSECTICIDES		
	3. Carzol 92 SP (1 lb)	
	5. Diazinon 50 WP (4 lb)	
	6. Dimethoate 2.67 EC (6 pt)	
	6. Dimethoate 25 WP (8 lb)	
	6. Dimethoate 400 (4 pt)	
	8. Guthion 50 WP (2 lb)	
	8. Guthion 35 WP (3 lb)	
	9. Imidan 50 WP (4 lb)	
	11. Lannate 1.8 EC (8 pt)	
	11. Lannate 90 SP (2 lb)	
	15. Morestan 25 WP (2 lb)	
	20. Phosphamidon 8 EC (1 pt)	
	26. Thiodan 50 WP (4 lb)	
	26. Thiodan 3 EC (2 $\frac{2}{3}$ qt)	
	29. Zolone 3 EC (4 pt)	
	30. Vydate 2 L (4-8 pt)	
	31. Pydrin 2.4 EC (10.7 fl oz)	
	34. Ambush 2 EC (12.8 oz)	
	34. Ambush 25 WP (12.8 oz)	
	35. Pounce 3.2 EC (8 fl oz)	
	35. Pounce 25 WP (12.8 oz)	
	37. Pay-off 2.5 EC (4 fl oz)	
	40. Asana 1.9 EC (3.5 fl oz)	

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Fire Blight	See "Special Apple Disease Controls," page 28	

APPLES

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Fire Blight	See "Special Apple Disease Controls," page 28	
INSECTS/MITES		
White Apple Leafhopper	3e, 6f, 11e	
Tarnished Plantbug	6e, 26g, 31e, 37e, 34e, 35e	
Green Fruitworm	11g, 18g,* 26f, 29g, 31e, 32g,** 35e, 37e	
Plum Curculio	8e, 9e, 18e,* 29g, 31e, 32g, 37e, 34e, 35e	
Leafrollers	8e, 9e, 11e, 18e,* 29e, 31e, 32e,** 37e, 34e, 35e	
Spotted Tentiform Leaf Miner (Larvae)	11e	
Oblique Banded Leafroller	See Pink	
INSECTICIDES		
3. Carzol 92 SP (1 lb)		
5. Diazinon 50 WP (4 lb)		
6. Dimethoate 2.67 EC (6 pt)		
6. Dimethoate 25 WP (8 lb)		
6. Dimethoate-400 (4 pt)		
8. Guthion 50 WP (2 lb)		
8. Guthion 35 WP (3 lb)		
9. Imidan 50 WP (4 lb)		
11. Lannate 1.8 EC (8 pt)		
11. Lannate 90 SP (2 lb)		
18. Penncap-M 2F* (4 pt)		
26. Thiodan 50 WP (4 lb)		
29. Zolone 3 EC (4 pt)		
29. Zolone 25 WP (6 lb)		
31. Pydrin 3.2 EC (10.8 fl oz)		
32. Lorsban 50 WP (2-3 lb)**		
34. Ambush 2 E (12.8 oz)		
34. Ambush 25 WP (12.8 oz)		
35. Pounce 3.2 EC (8 fl oz)		
35. Pounce 25 WP (12.8 oz)		
37. Pay-off 2.5 EC (4 fl oz)		
40. Asana 1.9 EC (3.5 fl oz)		
Comments:		
Asterisk (*)—WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6). Half rates of the combinations of Guthion plus methomyl or Imidan plus methomyl or Zolone plus methomyl will also control all petal fall pests.		
Vydate 2 L should not be used within 30 days post bloom at rates greater than $\frac{1}{2}$ pt./100 gal. or fruit thinning may occur.		
Double asterisk (**)—Use 2 lb/A. For plum curculio use 3 lb/A.		

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Primary)	See Silver Tip and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Fire Blight	See "Special Apple Disease Controls," page 28	
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 28	
INSECTS/MITES		
Plum Curculio	See Petal Fall	
Leafrollers	See Petal Fall	
Comments:		
If white apple leafhopper, green fruitworm, tarnished plantbug or aphids were not controlled at petal fall, then these pests should be controlled now with the chemicals recommended at petal fall.		

APPLES

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	50g, 51g, 52g and see page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Blister Spot on Mutsu	See "Special Apple Disease Controls," page 28	
INSECTS/MITES		
Codling Moth	5e, 8e, 9e, 11e, 17g, 18e, 23e, 29e, 31e, 37e	
San Jose Scale (crawlers)	5g, 18g, 32e*	
Tufted Apple Budmoth	8g, 11g, 29g, 18g, 31e, 32e, 37e	
Comments: Call the local pest management code-a-phone or determine from the Extension horticultural agent when sprays should be applied.		
FUNGICIDES		
	50. Captan 50 WP (6 lb)	
	51. Dikar 80 WP (6 lb)	
	52. Polyram 80 WP (6 lb)	
INSECTICIDES		
	5. Diazinon 50 WP (4 lb)	
	6. Dimethoate 400 (4 pt)	
	6. Dimethoate 2.67 EC (6 pt)	
	6. Dimethoate 25 WP (8 lb)	
	8. Guthion 50 WP (2 lb)	
	8. Guthion 35 WP (3 lb)	
	9. Imidan 50 WP (4 lb)	
	11. Lannate 1.8 (8 pt)	
	11. Lannate 90 SP (2 lb)	
	17. Parathion 15 WP (6 lb)	
	17. Parathion 8 F (1 pt)	
	18. Penncap-M 2F (4 pt)	
	23. Sevin 50 WP (8 lb)	
	23. Sevin 80 S (5 lb)	
	29. Zolone 3 EC (4 pt)	
	29. Zolone 25 WP (6 lb)	
	31. Pydrin 3.2 EC (10.8 fl oz)	
	32. Lorsban 50 WP (2-3 lb)	
	37. Pay-off 2.5 EC (4 fl oz)	
	40. Asana 1.9 EC (3.5 fl oz)	
Comments: If tufted apple bud moth is a problem, half rates of Zolone and Penncap-M or half rates of methomyl and Guthion will control this pest.		
Asterisk (*)—Use 2 lb/A. For tufted apple budmoth use 3 lb/A.		

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
INSECTS/MITES		
Codling Moth	See Second Cover	
Mites (adults)*	3e, 16g, 28e, 30g	
Mites (immature)	3e, 16g, 28g, 30g	
Red-banded Leafroller	See Petal Fall	
Green Apple Aphid	6e, 11g, 20e, 30g, 31f, 32f,* 37f	
Tufted Apple Budmoth	8g, 11g, 29g, 18g, 32e, 31e, 37e	
Comments: See note under 2nd cover on tufted apple budmoth. For mites, see "Special Apple Insect Controls," page 30.		
INSECTICIDES		
	3. Carzol 92 SP (1 1/4 lb)	
	6. Dimethoate 400 (4 pt)	
	6. Dimethoate 2.67 EC (6 pt)	
	6. Dimethoate 25 WP (8 lb)	
	8. Guthion 50 WP (2 lb)	
	8. Guthion 35 WP (3 lb)	
	11. Lannate 1.8 (8 pt)	
	11. Lannate 90 SP (2 lb)	
	16. Omite 6 F (32-40 fl oz)	
	16. Omite 30 WP (5 lb)	
	18. Penncap-M 2F (4 pt)	
	20. Phosphamidon 8 EC (1 pt)	
	28. Vendex 50 WP (1-2 lb)	
	28. Vendex 4 L (1-2 pt)	
	29. Zolone 25 WP (6 lb)	
	30. Vydate 2 L (4 pt)	
	31. Pydrin 2.4 EC (10.8 fl oz)	
	32. Lorsban 50 WP (2-3 lb)	
	37. Pay-off 2.5 EC (4 fl oz)	
	40. Asana 1.9 EC (3.5 fl oz)	

APPLES

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 26	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 27	
INSECTS/MITES		
Apple Maggot*	5g, 6e, 8e, 18e, 23f, 29g, 31f, 32f, 37e	
Codling Moth	See Second Cover	
Oriental Fruit Moth	5g, 8e, 18e, 19e, 23e, 29e, 31e, **32e, 34e, 35e, 40e	
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for apple maggots should be applied. See "Special Apple Insect Problems," page 30.		
INSECTICIDES		
5. Diazinon 50 WP (4 lb)		
6. Dimethoate 400 (4 pt)		
6. Dimethoate 2.67 EC (6 pt)		
6. Dimethoate 25 WP (8 lb)		
8. Guthion 50 WP* (2 lb)		
8. Guthion 35 WP (3 lb)		
9. Imidan 50 WP* (4 lb)		
18. Penncap-M* (4 pt)		
23. Sevin 50 WP (8 lb)		
23. Sevin 80 S (5 lb)		
29. Zolone 3 EC (4 pt)		
29. Zolone 25 WP (6 lb)		
31. Pydrin 2.4 EC (10.8 fl oz)		
32. Lorsban 50 WP* (2-3 lb)		
37. Pay-off 2.5 EC (4 fl oz)		
40. Asana 1.9 EC (3.5 fl oz)		
Comments: Asterisk (*)—Combinations of half rate of Lorsban plus half rate of Guthion, Imidan, Zolone, or Penncap-M will control apple maggot, San Jose scale and other pests with the exception of spotted tentiform leafminer and white apple leafhopper.		
Double asterisk (**)—Use 3 lb/A.		

FIFTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 26.	
Powdery Mildew	See "Special Apple Disease Controls," page 27	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 27	
INSECTS/MITES		
Apple Maggot	See Fourth Cover	
Codling Moth	See Second Cover	
Red-banded Leafroller	See Petal Fall	
Resistant Oblique-Banded Leafroller	11e, 31e, 37e	
Nonresistant Oblique-Banded Leafroller	8e, 9e, 11e, 29e, 31e, 37e	
Dogwood Borer	32e, See "Special Apple Insect Problems," page 30	
Oriental Fruit Moth	See Fourth Cover	
INSECTICIDES		
8. Guthion 50 WP (2 lb)		
8. Guthion 35 WP (3 lb)		
9. Imidan 50 WP (4 lb)		
11. Lannate 1.8 (8 pt)		
11. Lannate 90 SP (2 lb)		
29. Zolone 3 EC (4 pt)		
31. Pydrin 2.4 EC (10.8 fl oz)		
32. Lorsban 50 WP (3 lb/100 gal)		
37. Pay-off 2.5 EC (4 fl oz)		
40. Asana 1.9 EC (3.5 fl oz)		

APPLES

SIXTH, SEVENTH AND EIGHTH COVERS (IF NEEDED)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Apple Scab (Secondary)	See Second Cover and page 26	
Sooty Blotch, Fly Speck	See "Special Apple Disease Controls," page 27	
INSECTS/MITES		
Aphids	See Third Cover	
Apple Maggot	See Fourth Cover	
Codling Moth	See Second Cover	
Red-banded Leafroller	See Petal Fall	
Spotted Tentiform Leaf Miner (larvae)	11e, 30e	
White Apple Leafhopper	3e, 11e, 23e	
Tufted Apple Budmoth	8g, 29g, 18g, 31e, 32e, 37e	
San Jose Scale	5g, *32e, 18g	
Resistant Oblique Banded Leafroller	11e, 31e, 37e	
Nonresistant Oblique Banded Leafroller	8g, 9e, 11e, 29e, 31e, *32e, 37e, 18e	
Oriental Fruit Moth	See Fourth Cover	
INSECTICIDES		
	3. Carzol 92 SP (1/2 lb)	
	5. Diazinon 50 WP (4 lb)	
	8. Guthion 50 WP (2 lb)	
	8. Guthion 35 WP (3 lb)	
	9. Imidan 50 WP (4 lb)	
	11. Lannate 1.8 EC (2-4 pt)	
	11. Lannate 90 SP (1-2 lb)	
	18. Penncap-M 2F (4 pt)	
	23. Sevin 50 WP (4 lb)	
	23. Sevin 80 S (2 1/2 lb)	
	29. Zolone 3 EC (4 pt)	
	29. Zolone 25 WP (6 lb)	
	30. Vydate 2 L (4 pt)	
	31. Pydrin 2.4 EC (10.8 fl oz)	
	32. Lorsban 50 WP* (3 lb)	
	37. Pay-off 2.5 EC (4 fl oz)	
	40. Asana 1.9 EC (3.5 fl oz)	
Comments: Half rates of the combination of Guthion and Methomyl or Imidan and Methomyl or Zolone and Methomyl or Penncap-M and Methomyl will control all pests listed in 6, 7, and 8 cover sprays.		
Asterisk (*)—Use 2 lb/A. For tufted apple budmoth use 3 lb/A.		

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Phytophthora Collar Rot	See "Special Disease Problems and Controls," page 29	

APPLES

Special Apple Disease Problems and Controls

Apple Scab Control

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

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

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

2. After-infection spray program—After-infection fungicides are effective for a few days after the beginning of an infection period. Fungicides with after-infection activity should be used at their full recommended rate, because at lower rates their ability to stop infections is reduced or lost. The number of hours a compound remains effective after the beginning of an infection period is as follows:

Fungicide	Rate/acre	After infection activity (hr) ¹
Captan 50% WP	8 lb	18 to 24 hr.
dichlone 50% WP	2 lb	36 to 48 hr.
dichlone 50% WP	1 lb	30 to 36 hr.
funginex 18.2% EC	40 fl oz	72 hr.
cyprex 65%	2 lb	30 to 36 hr.
Rubigan 1 EC ² + Rubigan 1 EC 7 days later	12 fl oz 6-12 fl oz	72 to 96 hr.
polyram 80% WP	8 lb	18 to 24 hr.
ferbam 76% WP	8 lb	None
sulfur 95% WP	20 lb	None

¹Use beginning of rain as the start of infection. Based on average temperature of 50 to 60° F. At average temperatures lower than 50° F, use higher after-infection time figures.

²Use 12 fl oz as the standard after-infection rate. See "Rubigan," page 7.

Timing of after-infection schedules for primary apple scab is based on wetting and prevailing air temperatures (see table 1). After-infection fungicides are applied after

Table 1.

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

Temperature Average (°F)	Degree of Infection		
	Light (hrs. ²)	Moderate (hrs.)	Heavy (hrs.)
78	13	17	26
77	11	14	21
76	9½	12	19
63 to 75	9	12	18
62	9	12	19
61	9	13	20
60	9½	13	20
59	10	13	21
58	10	14	21
57	10	14	22
56	11	15	22
55	11	16	24
54	11½	16	24
53	12	17	25
52	12	18	26
51	13	18	27
50	14	19	29
49	14½	20	30
48	15	20	30
47	17	23	35
46	19	25	38
45	20	27	41
44	22	30	45
43	25	34	51
42	30	40	60
33 to 41 ³	—	—	—

¹From W. D. Mills, Cornell University.

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

³Data incomplete at these temperatures.

the length of wetting is sufficient for infection to occur. For example, at an average temperature of 58° F, primary infection will occur 10 hours after the start of the rain. After 22 hours of wetting, the degree of infection will be severe. Because the after-infection activity for most fungicides is limited to a few hours or days after infection, they must be applied soon after conditions for infection are satisfied. If a protectant fungicide is not applied before or within 9 hours after the beginning of the rain, chemicals with eradicative properties must be used.

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

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

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

5. 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 Cyprex 65% WP at 3 lb/acre and apply 2 applications one week apart. The first application should be applied as soon as possible after infection occurred or, if necessary, as soon as possible after lesions appear. In orchards where both dodine and benomyl resistance are suspect, use Captan 50% WP at 8 lb/acre.

Apple Powdery Mildew

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

Powdery mildew control should start at green tip, although pink may be early enough if temperatures are generally below 50° F. Early sprays (pink to petal fall) are

paramount to success in controlling powdery mildew. Applications should be continued until terminal growth stops. Mildew sprays should be applied every 5 to 7 days, particularly from pink to first cover, even though scab sprays may not be necessary. Because powdery mildew is most active when mild weather exists, failure to maintain protection from mildew infection during this period may allow infection to become established. Where mildew is controlled through first cover, spray intervals may be increased to about 10 days.

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

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

Fungicides	Rate/100 gal. dilute	Rate/acre
Scab fungicide plus Bayleton 50% WP ¹	1/2-1 1/2 oz	2-6 oz
OR		
Dikar 80% WP ²	2 lb	8 lb
OR		
Rubigan 1 EC ³	—	6-12 fl oz
OR		
Scab fungicide plus Wettable Sulfur 95% WP ⁴	2 lb	8 lb
OR		
Scab fungicide plus Dinocap (Karathane) 25% WP	1/2 lb	2 lb

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

²Dikar will control apple scab.

³Use 6-9 fl oz/acre for light to moderate infection levels, 9-12 fl oz/acre for severe infection levels. Also controls scab and rust.

⁴Other formulations of sulfur such as flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.

Sooty Blotch, Fly Speck, and Scab

TIMING: Cover sprays starting at third cover

Fungicides	Rate/100 gal. dilute	Rate/acre
Captan 50% WP	2 lb	8 lb
OR		
Dikar 80% WP	2 lb	8 lb
OR		
Polyram 80% WP	2 lb	8 lb

APPLES

Cedar-Apple Rust

TIMING: Pink to third cover

Fungicides	Rate/100 gal. dilute	Rate/acre
Bayleton 50% WP plus Scab fungicide	1/2-1 oz	2-4 oz
OR		
Rubigan 1 EC ¹	—	6-12 fl oz
OR		
Funginex 18.2% EC ²	10 fl oz	36-40 fl oz

¹Where rust is a severe problem use 9-12 fl oz/acre; for light to moderate problems, use 6-9 fl oz/acre. Also controls scab and mildew.

²For use from 1/2-inch green tip to petal fall. Also controls apple scab and mildew.

Blister Spot on Mutsu

Blister spot is a bacterial disease of apple caused by a bacterium in the genus *Pseudomonas*. It is a widespread and serious problem on the variety Mutsu. Because of this disease, planting of the Mutsu variety is not recommended. Additional information on this disease may be found in Bulletin NCR 45 "Diseases of Tree Fruits."

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

	Amount per 100 gallons
Streptomycin (Agristrep), ¹ plus	1/4 lb
Glyodin	1 pt

¹NOTE: Streptomycin-resistant *P. syringae* pv. *papulans* has been detected in other areas of North America where streptomycin was used for several years to control blister spot. Where 4 to 6 applications per season fail to reduce blister spot, streptomycin-resistant strains may be present. As long-term control of blister spot is uncertain, new plantings of the Mutsu apple variety are not advised.

If glyodin is not available, increase the rate of streptomycin to 1/2 lb per 100 gallons. The first spray should be applied no later than 2 weeks after petal fall and should be followed weekly by two additional sprays. Sprays should be applied dilute or 2X concentration.

Fire Blight of Apple and Pear

Two bactericides, streptomycin and Bordeaux mixture, are effective against the blossom phase of fire blight. Streptomycin is usually preferred because it is more effective and less phytotoxic to fruit and foliage.

Sprays are important, particularly during bloom, because they often prevent fire blight from getting started and spreading as a problem for the remainder of the season. Once the disease is established, control is difficult. These chemicals also give some control of terminal blight if applied as a preventative. The rates are:

Bactericide	Rate/100 gal. dilute
Bordeaux mixture	
Copper sulfate	2 lb
Hydrated spray lime	6 lb
OR	
Streptomycin 17%	1/2 lb

Streptomycin sprays: A program for successful management of fire blight depends on knowing the orchard history as well as monitoring weather conditions during the current growing season.

The first step in fire blight management is to remove the overwintering cankers before the trees bloom. Cut the branch 8 to 12 inches below the canker margin.

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" to be described below to determine whether to apply streptomycin.

In making your orchard risk assessment, consider that Jonathan, Idared, Rome Beauty, Fenton (Beacon), Monroe, Rhode Island Greening, Paulared, and many crab apple varieties are susceptible to fire blight, although Golden Delicious can also be affected. Trees propagated on M.26 rootstock tend to be more susceptible than others, and the rootstock itself is very susceptible. Young, vigorously growing trees are generally more susceptible than mature ones. The disease can be very destructive to young trees. All commercial pear varieties in Michigan are susceptible.

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

In addition to a general risk assessment for the orchard, "daily risk assessments" should be made. 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 preceding chart to determine the daily risk rating.

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 you have determined the daily risk rating, use the next chart to determine whether it is worthwhile to apply a streptomycin 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, application of a spray would be critically important.

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

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 will be effective for about four days. If rainfall of 0.5 inch or more occurs, however, it will end the application's effective period.

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

Phytophthora Collar Rot

Collar rot can be avoided by carefully selecting the type of soil and rootstocks for new apple orchards. Susceptible rootstocks should not be planted in orchards (or areas of the orchard) with heavy, poorly drained soils. Tiling of wet areas in an otherwise well-drained location

often improves internal soil drainage sufficiently to eliminate problems with this disease.

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

Ridomil for Collar Rot

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

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

Nonbearing Apple Trees. In nurseries and field plantings of nonbearing trees, make the first application of Ridomil 2E at the time of 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 2-4 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.

Aliette for Collar Rot

Aliette is applied 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 apple 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*.

APPLES

Special Apple Insect and Mite Problems and Controls

Mites

Plictran is lost forever, Savey will not be available in 1988 and registration of Apollo for 1988 is uncertain. With these losses management of mites in 1988 will be critical and require special attention.

Superior oil applied at the right time with good coverage at the full rate can provide control of mites until July. Morestan, a dithiocarbonate, has a different mode of action and will control resistant mites. Since it kills by contact action, good coverage is needed. This unique miticide is often overlooked. Use only pre-bloom.

Vendex, chemically, is closely related to Plictran. Although it is slower acting, it has longer residual action than Plictran. Vendex should be applied when the weather begins to warm and mites are just beginning to build up. Vendex 4L may give better control than Vendex WP. Back to back applications should be considered.

Dogwood Borer

The dogwood borer is a problem in some apple orchards in Michigan, mostly 4-9 years of age. Initially the dogwood borer larvae feed inside burr knots (adventitious roots) which can develop on the exposed above ground portion of clonal rootstocks. Feeding in the burr knot does little damage to the tree but feeding can continue below the bark where it is much more destructive and may eventually girdle the tree. Burr knots are aggregations of partially developed root initials which usually occur in clusters at or below the graft union. Reddish frass on the surface of a burr knot is a visible sign of infestation. Burr knots are fibrous and permit entry of pesticides so that larvae are readily controlled within the burr knot. The larvae can best be controlled with trunk applications of Lorsban 50 WP at the rate of 3 pounds per 100 gal. A single spray timed for the peak egg hatch in late June to mid-July will provide control.

Effectiveness of Insecticides in Controlling Insect Pests Attacking Apples

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

INSECT	STAGE										Pests															
	3	5	6	7	8	9	11	13	15	16	17	18	20	23	24	26	28	29	30	31	32	33	34	35	37	40
Apple Maggot	Adult	G	E	E	E	P		F	E	P	F			G	F	F		P	P	E	P					
Coddling Moth	Adult	E	E	E	E	E	P		G	E	P	E		E	P	E	E	E	E	E	E	E	E	E	E	
Cutworms	Larvae			P	F				P							E	E	E	E	E	E	E	E	E	E	
European Red Mite	Active	E	P	E			E	G	P			E		E	P	G							P			
Fruit Tree Leafroller	Larvae	G	E	E	E	E		G	E	F		E		E	P	E		E	E	E	E	E	E	E	E	
Green Apple Aphid	Active	P	E	G	P	P	G	P	P	F	P	E		G	G	F	F	F	F	F	F	F	F	F	F	
Green Fruitworm	Larvae	F		P	P	G		P	F	P		F		F	P	E		E	E	E	E	E	E	E	E	
Oblique Banded Leafroller	Larvae	G		E	E	E		G	E	F		E		E	P	E		E	E	E	E	E	E	E	E	
Plum Curculio	Adult	P	E	F	P		F	E	P		F			F	P	E		E	E	E	E	E	E	E	E	
Red Banded Leafroller	Larvae	G	P	E	E	P		G	E	P		E		E	P	E		E	E	E	E	E	E	E	E	
Rose Chafer	Adult							E	G								G					G	G	G	G	
Rosy Apple Aphid	Active	P	E	G	P	P	G	P	P	F	E	P	E		G	G	F	F	F	F	F	F	F	F	F	
Rust Mite	Active	E	P	P	P		G	G	P	P	G	E	G		G	G	F		P	P	P	P	P	P	P	
San Jose Scale	Adult		E					G		E							P	E	P	P	P	P	P	P	P	
Crawler	G							G									P	E	P	P	P	P	P	P	P	
Spotted Tentiform Leafminer	Larvae	P	F		E			P	P								F	P								
Tarnished Plantbug	Active	G	P	E		P	P	G		P	F		F		G	E	P	E	E	E	E	E	E	E	E	
Two-spotted Spider Mite	Active	E	P					G	G	P							E	F								
White Apple Leafhopper	Active	E	P	F	P	P	E	P	P	P	P	E ¹		F	P	F	P	P	P	P	P	P	P	P	P	
Wooly Apple Aphid	Active	F	G					P		P	F	G		E	G	P										
Beneficiaries	Bees	MT	HT	HT	NT	HT	HT	HT	NT	HT	HT	HT	NT	HT	HT	NT	NT	HT								
Mite Predators	HT	NT	MT	NT	NT	HT	MT	MT	NT	HT	HT	NT	HT	HT	NT	NT	HT									
Insect Predators	MT	HT	NT	MT	NT	HT	MT	NT	NT	HT	HT	NT	HT	HT	NT	NT	HT									

¹Second generation only.

²Use only before pre-pink stage.

PEARS

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

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing

materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide controlling the pest.

LATE DORMANT OR DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		
Pear Psylla	31e, 34e, 35e, 37e, *41e	
Comments: Pear psylla resistance to pyrethroids is imminent and has already appeared in some localized pear orchards. See page 34 for more information.		
INSECTICIDES		
	31. Pydrin 2.4 EC (8.1 fl oz)	
	34. Ambush 2 EC (9.6 fl oz)	
	35. Pounce 3.2 EC (6 fl oz)	
	37. Pay-off 2.5 EC (4 fl oz)	
	41. Dithane M-45* (8 lb)	
Comments: Asterisk (*)—Will control pear scab, Fabraea leaf spot and pyrethroid resistant psylla.		

GREEN TIP TO PRE-PINK

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Pear Scab	50g, 53g	
INSECTS/MITES		
European Red Mite	24e	
San Jose Scale	18g, 24e, 32e	
FUNGICIDES		
	50. Captan 50 WP (6 lb)	
	53. Ferbam 76 WP (4½ lb)	
Comments: Benlate at 6 oz/100 gal. dilute is preferred where pear scab is a problem. Limit sprays to 2 or 3 per season with Captan or Ferbam used at other times.		
INSECTICIDES		
	18. Penncap-M 2F (4 pt)	
	24. Superior Oil (6 gal)	
	32. Lorsban 4 EC (3 pt)	
Comments: Addition of an organophosphorous insecticide to superior oil enhances the effectiveness of scale control.		

PEARS

WHITE BUD

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Pear Scab	Fungicides listed under Green Tip to Pre-Pink	
INSECTS/MITES		
European Red Mite	3g, 15g	
Leafrollers	8e, 9e, 29e, 31e, 34e, 35e, 37e	
Green Fruitworm	26f, 29g, 31e, 34e, 35e, 37e	
Tarnished Plantbug	3g, 31e, 34e, 35e, 37e	
Pear Psylla	31e, 34e, 35e, 37e, *41e	
Pear Rust Mite	3e, 30f	
Comments: <i>European red mite control is not necessary if dormant oil was applied.</i> <i>Pear rust mite control requires pre-bloom and petal fall applications and post bloom treatments as needed. Alternate row spraying and high concentrate sprays are ineffective. See note on Mitac under Special Pear Insect Problems and Controls.</i> <i>Spraying at flower bud separation (green cluster) is the most effective pre-bloom timing for rust mite control.</i>		

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fireblight	See Fire Blight of Apple and Pear, page 28	
Pear Scab	See Green Tip	

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fireblight	See Fire Blight of Apple and Pear, page 28	
Pear Scab	See Green Tip	
INSECTS/MITES		
Plum Curculio	8e, 9e, 18e, 29e, 31e, 34e, 35e	
Green Fruitworm	18f, 26f, 29f, 31e, 34e, 35e	
Tarnished Plantbug	26f, 31e, 34e, 35e	
Pear Rust Mite	3e	
Comments: <i>WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6).</i>		

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fireblight	See Fire Blight of Apple and Pear, page 28	
Pear Scab	See Green Tip	
Comments: Where <i>Fabraea Leaf Spot</i> or <i>Septoria Leaf Spot</i> are problems, continue with applications of <i>Ferbam</i> or <i>Captan</i> until late July.		
INSECTS/MITES		
Plum Curculio	See Petal Fall	

SUMMER COVERS

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Pear Scab	Fungicides listed under Green Tip to Pre-Pink	
Comments: Where <i>Fabraea Leaf Spot</i> or <i>Septoria Leaf Spot</i> are problems, continue with applications of <i>Ferbam</i> or <i>Captan</i> until late July.		
INSECTS/MITES		
Codling Moth	2e, 5e, 8e, 9e, 17g, 18e, 23e, 29e	
San Jose Scale (crawlers)	5g, 17g, 18e	
Pear Psylla	2e, *41e	
Apple Maggot	5g, 8e, 9e, 18e, 29g	
Mites (adults)	3e, 16g, 28e	
Mites (immature)	3g, 16g, 28e	
Comments: Codling moth control is not necessary for first generation as the pear is too hard for the larvae to enter successfully. Hence no insect sprays, other than for pear rust mite, are required from petal fall until second generation codling moth in August. Check with your local Extension agent for timing of this application.		
INSECTICIDES		
2. Mitac 50 WP (1½-3 lb) 3. Carzol 92 SP (1½ lb) 5. Diazinon 50 WP (3 lb) 8. Guthion 50 WP (1½ lb) 8. Guthion 35 WP (2 lb) 9. Imidan 50 WP (3 lb) 16. Omite 30 WP (3¾ lb) 17. Parathion 15 WP (3 lb) 17. Parathion 8 F (1 pt) 18. Penncap-M 2F (6 pt) 23. Sevin 50 WP (6 lb) 23. Sevin 80 S (4 lb) 28. Vendex 50 WP (1½ lb) 29. Zolone 3 EC (3 pt) 41. Dithane M-45* (6-8 lb)		
Comments: Asterisk (*)—Will control pear scab, <i>Fabraea</i> leaf spot and pyrethroid resistant per psylla.		

Special Pear Insect Problems and Controls

Pear Psylla

Resistance to pyrethroids is imminent and has already appeared in some localized pear orchards. If control of psylla with pyrethroids in 1987 was unsatisfactory, then in 1988 spray the overwintering adults with pyrethroids before they lay their eggs. In an average year this will be about April 7 in the Fennville area, a week earlier in Berrien County, a week later in Oceana County and two weeks later in Leelanau County. Timing will vary according to yearly weather conditions. Pear psylla are dimorphic since the overwintering adults are larger with a

deeper body coloration and wings that are longer with black rather than translucent colored veins. Overwintering adults are much more susceptible to pyrethroids than the summer generations. The summer generations of pear psylla will be the first to develop resistance to pyrethroids.

Mitac 1.5 EC will be available in 1988. Mitac 50 WP will not control pear rust mites or mites. It will control pear psylla and codling moth. Dithane M-45 at 6-8 lb per acre will control pyrethroid resistant pear psylla, pear scab and *Fabraea* leaf spot.

PEACHES, NECTARINES, APRICOTS

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

After each pest appears a column of numbers and

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

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Peach Leaf Curl	4e, 6e, 12e	FUNGICIDES
Bacterial Spot	6f	4. Bravo 720 (3½-4½ pt) 6. Bordeaux mixture (see page 41) 12. Ferbam 76 WP (4½-6 lb)
Valsa Canker	See page 41	Comments: Apply leaf curl sprays in autumn after leaf drop or spring before bud swell.
Crown Gall	See page 42	
INSECTS		
Peach Tree Borer	26g, 32e	INSECTICIDES
Comments: Pre-Plant Treatment to control peach tree borer: Check plants for crown gall. If plants are not infested, dip trees in bundles or individually in Thiodan (3 lb/gal EC) used at the rate of 10 qt/100 gal water or Lorsban 4 E at the rate of 3 qt/100 gal water. Dip trees several inches above the grafting bud scar and plant immediately or allow to dry before returning to storage. Do not plant if infected with crown gall.	26. Thiodan 3 EC (4-5 qt)/100 gal 32. Lorsban 4 E (3 qt)/100 gal	

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		
San Jose Scale	32e	INSECTICIDES
Peach Twig Borer	32e	31. Pydrin 2.4 EC (8.1 fl oz) 32. Lorsban 4 E (3 pt) 34. Ambush 2 EC (9.6 fl oz)* 35. Pounce 3.2 EC (6 fl oz)*
Climbing Cutworms	31e, 32e, 34e, 35e	Comments: Asterisk (*)—Peaches only.

PINK

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	See Bloom	INSECTICIDES
Valsa Canker	See page 41	29. Zolone 3 EC (3 pt) 31. Pydrin 2.4 EC (8.1 fl oz) 34. Ambush 2 EC (9.6 fl oz)* 35. Pounce 3.2 EC (6 fl oz)*
INSECTS/MITES		
Tarnished Plant Bug	31e, 34e, 35e	Comments: Asterisk (*)—Peaches only.
Green Fruitworm	29g, 31e, 34e, 35e	

PEACHES, NECTARINES, APRICOTS

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 2e, 3e, 4g, 6e, 7g, 14f	
Valsa Canker	See page 41	
Comments: <i>Where pink bud spray is omitted, or if weather is unusually favorable for brown rot, begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.</i>		
FUNGICIDES <ol style="list-style-type: none"> 1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb) 2. Funginex 18.2 EC (1-1½ qt) 3. Rovral 50 WP (1½-2 lb) 4. Bravo 720 (3½-5½ pt) 6. Ronilan 50 WP (1½-2 lb) 7. Dichlone 50 WP* (1½ lb) 14. Wettable Sulfur 95 WP** (15 lb) 		
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i> <p>Asterisk (*)—Peaches only. Double asterisk (**)—Do not use on apricots. 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.</p>		

PEACHES, NECTARINES, APRICOTS

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 2e, 3e, 4g, 6e, 14f	
Powdery Mildew	1g, 2g, 14g	
Comments: <i>Powdery mildew is sometimes an economic problem in southwest Michigan, particularly on Reo-Oso-Gem and Redskin.</i>		
INSECTS		
Plum Curculio	8e, 9e, 18e, 29g, 31e, 34e, 35e	
Oriental Fruit Moth	5g, 8e, 9e, 17g, 18e, 23e, 29e, 31e, 34e, 35e	
Rose Chafer	18g, 23g	
Tarnished Plant Bug	26f, 31e, 34e,*** 35e***	
Green Peach Aphid	26e, 29g	
FUNGICIDES		
		1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb)
		2. Funginex 18.2 EC (1-1½ qt)
		3. Rovral 50 WP** (1½-2 lb)
		4. Bravo 720 (3⅓-5⅓ pt)
		6. Ronilan 50 WP** (1½-2 lb)
		14. Wettable sulfur 95 WP* (15 lb)
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i>		
INSECTICIDES		
		5. Diazinon 50 WP (3 lb)
		8. Guthion 50 WP (1½ lb)
		8. Guthion 2 EC (3 pt)
		8. Guthion 35 WP (2 lb)
		9. Imidan 50 WP (3 lb)
		17. Parathion 15 WP (4½ lb)
		17. Parathion 8 F (1 pt)
		18. Penncap 2 FM (6 pt)
		23. Sevin 50 WP (6 lb)
		23. Sevin 80 S (4 lb)
		26. Thiodan 3 EC (3 qt)
		26. Thiodan 50 WP (3 lb)
		29. Zolone 3 EC (3 pt)
		29. Zolone 25 WP (4½ lb)
		31. Pydrin 2.4 EC (8.1 fl oz)
		34. Ambush 2 EC*** (9.6 fl oz)
		35. Pounce 3.2 EC*** (6 fl oz)
Comments: <i>Triple asterisk (***)—Peaches only up to petal fall.</i>		

PEACHES, NECTARINES, APRICOTS

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	5g, 14f	FUNGICIDES 5. Captan 50 WP (6 lb)** 14. Wettable sulfur 95 WP* (15 lb)
Powdery Mildew	14g	
Bacterial Spot	See page 41	Comments: <i>Benlate is omitted on peaches and nectarines at shuck split through fourth cover in order to delay resistance problems. Topsin-M should not be used for the same reason.</i> <i>Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.</i>
		Asterisk (*)—Do not use on apricots. Double asterisk (**)—On apricots use Benlate 50 WP (12 oz) plus Captan 50 WP (4½ lb) or Funginex 18.5 EC (1-1½ qt) or Captan 50 WP (6 lb) or Rovral 50 WP (2 lb) or Ronilan 50 WP (2 lb).

INSECTS		INSECTICIDES
Plum Curculio	See Petal Fall	5. Diazinon 50 WP (3 lb)
Oriental Fruit Moth	See Petal Fall	17. Parathion 8 F (1 pt)
Rose Chafer	See Petal Fall	17. Parathion 15 WP (4½ lb)
Lecanium Scale	5g, 17g, 18e, 23g	18. Penncap-M 2F (4½ pt)
Tarnished Plant Bug	26f, 31e	23. Sevin 80 S (4 lb)
		23. Sevin 50 WP (6 lb)
		26. Thiodan 50 WP (4½ lb)
		26. Thiodan 3 EC (4½ qt)
		31. Pydrin 2.4 EC (10.8 fl oz)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	5g, 14f	FUNGICIDES 5. Captan 50 WP (6 lb)
Peach Scab	5g, 14g	14. Wettable sulfur 95 WP* (15 lb)
Powdery Mildew	14g	
Bacterial Spot	See page 41	Comments: <i>See shuck split for fungicides on apricots.</i>
X-Disease	See page 41	Asterisk (*)—Do not apply to apricots.
INSECTS		
Oriental Fruit Moth	See Petal Fall	
Tarnished Plant Bug	See Shuck Split	

PEACHES, NECTARINES, APRICOTS

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Peach Scab	Fungicides listed under First Cover	
Powdery Mildew	Fungicides listed under First Cover	
Bacterial Spot	See page 41	
INSECTS		
Oriental Fruit Moth	See Petal Fall	
Lesser Peach Tree Borer	26g, 32e	
Comments: For lesser peach tree borer control apply sprays between June 3 to 10 and another 3 weeks later. Apply with a hydraulic gun as a coarse dilute spray, with concentration on scaffold limbs, crotches and trunk.		

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Peach Scab	Fungicides listed under First Cover	
Powdery Mildew	Fungicides listed under First Cover	
Bacterial Spot	See page 41	
INSECTS		
Oriental Fruit Moth	See Second Cover	
Lecanium Scale	See Shuck Split	
Peach Tree Borer	26g, 32e	
Mites (adults)	16g	
Mites (immature)	16e	
Mites (eggs)	16g	
Comments: For peach borer control apply sprays the first week in July. Apply to the base of the tree as a coarse dilute spray. Use a hydraulic gun.		

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Bacterial Spot	See page 41	
INSECTS		
Oriental Fruit Moth	See Petal Fall Cover	

PEACHES, NECTARINES, APRICOTS

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 2g, 3e, 5g, 6e, 14f	
Comments: Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.		
INSECTS		
Oriental Fruit Moth	See Petal Fall	
FUNGICIDES <ol style="list-style-type: none"> 1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb) 2. Funginex 18.2 EC (1-1½ qt) 3. Rovral 50 WP* (1½-2 lb) 5. Captan 50 WP (6 lb) 6. Ronilan 50 WP* (1½-2 lb) 14. Wettable sulfur 95 WP** (15 lb) 		
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i>		
<i>Asterisk (*)—Do not apply more than 5 applications per season.</i> <i>Double asterisk (**)—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.</i>		

POST HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
X-Disease	See page 41	

PEACHES, NECTARINES, APRICOTS

Special Peach Disease Problems and Controls

Bacterial Spot

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

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

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

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

Bactericide	Rate/100 gal. dilute
Cyprox ¹ 65 WP, plus	1/2 lb
Captan 50 WP	1 lb
OR	
Mycoshield 17 WP ²	12 oz

¹Caution: Phytotoxicity may result if combined with, or applied near, solvent formulations of insecticides or sulfur. Do not apply during periods of high temperatures, at spray concentrations above 3X, or within 15 days of harvest. It also controls brown rot and scab.

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

For best results, time the spray or sprays before rain occurs.

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

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

X-Disease

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

Injection Treatments

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

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

Trunk Preparation: Drill two to four holes, depending on trunk diameter, 1 1/4 inches deep with a 7/32-1/4 inch drill bit at a slight downward slant into the trunk of infected trees.

Infusion Treatment: Trees 6 to 10 years old should receive 5 grams of product per tree in one quart to 1 gallon of liquid per tree. Younger trees should be treated with somewhat less product (about 2.5 grams product per tree). Old trees with large trunks can be treated with up to 7.5 grams per tree. This treatment will provide remission of X-disease symptoms for at least one year.

Valsa Canker

Delay pruning to pink or later to allow rapid healing. Recent studies indicate partial control of Valsa can be obtained as a benefit of using Benlate against brown rot.

PEACHES, NECTARINES, APRICOTS

X-Disease Control

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

and usually two years. Some trunk damage will result from the injection treatment but can be reduced by increasing the amount of water used to apply the chemical.

Other X-Disease Controls

1. Partial control of X-disease may be obtained as a benefit of using plum curculio, Oriental fruit moth, or plant bug insecticides that also have good activity against leafhoppers.
2. Remove infected cherry trees. Recent research indicates that X-diseased cherry on mazzard rootstock is an important source of the X-disease agent. Remove infected trees as soon as they are detected.

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

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

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 and p = poor for the pesticide in controlling the pest.

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Knot	See Comments	
Comments: <i>Prune out and burn all knots in the dormant season and continue to remove knots whenever they are observed. Make pruning cuts at least 6 to 8 in. below visible swellings. Do not plant new plum orchards next to old plantings with black knot. Remove infected wild plums and cherry seedlings from fence rows and nearby wooded areas before planting.</i>		
INSECTS/MITES		
European Red Mite	24e	
Lecanium Scale, San Jose	17 + 24e*, 32e	
Scale, Aphids, Peach Twig Borer, Climbing Cutworms	32e	
INSECTICIDES		
		17. Parathion 15 WP (3 lb)
		18. Penncap-M 2 F (6 pt)
		24. Superior Oil* (6 gal)
		32. Lorsban 4 EC (3 pt)

GREEN TIP

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e	
Black Knot	1g	
FUNGICIDES		
		1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb)
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i>		

PRUNES AND PLUMS

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 2e, 7g, 14f, 15e, 16e	
Black Knot	1g	
Comments: Where green tip spray is omitted, or if weather is unusually favorable for disease, begin bloom sprays earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.		
FUNGICIDES		
1. Benlate 50 WP (12 oz) plus Captan 50 WP (4½ lb) 2. Funginex 18.2 EC (1-1½ qt) 7. Dichlone 50 WP (1½ lb) 14. Wettable sulfur 95 WP* (15 lb) 15. Rovral 50 WP (1½-2 lb) 16. Ronilan 50 WP (1½-2 lb)		

Comments:

Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.

Asterisk ()—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		
Brown Rot	1e, 2e, 14g, 15e, 16e	
Leaf Spot	1e, 2e	
Black Knot	1g	
INSECTS		
Plum Curculio	8e, 9e, 18e, 29g, 31e	
FUNGICIDES		
1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb) 2. Funginex 18.2 EC (1-1½ qt) 14. Ferbam 76 WP (3 lb), plus Wettable sulfur 95 WP* (9 lb) 15. Rovral 50 WP (1½-2 lb) 16. Ronilan 50 WP (1½-2 lb)		
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i>		
<i>Asterisk (*)—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.</i>		
INSECTICIDES		
8. Guthion 50 WP (1½ lb) 8. Guthion 2 EC (3 pt) 8. Guthion 35 WP (2 lb) 9. Imidan 50 WP (3 lb) 18. Penncap-M 2 F (6 pt) 29. Zolone 3 EC (3 pt) 29. Zolone 25 WP (4½ lb) 31. Pydrin 2.4 EC (8.1 fl oz)		

PRUNES AND PLUMS

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 14g	1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb)
Leaf Spot	1e, 14g	14. Ferbam 76 WP (3 lb), plus Wettable sulfur 95 WP (9 lb)
Black Knot	1g	
INSECTS		
Plum Curculio	See Petal Fall	

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	See Shuck Split	5. Diazinon 50 WP (3 lb)
Leaf Spot	See Shuck Split	17. Parathion 15 WP (4½ lb)
Black Knot	See Shuck Split	17. Parathion 8 F (1 pt)
INSECTS		
Scale	5g, 17g	
Peach Tree Borers	See page 35	
Plum Curculio	See Petal Fall	
Comments: Sprays for scale should be timed when crawlers become active.		

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See Shuck Split	8. Guthion 50 WP (1½ lb)
Black Knot	See Shuck Split	8. Guthion 2 EC (3 pt)
INSECTS		
Apple Maggot	8e, 9e, 18e, 29g	8. Guthion 35 WP (2 lb) 9. Imidan 50 WP (3 lb) 18. Penncap-M 2F (5 pt) 29. Zolone 3 EC (3 pt)
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for apple maggot should be applied.		

THIRD AND FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See Shuck Split	INSECTICIDES
INSECTS/MITES		
Apple Maggot	See Second Cover	16. Omite 30 WP (3¾ lb)
Mites	16g	

PRUNES AND PLUMS

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 5g, 14f, 15e, 16e	
Leaf Spot	1e, 5f, 14f	
Comments: <i>Make first preharvest application for brown rot 2 to 3 weeks before harvest and repeat in 5 to 10 days.</i>		
FUNGICIDES <ol style="list-style-type: none"> 1. Benlate 50 WP (12 oz), plus Captan 50 WP (4½ lb) 5. Captan 50 WP (6 lb) 14. Wetttable sulfur 95 WP** (15 lb) 15. Rovral 50 WP* (1½-2 lb) 16. Ronilan 50 WP* (1½-2 lb) 		
Comments: <i>Fungicide-resistant plant pathogens may develop where Benlate is used. Topsin-M will increase problems with fungicide resistance and does not control Benlate-resistant pathogens.</i>		
<i>Asterisk (*)—Do not apply more than 5 applications per season.</i>		
<i>Double asterisk (**)—Flowable sulfur, liquid sulfur, and less concentrated wetttable sulfur should be used at rates that will give the same amount of sulfur as the 95% wetttable powder formulation except where prohibited by the product label.</i>		

TART CHERRIES

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

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing

materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Crown Gall	See page 42	
Phytophthora Root Rot	See "Special Tart Cherry Disease Problems and Controls," page 52	
INSECTS/MITES		
Mineola Moth	5g, 8e, 9e, 17g, 18e, 23g, 29e, 31e, 34e, 35e	
Eye-Spotted Bud Moth	5g, 8e, 9e, 17g, 18e, 23g, 29e, 31e, 34e, 35e	
Mites	24e*	
Scales	18e, 24e*	
INSECTICIDES		
	5. Diazinon 50 WP (3 lb)	
	8. Guthion 50 WP (1½ lb)	
	8. Guthion 35 WP (2 lb)	
	9. Imidan 50 WP (3 lb)	
	17. Parathion 15 WP (3 lb)	
	18. Penncap-M 2F (6 pt)	
	23. Sevin 50 WP (6 lb)	
	24. Superior Oil (6 gal)*	
	29. Zolone 3 EC (3 pt)	
	29. Zolone 25 WP (4½ lb)	
	31. Pydrin 2.4 EC (8.1 fl oz)	
	34. Ambush 2 EC (9.6 fl oz)	
	35. Pounce 3.2 EC (6 fl oz)	
Comments: Asterisk (*)—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.		

GREEN TIP

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 52	

TART CHERRIES

PRE-BLOOM (WHITE BUD STAGE)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 52	
Brown Rot	1e, 3e, 4f, 7g, 8f, 14f, 16e	
INSECTS		
Green Fruitworm	26f, 29f, 31e, 34e, 35e	
Plum Nursery Mite	28e	
FUNGICIDES 1. Funginex 18.2 EC (1-1½ qt) 3. Rovral 50 WP* (1½-2 lb) 4. Bravo 720 (3½-5½ pt) 7. Dichlone 50 WP (1½ lb) 8. Difolatan 80 DG** (2¼-3¾ lb) 14. Wettable sulfur 95 WP*** (15 lb) 16. Ronilan 50 WP* (1½-2 lb)		
Comments: <i>Asterisk (*)—Funginex, Rovral, and Bravo are for use from white bud to petal fall. Bravo may also be used at shuck split. Rovral and Ronilan may be used again at preharvest.</i> <i>Double asterisk (**)—Use Difolatan on mechanically harvested cherries only.</i> <i>Triple asterisk (***)—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.</i> <i>Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.</i>		
INSECTICIDES 26. Thiodan 50 WP (3 lb) 28. Vendex 50 WP (2 lb) 29. Zolone 3 EC (3 pt) 29. Zolone 25 WP (4½ lb) 31. Pydrin 2.4 EC (8.1 fl oz) 34. Ambush 2 EC (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz)		

BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 52	
Brown Rot	Fungicides listed under Pre-Bloom	
Comments: <i>Where pre-bloom spray is omitted, or if weather is unusually favorable for brown rot, begin bloom spray earlier and continue at 2- to 4-day intervals if wet, rainy weather prevails.</i>		

TART CHERRIES

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 52	
Brown Rot	1e, 3e, 4f, 8f, 16e	
Leaf Spot	1e, 4e, 8e	
INSECTS		
Green Fruitworm	26f, 29f, 31e, 34e, 35e	
Leafrollers	8e, 9e, 17g, 29e, 31e	
Plum Curculio	8e, 9e, 29g, 31e, 34e, 35e	
Rose Chafer	23g	
American Plum Borer	32e	
FUNGICIDES		
1. Funginex 18.2 EC (1-1½ qt)		
3. Rovral 50 WP (1½-2 lb)		
4. Bravo 720 (3½-5½ pt)		
8. Difolatan 80 DG* (2¼-3¾ lb)		
16. Ronilan 50 WP (1½-2 lb)		
Comments:		
Asterisk (*)—Use high rate of Difolatan during wet seasons or when disease pressure is heavy.		
Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.		
INSECTICIDES		
8. Guthion 50 WP (1½ lb)		
8. Guthion 2 EC (3 pt)		
8. Guthion 35 WP (2 lb)		
9. Imidan 50 WP (3 lb)		
17. Parathion 8 F (1 pt)		
17. Parathion 15 WP (4½ lb)		
23. Sevin 50 WP (6 lb)		
23. Sevin 80 S (4 lb)		
26. Thiodan 50 WP (3 lb)		
29. Zolone 3 EC (3 pt)		
29. Zolone 25 WP (4½ lb)		
31. Pydrin 2.4 EC (8.1 fl oz)		
32. Lorsban 4 E (3 qt/100 gal)		
34. Ambush 2 EC (9.6 fl oz)		
35. Pounce 3.2 EC (6 fl oz)		

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Bacterial Canker	See "Special Tart Cherry Disease Controls," page 52	
Leaf Spot	8e	
Brown Rot	8g	
INSECTS		
Plum Curculio	See Petal Fall	
Lesser Peach Tree Borer	26g, 32e	
FUNGICIDES		
8. Difolatan 80 DG (2¼-3¾ lb)		
INSECTICIDES		
26. Thiodan 3 EC (4-5 qt/100 gal)		
32. Lorsban 4 E (3 qt/100 gal)		
Comments:		
A spotting of tart cherry fruit may occur when liquid Guthion and Cyprex or Difolatan are applied at 65X concentration from aircraft with high temperatures at application or soon thereafter.		

TART CHERRIES

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	Fungicides listed under First Cover	
INSECTS		
Scale	5g, 17g, 18e*	
Comments: Apply spray for scales when crawlers become active.		

INSECTICIDES

5. Diazinon 50 WP (3 lb)
17. Parathion 15 WP (4½ lb)
17. Parathion 8 F (1 pt)
18. Penncap-M 2F* (6 pt)

Comments:

Asterisk (*)—WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6).

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	See First Cover	
INSECTS/MITES		
Cherry Fruit Fly	5g, 8e, 9e, 18e*, 23e, 29e, 31g, 34g, 35g	
Rose Chafer	See Petal Fall	
Scale	See Second Cover	
European Red Mite	28e	
Two-spotted Spider Mite	28e	
Bird Repellent	39e**	
Comments: Call the local pest management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.		
INSECTICIDES		
<ol style="list-style-type: none"> 5. Diazinon 50 WP (3 lb) 8. Guthion 50 WP (1½ lb) 8. Guthion 35 WP (2 lb) 9. Imidan 50 WP (3 lb) 18. Penncap-M 2F* (6 pt) 23. Sevin 50 WP (6 lb) 23. Sevin 80 S (4 lb) 28. Vendex 50 WP (2 lb) 29. Zolone 3 EC (3 pt) 29. Zolone 25 WP (4½ lb) 31. Pydrin 2.4 EC (8.1 fl oz) 34. Ambush 2 EC (9.6 fl oz) 35. Pounce 3.2 EC (6 fl oz) 39. Mesurol 75 WP** (2 lb) 		
Comments: Asterisk (*)—WARNING: Penncap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6).		
Double asterisk (**)—A maximum of 4 lb of product may be applied per acre per season. Applications may be made up to 14 days prior to harvest. If only one application (2 lb of product maximum) is made in a season, application may be made up to 3 days before harvest.		

CHERRY FRUIT FLY AERIAL CONTROL

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

TART CHERRIES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	8e, 14g	
Brown Rot	3e, 8g, 14g, 16e	
INSECTS		
Cherry Fruit Fly	See Third Cover	
Bird Repellent	See Third Cover	
Comments: Make first preharvest application for brown rot 2 or 3 weeks before harvest and repeat in 5 to 10 days.		
FUNGICIDES		
3. Rovral 50 WP (1½-2 lb) 8. Difolatan 80 DG (2¼-3¾ lb) 14. Cyprex 65 WP (¾ lb), plus Wettable sulfur 95 WP* (9 lb) 16. Ronilan 50 WP (1½-2 lb)		
Comments: Asterisk (*)—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used at rates that give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label. WARNING: Funginex has caused a ring-russet when applied in the pre-harvest period. Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.		

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	4e, 8e	
INSECTS		
Peach Tree Borer	See page 35	

Special Tart Cherry Disease Problems and Controls

Bacterial Canker

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

To prevent blossom blight, leaf and fruit spot 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 treatment may be combined with Difolatan when leaf spot and brown rot control is needed.

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 rootstock. Use of Ridomil is not a substitute for good cultural practices.

Nonbearing Cherry Trees: In nurseries and field plantings of nonbearing trees, make the first application of Ridomil 2E at the time of 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.

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 4E at 3 qt/100 applied with a hydraulic gun to the trunk at the petal fall stage when the first generation adults are emerging on tart and sweet cherries will give seasonal control. In addition, if the spray is directed at the base of the trunk and scaffold limbs, lesser peach tree borer and peach tree borer will be controlled for the season.

SWEET CHERRIES

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

After each pest appears a column of numbers and letters. These are provided to assist growers in choosing

materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide in controlling the pest.

PRE-BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Crown Gall	See page 42	
INSECTS/MITES		
Black Cherry Aphid	5g, 18e, 26e, 29g	
Mites	24e*	
Scales	24e*	
INSECTICIDES		
		5. Diazinon 50 WP (4 lb)
		18. Penncap-M 2F (8 pt)
		24. Superior Oil (8 gal)*
		26. Thiodan 50 WP (4 lb)
		29. Zolone 3 EC (4 pt)
		29. Zolone 25 WP (6 lb)
Comments:		
Asterisk (*)—Unless applied dilute (400 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 scale at the crawler stage.		

WHITE BUD OR POPCORN

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot (blossom blight)	1e, 3e, 4f, 6e, 7g, 14f	
INSECTS		
Green Fruitworm	26f, 29f, 31e, 34e, 35e	
FUNGICIDES		
		1. Funginex 18.2 EC (1-1½ qt)
		3. Rovral 50 WP (2 lb)
		4. Bravo 720 (3½-5½ pt)
		6. Ronilan 50 WP (2 lb)
		7. Dichlone 50 WP (2 lb)
		14. Wettable sulfur 95 WP* (20 lb)
Comments:		
Asterisk (*)—Flowable sulfur, liquid sulfur, and less concentrated wettable sulfur should be used as rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.		
Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended for cherries.		

INSECTICIDES

- 26. Thiodan 50 WP (4 lb)**
- 29. Zolone 3 EC (4 pt)**
- 29. Zolone 25 WP (6 lb)**
- 31. Pydrin 2.4 EC (8.1 fl oz)**
- 34. Ambush 2 EC (9.6 fl oz)**
- 35. Pounce 3.2 EC (6 fl oz)**

SWEET CHERRIES

BLOOM

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

PETAL FALL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	1e, 3e, 4f, 5f, 6e, 14f	
Leaf Spot	1e, 4e, 5f, 14f	
INSECTS		
Black Cherry Aphid	See Pre-Bloom	
Green Fruitworm	See Pre-Bloom	
Leafrollers	8e, 17g, 29e, 31e	
Plum Curculio	8e, 29g, 31e, 34e, 35e	
American Plum Borer	32e	
FUNGICIDES		
		1. Funginex 18.2 EC (1-1½ qt) 3. Rovral 50 WP (2 lb) 4. Bravo 720 (4½-5½ pt) 5. Captan 50 WP (8 lb) 6. Ronilan 50 WP (2 lb) 14. Ferbam 76 WP (4 lb), plus Wettable sulfur 95 WP (12 lb)*
Comments: Asterisk (*)—Flowable sulfur, liquid sulfur and less concentrated wettable sulfur should be used at rates that will give the same amount of sulfur as the 95% wettable powder formulation except where prohibited by the product label.		
Because Benlate-resistant brown rot and leaf spot are widespread in Michigan, Benlate and Topsin-M are not recommended in cherries.		

INSECTICIDES

- 8. Guthion 50 WP (2 lb)
- 8. Guthion 35 WP (3 lb)
- 17. Parathion 15 WP (6 lb)
- 17. Parathion 8 F (1½ pt)
- 29. Zolone 3 EC (4 pt)
- 29. Zolone 25 WP (6 lb)
- 31. Pydrin 2.4 EC (8.1 fl oz)
- 32. Lorsban 4 E (3 qt/100 gal)
- 34. Ambush 2 EC (9.6 fl oz)
- 35. Pounce 3.2 EC (6 fl oz)

Comments:

Pennkap-M should not be used at petal fall or shuck split because of hazard to pollinating insects.

SHUCK SPLIT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	4f, 5f, 14f	
Leaf Spot	4e, 5f, 14f	
INSECTS		
Plum Curculio	See Petal Fall	
Black Cherry Aphid	See Pre-Bloom	
FUNGICIDES		
		4. Bravo 720 (4½-5½ pt) 5. Captan 50 WP (8 lb) 14. Ferbam 76 WP (4 lb), plus Wettable sulfur 95 WP (12 lb)
Comments: Do not apply Bravo after shuck split and before harvest.		

SWEET CHERRIES

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	5f, 14f	
Leaf Spot	5f, 14f	
INSECTS		
Black Cherry Aphid	See Pre-Bloom	
Leafrollers	See Petal Fall	
Plum Curculio	See Petal Fall	
Rose Chafer	See Third Cover	
FUNGICIDES		
		5. Captan 50 WP (8 lb)
		14. Ferbam 76 WP (4 lb), plus
		Wettable sulfur 95 WP* (12 lb)
Comments:		
		Asterisk (*)—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.

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS		
Black Cherry Aphid	See Pre-Bloom	
Leafrollers	See Petal Fall	
Rose Chafer	See Third Cover	

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	Fungicides listed under First Cover	
Leaf Spot	See First Cover	
INSECTS/MITES		
Cherry Fruit Fly	5g, 8e, 18e, 23e, 29e, 31g, 34g, 35g	
Rose Chafer	23g	
European Red Mite	12e	
Two-spotted Spider Mite	12e	
Plum Nursery Mite	12e	
Bird Repellent	**39e	
INSECTICIDES		
		5. Diazinon 50 WP (4 lb)
		8. Guthion 50 WP (2 lb)
		8. Guthion 35 WP (3 lb)
		12. Vendex 50 WP (2 lb)
		18. Pennkap-M 2F* (6 pt)
		23. Sevin 50 WP (8 lb)
		23. Sevin 80 S (4 lb)
		29. Zolone 3 EC (4 pt)
		29. Zolone 25 WP (6 lb)
		31. Pydrin 2.4 EC (8.1 fl oz)
		39. Mesurol 75 WP** (2 lb)
		34. Ambush 2 EC (9.6 fl oz)
		35. Pounce 3.2 EC (6 fl oz)

Comments:

Call the local pest management code-a-phone or determine from the Extension agent when sprays for cherry fruit fly should be applied.

Comments:

Asterisk (*)—WARNING: Pennkap-M should not be applied if pollinators are working flowers (cover-crop) on the orchard floor (see page 6). 6 pt. is the maximum legal rate of Pennkap-M on sweet cherries.

Double asterisk (**)—See note on Mesurol on tart cherries.

Do not apply Imidan. It causes leaf spotting and defoliation of sweet cherry.

SWEET CHERRIES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Brown Rot	3e, 5g, 6e, 14f	3. Rovral 50 WP (2 lb)
Leaf Spot	5f, 14f	5. Captan 50 WP (8 lb)
INSECTS		
Cherry Fruit Fly	See Third Cover	6. Ronilan 50 WP (2 lb)
Bird Repellent	See Third Cover	14. Ferbam 76 WP (4 lb), plus Wettable sulfur 95 WP* (12 lb)
Comments: Make first application 2 or 3 weeks before harvest and repeat in 5 to 10 days.		
Comments: Asterisk (*)—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.		
WARNING: Funginex has caused a ring-russet when applied in the pre-harvest period.		

POST-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	4e, 11e	4. Bravo 720 (4½ pt) 11. Cyprex 65 WP (1½-2 lb)
INSECTS		
Peach Tree Borers	See American Plum Borer under "Special Tart Cherry Insect Problems"	

GRAPES

The rate of materials for use on grape is based on a standard of 200 gal/acre dilute spray. Vines trained to Geneva double curtain trellis should receive 300 gal/acre of dilute spray after vines are in full leaf. If you are

concentrate spraying—(less than 200 gal of water/acre), use the rate/acre figures, regardless of the amount of water you are spraying/acre.

DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Eutypa Dieback	1	FUNGICIDES 1. Benlate 50 WP (2 lb)
Comments: Eutypa lata ascospores infect pruning wounds during the winter when the temperature is above 32° F and rain occurs. Pruning wounds must be sprayed with thorough coverage after pruning but before a rain occurs to prevent new infections. All vines that have been pruned should be sprayed.		

BUD SWELL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Phomopsis Leaf and Cane Spot Disease	50, 51, 52, 55, 59	FUNGICIDES 50. Folpet (Phaltan) 50 WP (4 lb) 51. Dithane M-22 Special (1½-5 lb) 52. Mancozeb (Dithane M-45 or Manzate 200) (1½ lb) 55. Dikar WP (1¼-4 lb) 59. Captan 50 WP (4 lb)
Comments: Bud swell—shoots are 1 to 3 in. long.		
INSECTS		
Grape Flea Beetle	No effective pesticides registered	INSECTICIDES
Climbing Cutworms	32*	32. Lorsban 4 E (1 qt)*
Comments: Where Phomopsis leaf and cane spot disease is a problem, repeat this spray when shoots are 4 to 6 in. long. This second spray will suffice as the first black rot spray.		
Comments: Asterisk (*)—Lorsban will not control grape flea beetles.		

GRAPES

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot	1, 53	1. Benlate 50 WP* (1 lb)
Black Rot + Downy Mildew	50, 51, 52, 55	50. Folpet 50 WP** (4 lb) 51. Dithane M-22 Special (1½-5 lb) 52. Mancozeb (2 lb) 53. Ferbam 76 WP*** (3 lb) 55. Dikar WP**** (1¼-4 lb) 59. Captan 50 WP (4 lb)
Comments: <i>First cover—shoots 4 to 6 in. long.</i>		
FUNGICIDES <i>Asterisk (*)—Do not use Benlate alone repeatedly throughout the season. Either use it in combination with another fungicide as a tank mix or use it alternately with other chemicals. Repeated use of Benlate alone will hasten tolerance of fungi to Benlate.</i> <i>Double asterisk (**)—Folpet applied here will give further control of phomopsis leaf and cane spot disease.</i> <i>Triple asterisk (***)—Ferbam slightly controls downy mildew. Benlate gives no control of downy mildew.</i> <i>Captan is excellent against this disease and downy mildew, but weak against black rot.</i> <i>Quadruple asterisk (****)—Dikar gives good control of black rot, downy mildew, suppresses powdery mildew and spider mites. Dikar has a 66-day post-harvest interval. WARNING: The Karathane in Dikar may injure certain French hybrid grape varieties. Reduce the rate of Dikar to 1¼ lb/A after fruit formation on all types of grapes—American, French hybrid and vinifera.</i>		

GRAPES

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot	1, 53, 54, 55	
Black Rot and Powdery Mildew	1, 54, 55	
Black Rot, Downy and Powdery Mildews	50, 51, 52, 55, copper + lime	
Botrytis Rot (early-mid bloom)	1, 15	
Comments: Second cover—blossom opening.		
<i>NOTE: It is important to apply controls for downy mildew beginning with first bloom! Cover sprays for downy mildew should be continued through the growing season. A strong effort directed toward better control is necessary.</i>		
INSECTS		
Grape Berry Moth	5g, 8e, 9e, 17g, 18e, 23e, 29e	
Rose Chafer	18e	
Grape Phylloxera	26e, 29e	
Comments: The grape berry moth overwinters as a pupa. Adults start emerging the first or second week of June. There are 3 generations/year. Pheromone traps are available to detect the presence and seasonal activity of these moths.		
FUNGICIDES		
Fixed copper (actual) (3 lb), plus Hydrated lime (12 lb)		
1. Benlate 50 WP (1-1½ lb)		
15. Rovral 50 WP (1½-2 lb)		
50. Folpet 50 WP (4 lb)		
51. Dithane FZ (3 qt), plus Dinocap 25 WP (1½ lb)		
52. Mancozeb (4 lb), plus Dinocap 25 WP (1½ lb)		
53. Ferbam 76 WP (3 lb)		
54. Bayleton 50 WP (3-6 oz)		
55. Dikar WP* (1¼-4 lb)		
Comments: Dikar contains dinocap and will give some powdery mildew control. While Benlate is fair to good and Bayleton is excellent for control of black rot and powdery mildew, neither controls downy mildew. To insure control of downy mildew, add Dithane FZ, Mancozeb, Phaltan, or captan as a tank mix at the recommended rates.		
<i>NOTE: If black rot disease pressure is heavy, increase Bayleton rate to 6 oz/acre.</i>		
Asterisk (*)—Dikar may cause injury to some French hybrid varieties. Reduce Dikar rate to 1¾ lb/A after fruit formation.		
If fixed copper is used with organic phosphates, spray immediately as these materials may lose some insecticidal effectiveness when combined with lime or in alkaline solutions.		
INSECTICIDES		
5. Diazinon 50 WP (2 lb)		
8. Guthion 50 WP (1 lb)		
8. Guthion 35 WP (1.5 lb)		
9. Imidan 50 WP (2 lb)		
17. Parathion 15 WP (4 lb)		
17. Parathion 8 F (⅔ pt)		
18. Penncap 2 FM (8 pt)		
23. Sevin 50 WP (4 lb)		
23. Sevin 80 S (2½ lb)		
26. Thiodan 2 F (4 pt)		
26. Thiodan 50 WP (2 lb)		
29. Zolone 25 WP (8 lb)		
29. Zolone 25 WP (4 pt)		

GRAPES

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot, Downy and Powdery Mildews	See Second Cover	FUNGICIDES 51. Dithane FZ* (1½ qt)
Comments: <i>Third cover—Immediately after bloom; 90% of blossoms open. Reduce Dithane FZ to 1½ qt and Mancozeb to 2 lb.</i>		
INSECTS		
Grape Berry Moth	See Second Cover	INSECTICIDES
Grape Leaf Hopper	5g, 8f, 9f, 18e, 23e, 29e	5. Diazinon 50 WP (2 lb)
Rose Chafer	18e, 23g	8. Guthion 50 WP (1 lb)
Comments: <i>Timing for second brood berry moth is announced by your county agricultural agent.</i>		
<i>Control mites as populations increase.</i>		
INSECTICIDES		
		8. Guthion 35 WP (1.5 lb)
		9. Imidan 50 WP (2 lb)
		18. Penncap-M 2 F (8 pt)
		23. Sevin 50 WP (4 lb)
		23. Sevin 80 S (2½ lb)
		29. Zolone 25 WP (8 lb)
		29. Zolone 3 EC (4 pt)

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot, Downy and Powdery Mildews	See Second Cover and note rate change at Third Cover for Dithane FZ and Mancozeb	FUNGICIDES Comments: <i>NOTE: Time interval between last spray and harvest for Mancozeb is 66 days, but for Dithane FZ it is 7 days.</i>
INSECTS		
Grape Berry Moth	See Second Cover	INSECTICIDES
Grape Phyloxera	See Second Cover	Comments:
Grape Leaf Hopper	See Third Cover	<i>Guthion is restricted to three applications per year.</i>
Rose Chafer	See Third Cover	

FIFTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot, Downy and Powdery Mildews	See Second Cover and note rate change at Third Cover for Dithane FZ and Mancozeb	FUNGICIDES 15. Rovral 50 WP (1½-2 lb)
Botrytis Rot (Just before cluster tightening)	15	INSECTICIDES 28. Vendex 50 WP (2 lb)
INSECTS		
Grape Berry Moth	See Second Cover	
Grape Leaf Hopper	See Third Cover	
Mites	28e	

GRAPES

SIXTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		
Grape Berry Moth	See Second Cover	INSECTICIDES 28. Vendex 50 WP (2 lb)
Mites	28e	

SEVENTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Powdery Mildew	1, 14, 50, 54, 55	FUNGICIDES
INSECTS		
Grape Berry Moth	See Second Cover	1. Benlate 50 WP (1 lb) 14. Wettable sulfur 95 WP* (4 lb) 50. Folpet 50 WP (4 lb) 54. Bayleton 50 WP** (3-6 oz) 55. Dinocap (1½ lb)
Comments: Asterisk (*)—Refer to sulfur tolerance list for grapes. Sulfur can cause severe injury to certain grape varieties (p. 62). Double asterisk (**)—Bayleton gives superior control of powdery mildew on French hybrid grapes.		

EARLY RIPENING

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

EIGHTH COVER

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

PRE-HARVEST

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

Special Grape Disease Problems and Controls

Eutypa Dieback

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

Phomopsis Leaf and Cane Spot Disease

This disease is caused by *Phomopsis viticola*. The symptoms consist of small, angular, necrotic lesions on the expanding leaves in the spring and later elongated, brownish/purple lesions on canes, tendrils, petioles and cluster stems. It can also cause a fruit rot late in the season. This disease is probably responsible for the fruit falling off the clusters ahead of the mechanical harvester in some years. This disease is controlled by spraying at the 1- to 3-inch shoot stage and again when shoots are 4 to 6 inches long. Captan, Folpet, Dithane or Mancozeb are the best materials to use. If this disease has been severe in a given vineyard, later cover sprays should contain these materials (be careful of cut-off date between date of last spray and harvest) to ensure control of the fruit rot phase of this disease.

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

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

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

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

³Berries are not susceptible.

STRAWBERRIES

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

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

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Stem End Rot, Leaf Blight, Leaf Spot	1	FUNGICIDES 1. Benlate 50 WP* (1 lb), plus Captan 50 WP (5-6 lb)
INSECTS		
Spittlebug	8g, 23e, 26e	Comments: Asterisk (*)—Repeated use of Benlate will result in the rapid build-up of tolerance in fungi. Use Benlate with Captan together as a tank mix.
Mites*	28e	
Strawberry Clipper***	34e	
Slugs**	36g	
White Grubs	38e, See page 66	
Root Weevils	38e, See page 66	
Comments: Asterisk (*)—Apply as two-spotted spider mites begin to increase. Triple asterisk (***)—Apply first spray when first buds become visible followed by a second spray 10 days later.		
INSECTICIDES 8. Guthion 50 WP (1 lb) 8. Guthion 35 WP (1.5 lb) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2½ lb) 26. Thiodan 50 WP (2 lb) 26. Thiodan 3 EC (1½ qt) 28. Vendex 50 WP (2 lb) 32. Lorsban 4 E (1 qt) 34. Lorsban 4 E (1 qt) 36. Metaldehyde baits** 38. Lindane 25 WP (2 lb)		
Comments: Double asterisk (**)—Various formulations of Metaldehyde and Metaldehyde-Sevin baits have a label for slugs on strawberries. However, these products are usually packaged for the homeowner and are not available for commercial use.		

STRAWBERRIES

SECOND COVER (PRE-BLOOM)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem and Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56	
INSECTS		
Tarnished Plant Bug	26e	
Spittlebug	See First Cover	
Strawberry Leafroller	8e, 23e	
Strawberry Clipper	See First Cover	
Comments: Tarnished plant bug control is critical at this time. Best results are achieved with a specific Thiodan application at or before 10% king bloom.		
FUNGICIDES		
		1. Benlate 50 WP (1 lb), plus Captan 50 WP (5-6 lb)
		16. Ronilan 50 W (1½ lb), plus Captan 50 WP (5-6 lb)
		56. Topsin-M 70 WP (¾ lb), plus Captan 50 WP (5-6 lb)
INSECTICIDES		
		8. Guthion 50 WP (1 lb)
		8. Guthion 2 EC (2 pt)
		23. Sevin 50 WP (4 lb)
		23. Sevin 80 S (2½ lb)
		26. Thiodan 50 WP (2 lb)
		26. Thiodan 3 EC (1½ qt)

THIRD COVER (50% BLOOM)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56, 59	
INSECTS		
Comments: Asterisk (*)—As per label, after fruit formation, the maximum allowable rate of Benlate is ½ lb 50 WP/acre. Therefore, combine with Captan as a tank mix. The addition of captan will aid in the control of leather rot (<i>Phytophthora cactorum</i>). No insecticides should be used during bloom.		
FUNGICIDES		
		1. Benlate 50 WP* (½ lb), plus Captan 50 WP (5-6 lb)
		16. Ronilan 50 WP (1½ lb), plus Captan 50 WP (5-6 lb)
		56. Topsin-M 70 WP (¾ lb), plus Captan 50 WP (5-6 lb)
		59. Captan 50 WP (5-6 lb)

FOURTH COVER (BERRIES HALF GROWN)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	See Third Cover	
INSECTS		
Tarnished Plant Bug	See Second Cover	
INSECTICIDES		
Comments: A repeat application of Thiodan may be necessary when the tarnished plant bug continues as a problem. Do not reapply Thiodan within 15 days of a previous application or more than twice within a 35-day interval once fruit is present. Use no closer than 4 days to harvest.		

STRAWBERRIES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Blight, Leaf Spot	1, 16, 56	
INSECTS		
Strawberry Sap Beetle*	5g, 8g	
FUNGICIDES		
		<ol style="list-style-type: none"> 1. Benlate 50 WP (1/2 lb), plus Captan 50 WP (5-6 lb) 16. Ronilan 50 WP (1 1/2 lb), plus Captan 50 WP (5-6 lb) 56. Topsin-M 70 WP (3/4 lb), plus Captan 50 WP (5-6 lb) 59. Captan dust** (7.5 captan) (4 lb)
Comments: Double asterisk (**)—Use dust only as a relatively poor alternate choice.		
INSECTICIDES		
		<ol style="list-style-type: none"> 5. Diazinon 50 WP* (2 lb) 5. Diazinon 4 EC* (1 qt) 8. Guthion 50 WP* (1 lb) 8. Guthion 2 EC* (1 qt) 8. Guthion 35 WP (1.5 lb)
Comments: Asterisk (*)—Apply Guthion or Diazinon through the overhead irrigation system at the end of the sprinkling period. Introduce material over a time interval of at least 15 minutes. Begin applications when beetles first become numerous or when injury first appears. Repeat as necessary, but not within 5 days of harvest.		

HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Gray Mold, Stem End Fruit Rot, Leaf Diseases	See Pre-Harvest	
INSECTS/MITES		
Cyclamen Mites	26g	
INSECTICIDES		
		<ol style="list-style-type: none"> 26. Thiodan 3 EC (1 1/3 qt) 26. Thiodan 50 WP (2 lb)
Comments: Under certain circumstances cyclamen mites may become established in a planting. Usually the infestation is limited to small areas in the field. These can be spot treated with the suggested chemical. The material should be applied so the plants are thoroughly drenched. The addition of a wetting agent will improve control. NOTE: Be aware of days between final sprays and harvest (Thiodan 4 days).		

STRAWBERRIES

POST-HARVEST AND NEW PLANTING

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	1, 59	
INSECTS		
Strawberry Leafroller	5g, 8e, 17g, 23e	
Leafhoppers	5g	
Strawberry Aphids	26e	
Slugs***	36g See note page 63	
FUNGICIDES		
		1. Benlate 50 WP (1 lb)* 59. Captan 50 WP* (4 lb)
Comments:		
		<i>Asterisk (*)—This treatment is especially for new plantings, starting 10 days to 2 weeks after harvest and repeated 2 weeks later. These treatments will keep new plants relatively disease free and will allow maximum growth to occur in the fall.</i>
INSECTICIDES		
		5. Diazinon 15 WP (2 lb) 5. Diazinon 4 EC (2 pt) 8. Guthion 50 WP (1 lb) 8. Guthion 35 WP (1.5 lb) 17. Parathion 15 WP (4 lb) 17. Parathion 8 F ($\frac{2}{3}$ pt) 23. Sevin 50 WP (4 lb) 23. Sevin 80 S (2 $\frac{1}{2}$ lb) 26. Thiodan 2 EC** (2 qt) 36. Metaldehyde bait***
Comments:		
		<i>Double asterisk (**)—See label for restriction of Thiodan use.</i>
		<i>Triple asterisk (***)—Fall application of metaldehyde bait can ease slug problems the following spring. Bait should be applied during a period of clear and dry weather for best results.</i>

Special Strawberry Insect Problems and Controls

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

The label restricts Lindane to 2 lb. per acre. It requires 5 lb. active ingredient of Lindane per acre to control white grubs and root weevils. This amount can be legally used

if application is restricted to 4 ft. strips, then rototated into the soil after which the strawberries are planted in the center of this strip.

BRAMBLES

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

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

DELAYED DORMANT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Anthracnose		
Phytophthora Root Rot*	See Post-Harvest	
Comments:		
Asterisk (*)—May be applied one additional time in the fall. Do not apply within 45 days prior to harvest.		
FUNGICIDES		
Lime sulfur solution (20 gal)*		
Lime sulfur solution (10 gal)**		
Comments:		
CAUTION: If unable to apply the first mentioned eradication spray for anthracnose, a lime-sulfur spray at 5 gal/100 of water when a few leaves have unfolded from buds will give effective control. There is greater risk of lime-sulfur burn, however, by spraying at this later time.		
Asterisk (*)—When new leaves are exposed $\frac{1}{4}$ to $\frac{3}{4}$ in.		
Double asterisk (**)—When a few leaves have unfolded.		

PRE-BLOSSOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Anthracnose	59, 57	
Spur Blight	59, 57	
INSECTS		
Leafrollers	5g, 8e	
Raspberry Sawfly	8e, 13g	
Raspberry Fruit Worm	8e, 13g	
Raspberry Cane Borer*	See Comments	
Red-necked Cane Borer**	See Comments	
Comments:		
Asterisk (*)—To control the raspberry cane borer, cut off and destroy injured canes below the two rings made by the beetles. Do this as soon as wilted tips are noticed, usually in July.		
Double asterisk (**)—To control the red-necked cane borer, cut and burn in the fall or early spring any wild raspberries in the vicinity since this insect develops on wild raspberries. At pruning time remove and burn all canes showing any swellings.		
FUNGICIDES		
57. Bordeaux: Powdered bluestone (6 lb), plus Hydrated lime (6 lb)		
59. Captan 50 WP (4 lb)		
INSECTICIDES		
5. Diazinon 50 WP (2 lb)		
5. Diazinon 4 EC (2 pt)		
8. Guthion 50 WP (1-2 lb)*		
8. Guthion 35 WP (1.5 lb)		
13. Malathion 50 WP (4 lb)		
Comments:		
If Guthion is used with Bordeaux, spray tank mix immediately as Guthion's insecticide effectiveness is lessened if left standing.		
Asterisk (*)—If Guthion is used for raspberry fruit worm, apply at the rate of 2 lb/acre. For other pests, use the rate of 1 lb/acre.		

BRAMBLES

EARLY BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Anthracnose	59	
Botrytis Rot (Gray Mold), Penicillium Rot, Powdery Mildew	1	
FUNGICIDES 1. Benlate 50 WP* (3/4 lb) 59. Captan 50 WP (4 lb)		
Comments: Asterisk (*)—Benlate will give excellent control of spur blight and anthracnose diseases as well as control of fruit rots, although Benlate is not labeled for control of spur blight and anthracnose per se.		

FULL BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Botrytis Rot, Penicillium Rot, Powdery Mildew	1	
FUNGICIDES 1. Benlate 50 WP (3/4 lb)		

POST BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Botrytis Rot, Penicillium Rot, Powdery Mildew	1	
FUNGICIDES 1. Benlate 50 WP (3/4 lb)		
Comments: Up to 3 post bloom sprays of Benlate on a 14-day schedule are allowed up to within 3 days of harvest. Fruit rot incidence is worst when fruit is ripening and when rainy, wet conditions prevail.		

FIRST COVER (PETAL FALL)

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

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS/MITES		
Aphids	5g, 17f, 13e	
INSECTICIDES 5. Diazinon 50 WP (2 lb) 5. Diazinon 4 EC (2 pt) 13. Aqua Malathion 8 E (1 pt) 13. Malathion 25 WP (8 lb) 17. Parathion 15 WP (4 lb) 17. Parathion 8 F (2/3 pt)		

BRAMBLES

POST HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Phytophthora Root Rot	58	FUNGICIDES 58. Ridomil 15 G**
Comments: <i>Phytophthora root rot symptoms appear in summer and spring. Whole canes appear to suddenly wilt. Associated with low wet areas of soil.</i>		
<i>NOTE: A repeat application can be made once in the spring. Do not apply within 45 days of harvest.</i>		
INSECTS		
Aphids	5g	INSECTICIDES 5. Diazinon 50 WP* (2 lb) 5. Diazinon 4 EC* (2 pt)
Raspberry Crown Borer	5e*	Comments: <i>Asterisk (*)—Where raspberry crown borers are a major problem, apply a drenching crown spray using Diazinon. Use 400 to 500 gal of spray/acre. Apply the spray any time from mid-October to mid-November or as a drench to the crown area in early April to kill the overwintering stage.</i>

Special Brambles Disease Problems and Controls

Virus Diseases in Raspberries

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

1. Prior to planting, sample the planting site thoroughly for nematodes at 6 to 8 in. and 18 in. depths. Send the sample to the MSU Nematode Laboratory (see Extension Bulletin E-800, "Nematode Detection"). If

there are dagger nematodes (*Xiphinema americanum*) or root lesion nematodes (*Pratylenchus* spp.), you should fumigate the soil thoroughly the fall before spring planting (see section on soil fumigation for nematode control).

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

3. Try to plant the field 500 to 1,200 ft away from existing wild raspberries or existing old cultivated raspberries. If this cannot be done, attempt to eradicate wild raspberries for a radius of 500 to 1,200 ft with herbicides.

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

CURRANTS, GOOSEBERRIES

The rates of materials for use on currant and gooseberry are based on a standard of 200 gal/acre dilute spray. If less than 200 gal water is applied/acre, refer to

the rate/acre figures to insure that the proper amount of pesticide is applied.

DORMANT GREEN TIP

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Powdery Mildew		FUNGICIDES Lime sulfur solution (10 gal)

Comments:
Thorough coverage is essential.

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Powdery Mildew	lime sulfur	FUNGICIDES Lime sulfur solution* (10 gal)
INSECTS		
Imported Currant Worm	13g, 17g	Comments: Asterisk (*)—Thorough coverage is essential.
Currant Aphid	13g	INSECTICIDES 13. Malathion 25 WP (4 lb) 17. Parathion 15 WP (3 lb) 17. Parathion 8 F (1/3 pt)

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Leaf Spot	50	FUNGICIDES 50. Folpet 50 WP (4 lb)
Comments: The timing of the spray for leaf spot varies with the individual planting. However, for best disease control, spray when leaf spot is first noticed. Generally it is observed first on the lower leaves of the bushes. If leaf spot is present at harvest time, spray immediately after harvest with the fungicide suggested for second cover.		
INSECTS		
Imported Currant Worm	See First Cover	
Aphids	See First Cover	

BLUEBERRIES

Rates of materials for blueberry are based on standard amounts/acre used in air applications. NOTE: Do not apply any fungicides (except Funginex) listed by airplane. Thorough coverage by ground sprayers is essen-

tial with the recommended fungicides. See Extension Bulletin E-840, "Tractor-Mounted Air Blast Sprayers in Small Fruit Crops," for calibration of sprayers.

GREEN TIP (1/16")

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker	8	
Mummyberry (Shoot blight phase)	2	
FUNGICIDES 2. Funginex 20 EC* (24 fl oz) 8. Difolatan 80% "Sprills"** (2½ lb) 8. Difolatan 4 F** (2 qt)		
Comments: Asterisk (*)—Apply in 20 gallons water/acre by ground sprayer or in 5 gallons water/acre by airplane. Double asterisk (**)—A new label registration for Difolatan on blueberries allows for chemical control of Fusicoccum canker. Although Phomopsis canker is not on the label, Difolatan will give some control. Conidiospores of both fungi are spread from cankers on stems with each rain beginning at bud break and continuing into the fall. Do not apply Difolatan by airplane. Coverage is too poor to get good results.		

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

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Mummyberry (Shoot blight phase)	2	
FUNGICIDES 2. Funginex 20 EC (24 fl oz)		

BLUEBERRIES

PINK BUD

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Mummyberry (blossom infection stage)	1, 2	
Fusicoccum Canker	1, 2, 8	
Anthracnose	1, 2, 8	
Alternaria Fruit Rots	2, 8	
INSECTS		
Oblique Banded Leafroller	11e	
Spring Canker Worm	11e	
FUNGICIDES 1. Benlate 50 WP (1 lb), plus Difolatan 4F** (2 qt), OR Difolatan 80% "Sprills" (2½ lb) 2. Funginex 20 EC* (24 fl oz), plus Difolatan 4F** (2 qt), OR Difolatan 80% "Sprills" (2½ lb) 8. Difolatan 4 F** (2 qt) 8. Difolatan 80% "Sprills" (2½ lb)		
Comments: <i>Phomopsis canker will be partially controlled by Difolatan.</i> Asterisk (*)—Funginex controls mummyberry only. Difolatan or Captan needed for control of other diseases listed. Double asterisk (**)—Substitute Captan 50 WP at 5 lb/acre for Difolatan if allergic to Difolatan.		
INSECTICIDES 11. Methomyl 1.8 (2 pt) 11. Methomyl 90 SP (½ lb) 11. Lannate 2.4 LV (3 pt)		

25% BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Mummyberry (blossom infection stage)	1, 2	
Fusicoccum Canker	1, 2, 8	
Anthracnose	1, 2, 8	
Alternaria Fruit Rots	2, 8	
FUNGICIDES 1. Benlate 50 WP (1 lb), plus Difolatan 4 F** (2 qt), OR Difolatan 80% "Sprills" (2½ lb) 2. Funginex 20 EC* (24 fl oz), plus Difolatan 4 F** (2 qt), OR Difolatan 80% "Sprills" (2½ lb) 8. Difolatan 4 F** (2 qt) 8. Difolatan 80% "Sprills" (2½ lb)		
Comments: Asterisk (*)—Funginex controls mummyberry only. Double asterisk (**)—Substitute Captan 50 WP at 5 lb/acre for Difolatan if allergic to Difolatan. <i>Phomopsis canker will be partially controlled by Difolatan.</i>		

BLUEBERRIES

FULL BLOOM (EARLY PETAL FALL)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Mummyberry (blossom infection stage)	1, 2	
Fusicoccum Canker	1, 8	
Anthracnose	1, 2, 8	
Alternaria Fruit Rots	2, 8	
FUNGICIDES 1. Benlate 50 W (1 lb), plus Difolatan 4 F** (2 qt), OR Difolatan 80% "Sprills" (2½ lb) 2. Funginex 20 EC* (16 fl oz) 8. Difolatan 4 F** (2 qt) 8. Difolatan 80% "Sprills" (2½ lb)		
Comments: <i>Asterisk (*)—Funginex controls mummyberry only. The rate of Funginex must be reduced at fruit formation.</i> <i>Double asterisk (**)—Substitute Captan 50 WP at 5 lb/acre for Difolatan if allergic to Difolatan.</i> <i>Phomopsis canker will be partially controlled by Difolatan.</i> <i>Difolatan applied at full bloom may interfere with bee activity.</i>		

FIRST COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker	8	
Anthracnose	8	
Alternaria Fruit Rots	8	
FUNGICIDES 8. Difolatan 80% "Sprills"** (2½ lb) 8. Difolatan 4 F* (2 qt)		
Comments: <i>Asterisk (*)—Substitute Captan 50 WP at 5 lb/acre for Difolatan if allergic to Difolatan.</i> <i>Phomopsis canker will be partially controlled by Difolatan.</i>		

INSECTS		INSECTICIDES
Plum Curculio	8e, 9e, 23g	
Blueberry Tip Borer	8e, 9e, 23g	
Oblique Banded Leafroller	8e, 9e, 11e, 23g	
Cranberry Fruitworm	8e, 9e, 23e	
Cherry Fruitworm	8e, 9e, 23e	
Aphids	11e	
INSECTICIDES 8. Guthion 50 WP (1 lb) 8. Guthion 35 WP (1.5 lb) 9. Imidan 50 WP (2 lb) 11. Lannate 1.8 (2 pt) 11. Lannate 90 SP (½ lb) 11. Lannate 2.4 LV (3 pt) 23. Sevin 80 S (2½ lb)		
Comments: <i>For aphid control, sprays should be applied with a ground sprayer.</i>		

BLUEBERRIES

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker,	8, 59	
Anthracnose	8, 59	
Alternaria Fruit Rots	8, 59	
INSECTS	See First Cover	
Comments: <i>Phomopsis will be partially controlled by Difolatan.</i>		
Asterisk (*)—Substitute Captan 50 WP at 5 lb/acre for Difolatan if allergic to Difolatan.		

THIRD COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker,	8, 59	
Anthracnose	8, 59	
Alternaria Fruit Rots	8, 59	
INSECTS	See First Cover	
Comments: <i>Interval between last application and harvest for Difolatan is 21 days.</i>		
<i>Phomopsis canker will be partially controlled by Difolatan.</i>		

BLUEBERRIES

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker	8, 59	FUNGICIDES 8. Difolatan 80% "Sprills" (2½ lb) 8. Difolatan 4 F (2 qt) 59. Captan 50 WP (5 lb)
Comments: <i>If canker is a serious problem, make fungicide application about 4 to 6 weeks after Third Cover. If this application occurs within 21 days of harvest, use Captan instead of Difolatan.</i>		
INSECTS		
Blueberry Maggot	8e, 9e, 13g	INSECTICIDES 8. Guthion 50 WP (1 lb) 8. Guthion 35 WP (1.5 lb) 9. Imidan 50 WP (2 lb) 13. Malathion LV Concentrate* (10 fl oz) 13. Aqua Malathion 8 EC* (1 pt) 13. Malathion 25 WP* (8 lb) 39. Mesurol 75 WP** (2 lb)
Aphids	13g	
BIRDS		
Bird Repellent	39e, See Comments	Comments: <i>Asterisk (*)—24 hour interval between treatment and harvest.</i> <i>Double asterisk (**)—A maximum of 4 lb of product may be used per season. Applications may be made up to 7 days before harvest for maximum repellency of birds. Apply as berries first begin to ripen and repeat if necessary to maintain repellency with at least 7 days between applications.</i> <i>NOTE: ULV Malathion + Difolatan can burn blueberry fruit and leaves when applied as a tank mix.</i>

FIFTH COVER

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

SIXTH COVER

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

BLUEBERRIES

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker	59	FUNGICIDES 59. Captan 50 WP*** (5 lb)
INSECTS		
White Marked Tussock Moth	11e, 23e	Comments: <i>Triple asterisk (***)—If canker is a serious problem, and it has been 4 to 6 weeks since the last canker spray, apply a spray at this time.</i>
Oblique Banded Leafroller	11e, 23e	
Canker Worms	11e, 23e	
INSECTICIDES		
		11. Lannate 1.8* (2 pt)
		11. Lannate 90 SP (½ lb)
		11. Lannate 2.4 LV (3 pt)
		23. Sevin 80 S** (2½ lb)
Comments: <i>Asterisk (*)—3 days between treatment and harvest.</i>		
<i>Double asterisk (**)—No interval between treatment and harvest.</i>		

POST HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Fusicoccum Canker	8	FUNGICIDES 8. Difolatan 80% "Sprills" (2½ lb) 8. Difolatan 4 F (2 qt)
Comments: <i>If canker is a serious problem, apply the spray if it has been 4 to 6 weeks since the previous canker spray. Continue spray applications on a 4 to 6 week interval through leaf drop in the fall.</i>		

Plant Growth Regulators

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

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

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

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

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

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

4. Coverage: Responses are generally localized. All plant growth substances must be applied with precision. Ensure that the proper amount is applied in a correct manner. Uniform, thorough coverage is essential. Calibrate your sprayer accurately. For large trees, direct 2/3 of the spray volume into the upper 1/3 of the tree. When-

ever possible, apply growth substances as a dilute spray.

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

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

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

Apples

Chemical Thinning

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

Thinning With NAA

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

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

1. Varieties Easy to Thin: McIntosh, Delicious, Empire, Idared, Paulared, Jerseymac, Jonathan, Northern Spy, and Rhode Island Greening: 4 grams of *actual* NAA per 100 gallons (10 parts per million). Spur type Delicious are harder to thin than regular Delicious and require 2 to 3 more parts per million concentration.

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

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

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

Thinning with NAD

Amid-Thin (NAD) is suggested for use on apples in Michigan at 50 parts per million at petal fall, applying at least 3 gallons per acre on large mature trees. Concentrations lower than this have not given adequate thinning. Applying Amid-Thin *after* petal fall has resulted in *poor* thinning; and it has caused the fruit to stick fast to the tree so that no "June drop" occurred giving a large crop of valueless, small apples.

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

Sevin as a Thinning Agent

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

Sevin may be useful for fruit thinning, but it has not produced consistent and adequate results in research trials. Thinning with Sevin does not appear to be concentration-dependent. If not used as an insecticide, rates of $\frac{3}{4}$ to 2 lb/100 gal will result in similar thinning responses. Apply Sevin at first cover for fruit thinning. Sevin used at second cover following thinning applications of NAA can cause overthinning and increase mite problems.

Evaluating Results

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

Cautions

- As a general rule, apply NAA under fast-drying conditions, when the temperature is between 70° and 75° F. On the other hand, Amid-Thin gives best results when applied under slow-drying conditions. Amid-Thin is often applied in the evening.
- Weak trees are thinned more easily than vigorous ones. Weak wood in lower portion of tree thins easier than vigorous wood in the top.

Guide for Chemical Thinning of Apples in Michigan¹

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

¹This table should be used as a guide only. Specific chemical methods, and chemical concentrations may vary depending upon tree vigor, fruit set, environmental conditions, and application techniques.

²Some spur type Delicious may require higher concentrations.

³NAA may cause premature ripening and fruit cracking.

⁴Sevin may cause fruit russetting of Golden Delicious.

⁵Varieties which mature before McIntosh.

- Thinning with NAA and Amid-Thin is greater when weather conditions during bloom do not favor good pollination and fruit set. However, when fruit set is questionable, but chemical thinning is a "must," use Amid-Thin at 50 parts per million at petal fall.
- If the weather during the week preceding bloom or the week after bloom is cloudy, wet, and humid, thinning is accomplished more easily than if the weather during these periods has been fair and sunny.
- When freezing temperatures (32° F and lower) occur after pink and before applying the thinning sprays, NAA may cause excessive thinning. Reduce the

concentration by 2 or 3 parts per million if frost, wind, chemical or insect damage to foliage has occurred.

- Each grower must work out the concentrations of NAA best suited for individual orchard conditions. Sprays of NAA will remove all the fruit and severely damage the leaves if too high concentrations are used. When conditions exist which might result in injury, or loss of crop from overthinning with NAA, Amid-Thin applied at petal fall using 50 parts per million is safer for widespread use. However, these decisions must be made by the grower.
- Uniform coverage is important to avoid over-thinning or under-thinning different parts of the tree.
- Thinning is most effectively accomplished with NAA applied 5 to 15 days after petal fall. The earlier applications permit evaluation and a second application, if necessary.

Thinning with Concentrated Mixtures

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

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

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

Defruiting Young Apple Trees

Removing fruit on small trees before they are large enough to produce a profitable crop is often desirable. On some varieties, these fruit reduce tree growth and may contribute to a buildup of insects and diseases if the orchard is not on a full spray schedule. NAA at 15 ppm plus Sevin 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 per 100 gal. Higher concentrations may cause some leaf damage, and should not be used.

Pre-Harvest Drop Control of Apples

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

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

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

Alar is effective for pre-harvest drop control when applied at 750 to 1,000 ppm, 70 days before anticipated harvest. **Do not apply Alar within 60 days of harvest.** Alar tends to retard maturation, and treated fruit are generally more firm than non-treated apples at the time of normal harvest. For greater pre-harvest drop control, NAA may be applied in addition to a previous application of Alar.

Alar on Apples

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

Alar can be used any time after petal fall to 60 days before harvest in apple orchards. Early season applications 10 to 21 days after petal fall at the rate of 1,000 ppm (1 lb/100 gal), tend to promote flower bud formation and to reduce the amount of vegetative growth. If applied to fruiting trees, particularly weak trees, reduction of fruit size is likely to occur that same season. Jonathan fruit size is markedly reduced by high concentrations applied shortly after petal fall. Early season applications may also produce similar results to those made 60 to 70 days prior to harvest, but the response may not be as pronounced nor as consistent. In general, the earlier the application, or the higher the concentration, the greater the reduction of fruit size during the current growing season.

Mid-summer applications of 500 to 700 ppm (1/2 to 3/4 lb/100 gal) up to 60 days prior to harvest provide pre-harvest drop control, extend the harvest period, delay maturity, delay fruit softening and delay water core development.

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

Ethepron on Apples

Pre-harvest applications of ethephon favor red color development, hasten fruit maturity and ripening, and

promote abscission of apples. The type and degree of response depends on the concentration, time of application, and the variety of apple. Ethephon will not completely overcome conditions unfavorable for development of red color. Conditions that are normally associated with poor fruit color, such as high temperatures, excessive vigor, or dense trees, may limit red color development to the point that adding ethephon still will not bring color up to a satisfactory level. Use ethephon only on apples intended for early sale since its ripening effect may shorten the storage life of the fruit.

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

Ethephon promotes fruit abscission. NAA must be used to counteract the abscission effect or excessive fruit drop will occur. A previous Alar application (1,000) is recommended to increase firmness of ethephon-treated fruit, but will not likely control fruit drop without the addition of NAA.

Water Sprout and Sucker Control (Apple and Pear)

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

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

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

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

Pears

Chemical Thinning

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

The following rates are given as guides: (1) trees of low vigor 25 parts per million (ppm); (b) trees of medium vigor 35 ppm, and (c) trees of high vigor 45 ppm. When the thinning spray is applied after petal fall, leaves are more subject to epinasty or twisting.

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

Peaches

Chemical Thinning

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

Cherries

Ethephon on Cherries

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

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

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

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

Temperature and tree vigor are associated with the degree of response achieved. At higher temperatures

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

Consider the following points before applying ethephon to cherries:

1. Concentration: For light sweet cherries, 300 ppm (1 pt/100 gal); for dark sweet varieties, 400 ppm (1½ pt/100 gal); for tart cherries, 200 ppm (⅔ pt/100 gal).

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

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

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

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

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

Gibberellic Acid on Cherry

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

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

Alar on Cherries

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

For *tart* cherry, research suggests that Alar applied at the rate of 2 to 4 lb/100 gal, two weeks after full bloom, will likely result in improved red color, increased fruit

firmness, advanced maturity, and promotion of fruit loosening. Vigorous trees exhibit little or no response to Alar applications.

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

Grapes

Alar on Concord Grapes

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

To increase fruit set, apply Alar between first bloom and full bloom at the rates in table below.

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

Recommended Rate of Alar-85 on Concord Grapes

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

Herbicides

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Weed Control in Fruit Crops

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

It is necessary to provide optimum growing conditions the first few seasons to produce a healthy tree with a strong trunk and scaffold branches. Control perennial weeds, such as quackgrass, nutsedge, or Canada thistle, with repeated tillage of 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 at least to the drip-line of the tree.

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

Herbicides for Fruit Crops

AMS (Ammate-x). Label voluntarily withdrawn. Not available after existing supplies marketed. Ammate is an herbicide which is effective on woody perennials such as poison ivy. It kills both by contact and translocation. It may be utilized safely in apple orchards if care is taken not to allow the chemical to contact the foliage or newly formed bark. Apply Ammate when poison ivy or other perennials are leafed-out in late spring. Thoroughly soak the foliage, using 60 pounds of chemical per 100 gallons

of water. The residual life of this chemical in the soil is very short during the summer months. Ammate is extremely poisonous, may be corrosive to sprayers and should be handled carefully. It is usually used as a spot spray with a small hand sprayer.

2,4-D (Dacamine 4D, Acme Hi Dep, Weedar 64 Broadleaf Herbicide). These nonvolatile forms of 2,4-D may be utilized safely on the orchard floor if care is taken to avoid drift onto the foliage of trees. The primary use is to control perennial broadleaved weeds such as dandelions, field bindweed and common milkweed. 2,4-D is absorbed through the foliage of these weeds and translocated to the root system. Apply the chemical at low pressure using 1 pound of active chemical per acre on perennials which are growing actively. At this rate of application, the chemical disappears from the soil in 2 to 3 weeks. Several spot applications are often needed to completely eradicate these deep-rooted perennials. It may be combined with other herbicides. Never use in sprayers that will later be used for foliar applications on fruit and vegetable crops. **Applications after harvest and before frost preferred.**

For newly planted apple and pear.

For established apple and pear.

Dalapon (Dowpon, Weedar 64 Broadleaf Herbicide labeled for stone fruit). Dalapon is utilized primarily for quackgrass control under apple and pear trees which are well established. It controls only grasses. Apply at 10 pounds/acre when quackgrass is 4 to 6 inches high in the spring. Dalapon is absorbed both by the foliage and root system. It is usually combined with simazine (Princep) or diuron (Karmex) to obtain season-long control of the entire weed spectrum. Do not use Dalapon under stone fruits or grapes because of toxicity that has occurred particularly on sandy soils.

For newly planted apple.

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

Dichlobenil (Casoron, Norosac). This chemical effectively controls quackgrass in established fruit plantings. It is labeled for all tree fruit, brambles, grapes and blueberries. The granular formulation is superior to the wettable powder for controlling quackgrass. Proper timing of application is critical for obtaining optimum results. The most consistent results have been obtained with application in November prior to snowfall. Six pounds of chemical (150 pounds of 4 percent granules) per acre will

control quackgrass and annual weeds until late summer of the following year. Some other perennial weeds such as field bindweed and Canada thistle are also suppressed by this chemical.

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

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

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 pounds/acre prior to the emergence of weeds, it will provide acceptable weed control for the growing season. There is no buildup of chemical in the soil from annual applications of this rate. Diuron is utilized successfully with paraquat or glyphosate to obtain season-long control of most weeds. It can also be tank-mixed with other soil-active herbicides for improved control of a wider range of weed species.

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

Fluazifop-butyl (Fusilade 2000) is a systemic herbicide only effective on grasses. It is labeled only for non-bearing fruit crops and cannot be applied within 12 months of harvest. Add 1 quart of crop oil or 1 pint of non-ionic surfactant for every 25 gallons of diluted 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).

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

Do not apply within 12 months of harvest.

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

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

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

Napropamide (Devrinol). Napropamide can be applied at 4 pounds/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 but has exhibited poor performance in established Michigan orchards for the usual spectrum of weeds present.

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

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

Norflurazon (Solicam). This chemical is labeled for apple, pear, peach, plum and blueberry, and can be applied to newly planted apple and peach trees after the soil has settled. Apply before weeds emerge or combine with paraquat or glyphosate for control of existing vegetation. Apply 2.5 to 5 pounds/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.

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

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

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

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

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

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 pounds/acre as a direct spray to the base of the trees. It can be applied in combination with paraquat, glyphosate and oryzalin.

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

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

Paraquat (Gramoxone). Paraquat provides very rapid knockdown of annual and perennial weeds and may be utilized in all fruit plantings. 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. If weed growth is severe, apply at a rate of 1 pound of active ingredient per acre. On lighter infestations, $\frac{1}{2}$ pound/acre is adequate. The addition of a wetting agent at 1 quart per 100 gallons of spray usually increases the effectiveness of the material. To eliminate weed competition for the entire growing season, 2 to 3 applications are necessary. Paraquat is extremely toxic and should never be allowed to touch skin or eyes. Avoid inhaling mist of this chemical. Paraquat may be combined with other soil-active herbicides to provide season-long weed control.

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

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

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

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

Pronamide (Kerb). Pronamide acts through the soil to kill quackgrass rhizomes and germinating annual weeds. It is most effective on grasses and will miss several weeds in the compositae family. Works best when applied during cool wet conditions. On sandy loam soils, apply at rates of 1 to 2 pounds/acre of active ingredient. It is not effective on soils with a high organic matter content.

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

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

For newly planted apple, pear, peach, cherry, plum, grape and blueberry. Do not apply within 1 year of harvest.

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

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

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

In tree fruits, spring applications (April 15-May 1) of Sinbar at 1 pound of active ingredient per acre control annual weeds. Two or 3 pounds/acre are needed to control quackgrass, the lower rate being adequate on lighter soils. Sinbar may move quite readily in very sandy soils and tree injury, manifested as veinal chlorosis of leaves, results from applying too much chemical on these soils. Do not apply Sinbar on sandy or gravelly knobs or bulldozed areas where there is essentially no organic matter in the soil.

For established apple, pear, peach, bramble and blueberry—all at least 3 years old.

Herbicide Combinations. Materials such as paraquat and glyphosate are applied after weeds have emerged to provide control of weed growth present at time of treatment. The addition of soil-active herbicides such as simazine, diuron and/or terbacil can provide season-long weed control.

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 lambsquarter, pigweed and foxtail occur, the addition of terbacil or diuron improves the degree of weed control. Terbacil does not control

redroot pigweed and should be combined with diuron or simazine if pigweed is a major orchard weed problem. Simazine does not control horseweed (maretail). Terbacil is required to control this weed. Combinations with terbacil require caution. Generally, about 1 lb per 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.

Oryzalin or napropamide can be utilized in new plantings to control grasses and some broadleaved annual weeds. Combination with oxyfluorfen provides control of a wider spectrum of broadleaved weeds.

Herbicides for Strawberries

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

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

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

Diphenamid (Enide). Diphenamid is more effective on annual grasses than on broadleaved weeds, but will provide acceptable control of several common broadleaves if irrigation is utilized soon after application. Diphenamid has inhibited rooting of runner plants on light sandy soils and is not suggested for use on new plantings located on these soils. It may be used safely on

established plantings at 4 pounds/acre on light soils and 6 pounds/acre on heavier soils. One application will control weeds for 6 to 10 weeks. It controls germinating grain in mulched plantings. Do not apply within 60 days of harvest. Combinations of diphenamid with chloroxuron are very effective.

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

Napropamide (Devrinol). Napropamide is extremely effective on annual grasses and some broadleaved weeds when applied preemergence in strawberries at 1 to 2 pounds/acre. It is sensitive to soil moisture and should be either incorporated into the soil about 2 inches deep prior to establishing new plantings, or irrigated in on established plantings. It may be applied in spring or fall or at other times of the year after cultivation. It is an amide herbicide like diphenamid and has the potential for inhibition of runner rooting on extremely light sandy soils.

Terbacil (Sinbar). Terbacil is labeled for pre- and post-emergence weed control in established strawberries. Although it controls some problem weeds that are not killed by the above herbicides, the safety margin on strawberries is extremely narrow. Do not apply terbacil on newly planted berries, and avoid application during periods of the year when the plants are making active growth. The safest times to apply are after mowing the plants at renovation time or late fall after growth stops. Application rates should not exceed $\frac{1}{8}$ pound/acre active ingredient on sandy loams and $\frac{1}{6}$ pound/acre on loam soils.

Weed Sprayers

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

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

2. Solution agitation (stirring). It can be either mechanical or a bypass from the pump. If a power takeoff sprayer does not provide agitation, add a bypass to a galvanized tee between the pump and pressure gauge. To increase agitation in the tank, place an agitator nozzle on the end of the overflow hose. In this case, a separate

valve on the bypass line will regulate pressure. If the pump does not have enough capacity for agitation under specific spraying conditions, provide it by using both the next lower tractor gear and nozzle tips with a smaller orifice.

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

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

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

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

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

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

Sprayer Calibration

One of the most important factors in effective weed spraying is accurate calibration—determining the amount of spray material applied per acre. A range of 20

to 60 gallons per acre, at a pressure of 20 to 60 pounds per square inch, is satisfactory.

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

A good way to calibrate a sprayer is to:

1. Fill the spray tank with water only.
2. Spray a measured area, in a field if possible, at a fixed tractor speed and pressure gauge setting. Be sure to allow for partial coverage if bands are used.
3. Measure the amount of water needed to refill the tank.
4. Divide this amount by the fraction of an acre sprayed to get the gallons applied per acre.
5. Mix the amount of chemical desired per acre with water to give this much spray material.

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

Band Application

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

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

Names, Sources and Formulations of Herbicides for Fruit Crops¹

Common Name	Trade Name and Manufacturer	Concentration and Commercial Formulations ²
AMS	AMMATE-X-N1 (DuPont)	95% salt
chloroxuron	TENORAN (Ciba-Geigy)	75 WP
dalapon	DOWPON (Vertac)	85% salt
DCPA	DACTHAL (SDS)	75 WP
dichlobenil	CASORON (Uniroyal)	4 G
diphenamid	ENIDE (Upjohn)	50 WP; 90 WP
diuron	KARMEX (DuPont)	80 WP; 90 WG
fluazifop-butyl	FUSILADE 2000 (ICI)	1 lb/gal L
glyphosate	ROUNDUP (Monsanto)	3 lb/gal L
hexazinone [†]	VELPAR (DuPont)	2 lb/gal L; 90 SP
napropamide	DEVRINOL (Stauffer)	50 WP
norflurazon	SOLICAM (Sandoz)	80 DF; 80 WP
oryzalin	SURFLAN (Elanco)	4 lb/gal L; 75 WP
oxyfluorfen	GOAL (Rohm & Haas)	1.6 lb/gal L
paraquat	GRAMOXONE SUPER (ICI)	1½ lb/gal L
pendimethalin	PROWL (Amer. Cyanamid)	4 lb/gal L
pronamide	KERB (Rohm & Haas)	50 WP
sethoxydim	POAST (BASF)	1.5 lb/gal L
simazine	PRINCEP (Ciba-Geigy)	80 WP; 90 WG
terbacil	SINBAR (DuPont)	80 WP
2,4-D	ACME HIDEP (PBI Gordon Corp.) DACAMINE 4D WEEDAR 64 (Rhone-Poulenc)	3.6 lb/gal L 3.8 lb/gal L

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

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

Weed Control Recommendations for Orchards, Vineyards and Small Fruit Plantings

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Rates given are four pounds of active ingredients per acre actually covered with spray material unless otherwise specified. These amounts should not be interpreted

as the amounts required to treat an acre of orchard. Always read the label on the container. See page 82 for detailed herbicide information.

TREE FRUITS

APPLES, PEARS

(Year of Planting)

Weed Problem	Chemical	Ib/acre active ingredient	Time of Application	Remarks and Limitations
Emerged annuals	paraquat (Gramoxone)	1/2 to 1	Before or after planting trees and again during season as needed	Spray in band about 4 feet wide to emerged weeds. Two to 3 applications are needed for season-long control. Do not allow spray to touch foliage of trees. Do not spray high on the trunks of newly planted trees.
Annuals	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting	Delay application until ground has settled following planting. Use lower rate on lighter soil.
	Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
	pronamide (Kerb)	1 to 2	November	Apply after harvest and before soil freezes.
	norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	Use only on apples; use lower rate on sandy soils. Most effective when applied in the fall.
Annual broad leaf	oxyfluorfen (Goal)	1/2 to 2	Dormant	Do not apply after bud swell.
Grasses	Fluazifop-butyl (Fusilade 2000)	0.25 to 0.5	To actively growing grass.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants.
	sethoxydim (Poast)	0.3 to 0.4		

WEED CONTROL

APPLES, PEARS

(Established One Year or More*)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Germinating annuals	simazine (Princep)	2 to 4	Fall or spring before weeds emerge.	Simazine rate may be decreased if weed control was complete in the previous year.
	diuron (Karmex)	2 to 3	In spring before weeds emerge.	
	terbacil (Sinbar)	½ to 1	Late April or early May.	Use only on apples. Use lowest rate on sandy soils. Do not apply on sand pockets or knobs.
	norflurazon (Solicam)	3 to 6	Fall or spring before weeds emerge.	Use lower rates on sandy soils.
	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground.	Use lower rate on lighter soil. Apply in early spring.
Quackgrass and emerged weeds	Napropamide (Devrinol)	4	Apply to weed-free ground.	Incorporation protects from rapid photo inactivation.
	simazine (Princep) plus Paraquat	4 plus ½ to 1	Same as above.	Simazine rate may be decreased if weed control was complete in the previous year.
	dichlobenil (Casoron)	6	November	Use granular formulation.
Dandelions	2,4-D (Dacamine 4D)	1	After fruit harvest in fall and prior to bloom in spring.	Use these low volatile forms of 2,4-D only. Spray at low pressure when there is no danger of drift onto trees.
Quackgrass	glyphosate (Roundup)	1½ to 2	Quackgrass should be 8-10 inches tall.	This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees.
	dalapon (Dowpon, Basfapon)	10	When quackgrass has 4 to 6 inches of new growth.	Will suppress quackgrass for 1 to 2 months. May be used with simazine to control annual weeds.
	pronamide (Kerb)	1 to 2	November	Apply before soil freezes.
Field-bindweed and other problem perennials	2,4-D (Dacamine 4D)	1	When weeds are growing rapidly.	Use these low volatile forms of 2,4-D only. Spray at low pressure when there is no danger of drift onto trees. Where growth is dense, use 80 to 100 gallons of water per acre. Do not apply within 40 days prior to harvest.
	glyphosate (Roundup)	2 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees.

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

WEED CONTROL

CHERRIES

(Nonbearing)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Emerged annuals and perennials	glyphosate (Roundup)	1 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots of trees. Do not apply to cherry trees that will bear fruit within a year after application.

CHERRIES (TART AND SWEET), PEACHES, PLUMS

(First Year Plantings and Established Orchards)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	paraquat (Gramoxone)	1/2 to 1	Before or after planting trees and again during season as needed.	Spray in band about 4 feet wide to emerged weeds. Repeat applications are needed at 30 to 40 day intervals for season-long control. Do not allow spray to touch foliage of trees. Do not spray high on the trunks of newly planted trees.
	Oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting.	Delay application until ground has settled following planting. Use lower rate on lighter soil.
	Napropamide (Devrinol)	4	Apply to weed-free ground after planting.	May be used around newly planted trees. Incorporation protects from rapid photo inactivation.
	norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	
Annual broadleaf	oxyfluorfen (Goal)	1/2 to 2	Dormant	Do not apply after bud swell.
Perennial broadleaf weeds	2,4-D (Hi Dep, Weedar 64)	1 to 1 1/2	When weeds are actively growing.	Do not apply within 40 days prior to harvest. Post-harvest treatment preferred.
Grasses	Fluazifop-butyl (Fusilade 2000)	0.25 to 0.5	To actively growing grasses.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants.
	sethoxydim (Poast)	0.3 to 0.4		

WEED CONTROL

CHERRIES (TART AND SWEET), PEACHES, PLUMS

(Established One Year or More)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals and quackgrass	simazine (Princep) plus paraquat (Gramoxone)	2 to 4 plus 1/2 to 1	When weeds are 2 to 4 inches high.	Do not spray on sand pockets or knobs. Use lowest rate of simazine on plums. Simazine rate may be decreased if weed control was complete in the previous year.
	simazine (Princep)	4	October or November.	Use granular formulation. More effective if followed by paraquat at 1/2 lb/acre in the spring.
	dichlobenil (Casoron)	6	November	Use granular formulation.
	norflurazon (Solicam)	3 to 6	Apply to weed-free ground after soil settles.	Fall applications generally more effective.
	glyphosate (Roundup)	1 1/2 to 2	Quackgrass should be 8-10 inches tall.	This chemical will not prevent annual weeds from coming up again from seed. Can be combined with simazine to control annual weeds.

PEACHES

(Established 3 Years or More)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals and quackgrass	terbacil (Sinbar)	1/2 to 2	Late April or early May.	Use lowest rate on sandy soils. On sand pockets or knobs, do not apply any chemical.

WEED CONTROL

SMALL FRUITS

BLUEBERRIES, BRAMBLES

(Year of Planting)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	oryzalin (Surflan)	2 to 4	Apply to weed-free ground after planting.	Use lower rate on lighter soil.
Grasses	Fluazifop-butyl (Fusilade 2000)	0.25 to 0.5	To actively growing grasses.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants. Blueberry only.

BLUEBERRIES, BRAMBLES

(Established One Year or More*)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	diuron (Karmex)	2 to 4	In spring before weed growth starts.	Apply at least 60 days before harvest. Not effective on organic soils. Use low rate on young plantings.
	simazine (Princep)	2 to 4	Late fall or in spring before growth starts.	Use low rate on young plantings.
	Napropamide (Devrinol)	1 to 2	Apply before weeds emerge in spring.	
Quackgrass and annuals	dichlobenil (Casoron)	4 to 6	November	Granular formulation is most effective on quackgrass. Do not exceed 4 lb/acre on brambles.
	pronamide (Kerb)	1 to 2	November	Apply to dormant quackgrass or before emergence of annual weeds. Do not use on muck soils. Blueberry only.
	terbacil (Sinbar)	1.6 to 3.2	In spring before weed growth starts.	Use only in plantings that have been established at least a year. Apply the lower rate on sands and sandy loams and the higher rates on clay loams.
	simazine (Princep)	4	October or November	Granular formulation is most effective on quackgrass.
	norflurazon (Solicam)	2 to 4	Fall to early spring before weeds emerge.	
Emerged weeds	paraquat (Gramoxone)	1/2 to 1	Spring	Apply as a directed spray to emerged weeds. On brambles, apply before growth starts in the spring. Avoid contact on new canes or shoots of brambles or blueberries or injury will occur.
Woody perennials	hexazinone (Velpar)	1 to 2	Early spring before bud break.	Do not apply on light sandy soils or in successive years. Blueberry only.

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

WEED CONTROL

GRAPES

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Annuals	Oryzalin (Surflan)	2 to 4	After planting.	Wait until soil has settled after planting. Apply to weed-free soil and avoid spray contact with leaves and trunks. Use the lower rate on sandy soils.
	diuron (Karmex)	2 to 5	In spring before weed growth starts.	Use lower rates on sandy soils. Do not apply in vineyards less than 3 years old.
	simazine (Princep)	2 to 4	In spring before weed growth starts.	Same as above.
	Napropamide (Devrinol)	4	Apply to weed-free ground.	Apply in early spring.
	norflurazon (Solicam)	2 to 4	Fall to early spring before weeds emerge.	
Annuals and perennials	paraquat (Gramoxone) plus simazine (Princep)	1/2 4	Apply when weeds are 4 to 6 inches high.	For maximum knockdown, add a surfactant at 2 qt/100 gal of spray. Do not allow spray to touch grape leaves.
	dichlobenil (Casoron)	6	November	Granular formulation is most effective on quackgrass.
	glyphosate (Roundup)	1 to 3.7	Follow label instructions on best weed size for treatment.	Follow label instructions on proper rates for each weed species. This chemical will not prevent annual weeds from coming up again from seed. Do not allow the spray or drift to contact leaves or green shoots. Unless all spray can be kept off green tissues, applications should not be made after the bloom stage.
Broadleaves	oxyfluorfen (Goal)	1/2 to 2	Dormant	Vines must be 3 years old and trellised.
Grasses	Fluazifop-butyl (Fusilade 2000)	0.25 to 0.5	To actively growing grass.	Apply to grass 4 to 8 inches tall. Add non-ionic surfactant or crop oil concentrate as label specifies. Apply only to nonbearing plants.
	sethoxydim (Poast)	0.3 to 0.4		

WEED CONTROL

STRAWBERRIES

(New and Established Plantings)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Germinating grasses	diphenamid (Enide)	4 to 6	About 5 days after planting and before weeds emerge. In spring or fall on established fields.	Do not use on new plantings on sandy soils. Do not apply within 60 days of harvest. Controls seedling grains if applied prior to mulching.
	DCPA (Dacthal)	6 to 8	About 5 days after planting and before weeds emerge. In spring on established fields.	Particularly effective on sandy soils. Do not apply after first bloom.
Germinating and emerged broadleaves	chloroxuron (Tenoran, Norex)	4	After transplanting and before weeds are 2 inches high. In fall or spring on established fields.	Do not apply within 60 days of harvest. Do not apply more than twice in a season.
Select strawberry herbicides according to your weed problem. If both grasses and broadleaves are a problem, use a combination of chloroxuron + diphenamid or chloroxuron + DCPA.				
Annuals	Napropamide (Devrinol)	1 to 2	Apply before weeds emerge in spring, fall or following cultivation.	May inhibit runner rooting on extremely light sandy soils. Must be irrigated in or incorporated into the soil at 2" deep prior to planting.

STRAWBERRIES

(Established Plantings)

Weed Problem	Chemical	lb/acre active ingredient	Time of Application	Remarks and Limitations
Emerged broadleaved weeds	2,4-D (Formula 40)	1	Apply after harvest at renovation time.	Do not apply after August 1 or misshapen fruit may be produced the next season.
	terbacil (Sinbar)	1/4 to 5/8	Apply at renovation (after mowing) or in late fall.	Use the lowest rate on sandy soils. Do not use on new plantings. Do not use on the 'Guardian' and 'Earliglow' varieties. Check the label for crops that can be planted after strawberries.

Post-Harvest Disorder Control

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

Scald on Apples

Scald is a physiological (non-parasitic) disorder that develops on susceptible varieties of apples during storage and marketing. The most common symptom is a brown discoloration of the skin. Treat susceptible varieties of McIntosh, Cortland, Delicious, Greening, Stayman, Turley and Roman Beauty (Red Rome) with a scald inhibitor whenever storage of several months or longer is anticipated. The occasional development of scald on Jonathan, Idared and Golden Delicious is not always severe enough to justify fruit treatment for its control, yet these varieties are treated sometimes.

Control

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

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

Ethoxyquin, liquid at 2,700 ppm. Follow label recommendations as provided by the several suppliers. Although the mixture can be reused until dirty, frequent changing is recommended. It requires good agitation

and should include a fungicide (see below). However, do not use Mertect Flowable® with Decocquin® because of possible fruit injury.

Internal Breakdown and Bitter Pit of Apples

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

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

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

Fruit Rots of Apples and Pears

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

Suggested Chemicals

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

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

Fruit Rots of Stone Fruits

Stone fruits that are not consumed within a day or so after picking should receive a post-harvest spray,

drench, or dip treatment to decrease decay from brown rot and *Rhizopus* rot. A good pre-harvest spray or dust program is essential for rot control whether or not a post-harvest treatment is applied. Additionally, refrigerate to reduce the rates of fruit ripening and decay development.

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

Fungicides	Rate/100 gal dilute
Benomyl (Benlate) 50% WP plus	1/2 lb
Botran 75 WP ¹	1/2 lb

¹Omit Botran from this mixture when treating apricots, nectarines, and prunes. Botran has not been cleared for this use on these fruits as a drench or dip. Botran has been cleared for post-harvest treatment of sweet cherries and peaches.

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

Nematode Control

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Plant parasitic nematodes cause significant economic losses in fruit production systems as plant pathogens, virus vectors, and predisposition agents. The objective of this chapter of E-154 is to provide Michigan fruit growers with nematicide recommendations for fruit production. All other aspects of nematode control in fruit produc-

tion are covered in MSU Extension Bulletin E-801, "Orchard Site Preparation for Avoidance of Replant Problems." Additional information about soil fumigation is presented in MSU Extension Bulletin E-1832, "Safe Use of Soil Fumigants."

FRUIT NURSERYSTOCK

PREPLANT APPLICATION

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons) Telone II	Broadcast: 30 gal	Apply as a pre-plant treatment at least 21 days prior to planting when soil temperature is between 50° and 80° F. Inject at an 8-inch soil depth. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F or if soil has become very wet.
1,3-D and Chloropicrin Telone C-17	Broadcast: 35 gal	Same as 1,3-D
Methyl Bromide and Chloropicrin (98% and 2%, respectively) Brom-o-gas	Broadcast: 250-350 lb	Apply as a pre-plant treatment in plant beds for production of transplants only. Prepare plant bed as if for planting. Seal with airtight cover. Inject material, treating when soil temperature is above 50° F. Expose to fumigation for 48 hours. Aerate treated area for 2 days before planting.
Methyl Bromide and Chloropicrin (67% and 33%, respectively) Terr-o-gas 67	Broadcast: 250-350 lb	Apply as pre-plant treatment. Inject material at 6- to 8-inch depth. Seal treated soil with airtight cover. Expose to fumigation for 48 hours. Aerate for 2 days before planting in transplant bed. Allow at least two weeks soil aeration between field fumigation and planting when transplants are for fruit production. Do not treat soil if temperature is below 45° F at 5-inch level.
MITC (Methyl Isothiocyanate and 1,3-D) Vorlex	Broadcast: 20 gal	Apply as pre-plant treatment. For broadcast application, use shanks spaced 8 inches apart injecting at a depth of 8 inches. For row application, use two chisels spaced 8 inches apart per row. Seal soil immediately after application. If soil is 70° F or more at 6-inch depth, seal soil surface with plastic tarp. Keep soil moist and undisturbed for 4 to 7 days. Colder soils require longer fumigation periods. Cultivate soil and allow to aerate one week for each 10 gal/acre of material.
Fenamiphos Nemacur 3S Nemacur 15G	Broadcast: 6 gal Broadcast: 100-125 lb	For root-lesion and dagger nematode control for apple, peach, cherry and strawberry nurseries. Apply the 3S formulation in 20-40 gal of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft and rate is for treated area. Apply uniformly and incorporate into the soil.
Oxamyl Vydate 2L	Broadcast: 3-4 gal	Apply in a minimum of 20 gal of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4 to 8 inches immediately after application. READ LABEL WARNINGS CAREFULLY!
Oxamyl 10G	Broadcast: 60-80 lb	Pre-plant soil incorporation to a depth of 4-6 inches.
Carbofuran Furadan 15G Furadan 4F	Row: 40-70 lb Row: 1.5-2.5 gal	Incorporate granules into top 3 inches of soil. Use lower rates in light soils. Incorporate into top 1-2 inches of soil. Use lower rate in light soils.
Aldicarb Temik 10G	Broadcast: 75-100 lb	See Michigan label for specific application directions and safety cautions.

POST-PLANT TREATMENT

Nematicide	Application rate/acre	Limitations and/or Directions
Fenamiphos	Strip: 6 gal	For root-lesion and dagger nematode control for apple, peach and cherry nurseries. Apply in 20-40 gal of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft and rate is for treated area. Incorporate to 2-4 inch depth. Do not use more than 3 applications, 6 gal or 120 lb/acre/site/year. Do not use site for grazing or for feed.
Nemacur 3S	Strip: 120 lb	
Nemacur 15G	Broadcast: 120 lb	
Oxamyl	Foliar Spray: 2 qt/100 gal	Mix 2 qt of Vydate L with 100 gal of water and add 4 oz of a recommended surfactant. Apply to run-off as a foliar spray. Make 4 applications on a 14 to 21 day schedule. READ LABEL WARNINGS CAREFULLY!
Vydate 2L		
Carbofuran		Incorporate granules into top 3 inches of soil. Use lower rates in light soils.
Furadan 15G	Row: 40-70 lb	
Furadan 4F	Row: 1.5-2.5 gal	Incorporate into top 1-2 inches of soil. Use lower rate in light soils.
Aldicarb	Rows: (100 oz/1,000 ft)	Side dress granular 3-4 inches deep 10-12 inches to both sides of the row. See label for safety cautions.
Temik 10G		

TREE FRUIT ORCHARD (ESTABLISHED)

PREPLANT APPLICATION

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons)	Broadcast or row-strip: 30 gal	Apply as pre-plant fall treatment when the soil temperature is between 50° to 80° F. Space chisels 12 inches apart. Inject at 8-inch depth. Seal soil immediately. Treat a 7- to 10-foot wide strip in which new trees are to be planted.
Telone II	Individual tree site: 30 ml	Individual trees can be treated by injecting with a handgun in a 10-foot area. Inject 10 feet, 12 inches deep, with spacing 12 inches apart. Seal soil. Allow 3 to 6 months to lapse between treating and planting or longer if the odor remains in the soil. See MSU Nematology Note (9/3/74) for more specific directions for the individual tree site application technique.
1,3-D and Chloropicrin	Broadcast or strip: 32-40 gal	Same as 1,3-D
Telone C-17		
MITC (Methyl isothiocyanate and chlorinated C ₃ hydrocarbons)	Broadcast or strip: 20 gal	Apply as a pre-plant broadcast treatment. Space chisels 8 inches apart and inject at 8-inch depth. Seal with drag and smooth roller immediately after application. If soil is 70° F or higher at 6-inch depth, special attention must be given to sealing soil surface: tarping gives best seal. Allow 3 to 6 months to elapse between treating and planting.
Vorlex		
Methyl Bromide and Chloropicrin (98% and 2%, respectively)	Individual tree site: 1.0 lb	Deep inject with methyl bromide soil auger. Apply during fall before planting.
Brom-o-gas		
Fenamiphos		
Nemacur 3S	Row-strip: 4-6 gal	For root-lesion and dagger nematode control in apple, peach and cherry orchard sites. Apply in 20-40 gal of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft and rate is for treated area.
Oxamyl	Broadcast: 3-4 gal	
Vydate 2L	Strip: 3-4 gal	Apply in a minimum of 20 gal of water per acre. Thoroughly incorporate with a rotary tiller to a depth of 4 to 8 inches immediately after application. READ LABEL WARNINGS CAREFULLY!

AT-PLANTING TREATMENT

Nematicide	Application rate/acre	Limitations and/or Directions
Oxamyl Vydate 2L	Root Dip: 1 pt/50 gal	Mix 1 pt of Vydate L in 50 gal of water and soak roots in solution for 15 minutes. READ LABEL WARNINGS CAREFULLY.

POST-PLANT TREATMENT (NON-BEARING ORCHARD)

Nematicide	Application rate/acre	Limitations and/or Directions
Oxamyl Vydate 2L	Foliar Spray: 2 qt/100 gal	Use only on trees and strawberry plants that will not bear fruit within one year after application. Mix 2 qt of Vydate L with 100 gal of water and add 4 oz of a recommended surfactant. Apply to run-off as a foliar spray. Make 4 applications on a 14 to 21 day schedule. READ LABEL WARNINGS CAREFULLY!
Oxamyl 10G	Broadcast: 60-80 lb	Pre-plant soil incorporation to a depth of 4-6 inches. Incorporate granules into top 3 inches of soil. Use lower rates in light soils. Non-bearing trees only. Incorporate into top 1-2 inches of soil. Use lower rate in light soils. Non-bearing trees only. For root-lesion and dagger nematode control for apple, peach and cherry orchards. Apply in 20-40 gal of water per acre as an emulsion spray to the soil. Band widths should be 4-6 ft and rate is for treated area. Incorporate to 2-4 inch depth.
Carbofuran Furadan 15G Furadan 4F	Strip: 40-70 lb Strip: 1.5-2.5 gal	Incorporate granules into top 3 inches of soil. Use lower rates in light soils. Non-bearing trees only. Incorporate into top 1-2 inches of soil. Use lower rate in light soils. Non-bearing trees only.

POST-PLANT TREATMENT (BEARING ORCHARD)

Nematicide	Application rate/acre	Limitations and/or Directions
Fenamiphos Nemacur 3S Nemacur 15G	Strip: 4-6 gal Strip: 70-130 lb	For root-lesion and dagger nematode control for apple, peach and cherry orchards. Apply in 20-40 gal of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft and rate is for treated area. Incorporate to 2-4 inch depth. Do not apply within 72 days of apple harvest or 45 days of peach or cherry harvest. Do not use more than 6½ gal or 133.3 lb/acre/site/year. Do not use on feed or grazing land.

VINEYARDS AND SMALL FRUIT PLANTINGS

PREPLANT APPLICATION

Nematicide	Application rate/acre	Limitations and/or Directions
1,3-D (Dichloropropene and related chlorinated hydrocarbons) Telone II	Broadcast: 30 gal	Apply as a pre-plant treatment at least 21 days prior to planting when soil temperature is between 50° and 80° F. Inject at an 8-inch soil depth. Seal soil immediately after application. Allow additional time before planting if temperatures are below 60° F or if soil has become very wet.
1,3-D and Chloropicrin Telone C	Broadcast: 35 gal	Same as 1,3-D

PREPLANT APPLICATION (Continued)

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

POSTPLANT TREATMENT

Nematicide	Application rate/acre	Limitations and/or Directions
Fenamiphos Nemacur 3S Nemacur 15G	Strip: 6 gal Strip: 120 lb Broadcast: 6 gal Broadcast: 120 lb	For root-lesion, root-knot and dagger nematode control for vineyard only. Apply in 20-40 gal of water per acre as an emulsion spray to the soil. Band width should be 4-6 ft and rate is for treated area. Incorporate to 2-4 inch depth. Do not use more than 3 applications, 6 gal or 120 lb/acre/site/year. Do not use site for feed or grazing.

Wildlife Damage Control in Orchards

Glenn Dudderar
Department of Fisheries and Wildlife

Mouse Damage Control *Habitat Reduction*

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

Mouse Guards

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

Repellent Chemicals

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

Poison Baits

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

seem to be most effective while the zinc phosphide baits seem to be least effective. Chlorophacinone baits are most effective against pine mice, especially when applied to burrow openings.

Zinc phosphide* and zinc phosphide baits are available from the USDA Animal Damage Control office in St. Johns, Michigan. The zinc phosphide poison may be used to make baits using only apply cubes. It cannot be applied to grain. Consult with your local county Cooperative Extension Service office for details.

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

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

*restricted use

Rabbit Damage Control

Habitat Reduction

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

Population Reduction

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

Ground Squirrel Damage Control

Population Reduction

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

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

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

Porcupine Damage Control

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

Woodchuck Damage Control

Habitat Alteration

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

Population Reduction—Trapping, Gassing, Others

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

Woodchucks may be gassed in their burrows by the following materials: (a) USDA gas cartridges; (b) calcium cyanide; and (c) aluminum phosphide (Phostoxin).* With all of these materials, it is vital that the woodchuck burrows be located early in the spring; and prior to placement of any of the materials, preparation be made to seal the burrow entrances with a piece of inverted sod or other appropriate device. Specific directions for the use

*restricted use

of these materials in woodchuck control are found on the labels but the following information is essential. When using the gas cartridge, wait for approximately 15 minutes after sealing the burrow entrance and look for a plume of smoke emerging from a second burrow entrance. Seal the second entrance as well. Regardless of which material is used, check all burrow entrances within a week of treatment and re-treat any burrow that has been reopened. Young woodchucks usually leave their mother's den in late June or July thus making springtime gassing far more effective than summer treatment.

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

Deer Damage Control

Exclusion

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

Specially designed 5 wire high tensile strength, steel wire electric fences can be used to repel deer efficiently, but must be erected exactly as specified. Vegetation control along the fences to prevent shorting is also essential. Where deer are numerous, it is usually necessary to obtain a kill permit from the DNR in order to eliminate any deer which get inside the fence. Fences must be checked regularly and the lower wire disconnected when buried by snow. Sources of designs for deer fences can be obtained from county Extension offices.

Repellent Chemicals

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

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

Feather meal, meat meal and putrescent whole egg solids are the most effective repellents in fruit areas, but each has certain limitations that must be accounted for if

they are to be effective. Use feather meal, tankage or small bars of soap *only* during the warm months of the year. They provide protection for at least thirty days, but usually no more than 60 to 90 days. Place two to three teaspoons of feather meal or tankage in small cloth bags and hang one bag or one small bar of soap in each tree in the orchard. Inspect the orchard every 30 days for damage and if damage resumes, reapply fresh materials. Do not hang soap bars near the trunk of the tree. Mice will be attracted to the fat in the dissolved soap as it runs down the trunk.

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

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

Population Reduction

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

Bird Damage Control

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

Repellent Devices and Chemicals

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

Methiocarb (Mesurol) is registered for use on cherries and blueberries to control bird damage. Apply at the rate of 2 lb/acre at first ripening or sign of damage, but do not exceed 4 lb/season. If only one application of a maximum of 2 lb is made, application may be made up to 3 days before harvest. Otherwise, application may *not* be made within 7 days of harvest.

Population Reduction

Large decoy traps baited with a variety of moist foods such as apples, cherries, blueberries, lettuce and pota-

toes can be used to catch large numbers of birds efficiently. Starlings, which are unprotected, can be quickly and easily destroyed. Decoy traps appear to be most effective if operated in the spring when birds first appear in the orchard. If operation is begun during the ripening process the trap may not trap birds as efficiently as it attracts them and may result in increased damage, especially where birds are extremely numerous. Studies at MSU indicate that spring trapping makes the use of methiocarb more effective with less material needed.

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

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

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

USDA Animal Damage Control Office
108 Spring St.
St. Johns, MI 48879 (517) 224-9517

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

Compatibility Chart

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

- 1 Materials compatible
- 2 Decomposes on standing; residual action reduced
- Q Questionable, compatibility not clear
- Not compatible

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

Days Between Final Spray and Harvest

Listed below are some of the commonly used pesticides and the intervals from last application to harvest for

each crop. See spray schedules for recommended materials. Consult product label.

FUNGICIDES

Chemical	Apples	Pears	Peaches	Plums and Prunes	Cherries	Grapes	Straw-berries	Rasp-berries	Currants and Goose-berries	Blue-berries	Apricots
Bayleton	0						14				
Dikar	31										
Difolatan ¹					0 (Sour)					21	
Botran			1j		0j (Sweet)						
Bravo				m	m	m					m
Captan	0	0	0j	0	0j	0	0	0		0	0
Copper (copper-lime mixtures)	h	h			h	h	h	h			
Dodine (Cyprex)	7		15		0		14				
Dichlone (Quintar)	1		7	3	3						
Ferbam	7	7		7	0	7		40	14	40	
Folpet (Phaltan)						0				0	
Funginex ²										40	
Glyodin	0e										
Dinocap (Karathane)	21					21	21	7			
Ronilan			3	3	3		0				
Rovral			0	0	0	0					
Rubigan	60n										
Streptomycin	50	30									
Sulfurs	h		h	h	h						
Thiram (Thylate)	0		7				3e				
Topsin-M	0		1	1	1		0				
Zineb	30			30		7					
Polyram	30										
Benomyl (Benlate)	0j	0j	0j	0j	0j	7	0	3		21	0j
Benomyl + Mancozeb	30										
Benomyl + Captan	0	0	0	0							
Benomyl + Polyram	30										
Mancozeb					66						
Dithane FZ					7						
Ridomil (soil application only)	f						45				

¹Difolatan flowable fungicide and aqua malathion when tank mixed and applied with ground spray equipment can cause foliar injury and damage to the fruit.

²Application of Funginex after fruit formation has occurred may result in russetting of fruit.

Legend: a = Not after fruit begins to form.	i = 4 hours of harvest using 3% dust at 20 lb/acre.
b = Do not repeat application within 30 days.	j = May be used as Post-harvest treatment—See label.
c = Pre-bloom or Post-harvest application only.	k = 3 weeks after full bloom.
d = Post-harvest application only.	l = 21 days if only 2 sprays are applied.
e = No residue if used according to recommendations.	m = Do not apply after shuck split and before harvest.
f = See label restrictions on use.	n = Do not apply after second cover or ½-inch diameter fruit, whichever occurs first.
g = Remove excess residues at harvest.	
h = Sulfurs and copper plus lime mixtures are exempt if used as recommended.	

INSECTICIDES

Chemical	Apples	Pears	Peaches	Plums and Prunes	Cherries	Grapes	Straw- berries	Currants and Goose- berries			Apricots
Ambush		14	14			3					
Carzol	7f	7f									
Cythion ULV					1	7				0	
Dithane M-45	30	15									
Diazinon	14	14	20	10	10	10	5	7		7	10
Dimethoate (Cyon) ¹	28	28									
Ethion	60f	60f	30f	21f	f	28f	2				f
Guthion	7	7	21	15	15	0	5	14		14i	21
Imidan	7f	7f	14f	7	7	7					14
Lannate	8										
Lorsban	28		14		14						
Malathion ¹	3	1	7	3	3	3	3	1	1.3f	0-1f	7
Methoxychlor	7	7	21	7	7	14	3	3	14g	14	21
Mitac		7									
Morestan	35f	35f	a, e	a, e	a, e						a
Omite	7f	14f	14f	28f							
Parathion	14	14	14	14	14	14	14	15	30, 15f	14	14
Penncap-M	14	14	14	14	14	14					
Pay-off	14	14									
Phosphamidon	30				f						
Pounce	21		14		3						
Pydrin	21	28	14	14	14						
Sevin	1	1	1	1	1	0	1	7		0	3
Superior oil	e	e	e	e	e	e	e	e	e	e	e
Thiodan	30f	30l	30f	7f	21f	7	4f				30f
Vendex	14f	14f			14	28					
Vydate L	14										
Zolone	14	14	14f	14f	14f	14					14f

Legend: a = Not after fruit begins to form.

b = Do not repeat application within 30 days.

c = Pre-bloom or Post-harvest application only.

d = Post-harvest application only.

e = No residue if used according to recommendations.

f = See label restrictions on use.

g = Remove excess residues at harvest.

h = Sulfurs and copper plus lime mixtures are exempt if used as recommended.

i = 4 hours of harvest using 3% dust at 20 lb/acre.

j = May be used as Post-harvest treatment—See label.

k = 3 weeks after full bloom.

l = 21 days if only 2 sprays are applied.

m = Do not apply after shuck split and before harvest.

n = Do not apply after second cover or ½-inch diameter fruit, whichever occurs first.

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line

Notes:

Spray Record Sheet

GROWER	YEAR
CROP	HARVEST DATE

Cut Along This Line



PESTICIDE EMERGENCY INFORMATION

(Please post in an appropriate place)



For any type of emergency involving a pesticide, the following Emergency Information Centers should be contacted immediately for assistance. This Cooperative Extension Service Bulletin is the latest information available as of July 1987, and replaces all previous listings of similar information.

HUMAN PESTICIDE POISONING

Eastern Half of Michigan

within the Detroit City proper

***(313) 745-5711**

within the 313 area code

***(800) 462-6642**

statewide

***(800) 572-1655**

Poison Control Center

Children's Hospital of Michigan

3901 Beaubien

Detroit, MI 48201

Western Half of Michigan

within the Grand Rapids City proper

***(616) 774-7854**

within the 616 area code

***(800) 442-4571**

statewide

***(800) 632-2727**

Blodgett Regional Poison Center

Blodgett Memorial Medical Center

1840 Wealthy, S.E.

Grand Rapids, MI 46506

Upper Peninsula of Michigan

within the Marquette City proper

***(906) 225-3497**

Upper Peninsula only

***(800) 562-9781**

U.P. Poison Control Center

Marquette General Hospital

420 West Magnetic Street

Marquette, MI 48955

SPECIAL PESTICIDE EMERGENCIES

Animal Poisoning

Your Personal Veterinarian

() - - -

and/or

Animal Health Diagnostic Laboratory

Michigan State University

(517) 353-1683

Pesticide Fire

Local Fire Department

() - - -

and

Fire Marshal Division, Michigan State Police

(Local authorities will assist in contacting the State Fire Marshal)

Traffic Accident

Local Police Department or Sheriff's Department

() - - -

and

Motor Carrier Division, Michigan State Police

() - - -

Environmental Pollution

Pollution Emergency Alerting System (PEAS)

Michigan Department of Natural Resources

***(800) 292-4706**

Pesticide Use Incident

Pesticides & Plant Pest Management Division

Michigan Department of Agriculture

(517) 373-1087

* Telephone Number Operated 24 Hours

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Fungicides

Insecticides

Tree Fruit

Apples

Pears

Peaches-Nectarines-Apricots

Prunes-Plums

Red Tart Cherries

Sweet Cherries

Small Fruit

Grapes

Strawberries

Brambles

Currants-Gooseberries

Blueberries

Growth Regulators

Herbicides

Nematicides

Wildlife Control

Contents

Compatibility Chart	105
Days Between Final Spray and Harvest	106
Chemical Thinning	77
Fungicides	7
Herbicides	82
Insecticides	9
Insect Monitoring	13
Nematode Control	97
Pesticide Safety	5
Plant Growth Regulators	77
Poison Control Centers	2
Post-Harvest Disorder Control	95
Tree Row Volume	14
Weed Control in Fruit Crops	88
Wildlife Control in Orchards	101



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