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Insect, Disease and Nematode Control on Commercial Vegetables Michigan State University Extension Service Ed Grafius, Entomology; Mary Hausbeck, Botany and Plant Pathology; Goerge Bird, Nematology; Larry Olsen, Pesticide Education Revised January 1995 104 pages

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Insect, Disease and Nematode Control for Commercial Vegetables



Remember that the pesticide label is the legal document on pesticide use. Read the label and follow all instructions closely. The use of a pesticide in a manner not consistent with the label can lead to the injury of crops, humans, animals and the environment. The use of a pesticide inconsistent with the label directions can also lead to civil or criminal fines and/ or condemnation of the crop. Pesticides are good management tools for the control of pests on crops, but only when they are used in a safe, effective and prudent manner according to the label.

These recommendations are not intended to replace the specific product labels. Always read and follow label instructions carefully.

Contents

1995 Insect, Disease and Nematode Control Recommendations

How to Use This Bulletin	2
Safety Tips and Special Warnings	.2
Pesticide Emergency Preparedness	.3
Pesticide Registration	.3
Pesticide Tolerances on Veg. Crops	.4
Use of Pesticides for Insects Not on Label	.4
Record Keeping	.4
Agricultural Chemical Use Precautions	.4
Re-entry into the Application Area	.5
SARA Title III and Right to Know	.5
Porker Protection Standard	.5
stect Nontarget Organisms	.6
Endangered Species Act	.6
Right to Farm	.6
Pesticide Name	.6
Pesticide Formulations	.6
Restrictions	.7
Compatibility	.7
Pesticide Additives	.7
Soil Type Considerations	.8
Protecting Groundwater	.8
Keeping Pesticides Out of	
Groundwater and Surface Water	.9
Transporting Pesticides	10
Storing Pesticides	10
Handling and Mixing Pesticides	10
Application Equipment	11
Accurate Equipment Calibration	11
Unused and Unwanted Pesticides	11
Cleaning and Care of Pesticide	
Application Equipment	11
Handling and Disposing of Pest. Containers	12
Notes on Nematode Management	12
For More Information	13
List of Insecticides and Nematicides	
Used on Commercial Vegetables (Table)	14
List of Fungicides Used on Commercial	
Vegetables (Table)	16
mpatibility of Insecticides and	
ungicides (Table)	17
Insecticide Effectiveness (Table)	18

Conversion Equivalents and
Abbreviations
Calculation of Banded Rates
Asparagus22
Beans (Snap)
Beets (Red)
Broccoli
Brussels Sprouts
Cabbage
Carrots
Cauliflower41
Celery
Corn (Sweet)
Cucumber
Eggplant53
Garden Greens
Garlic56
Leeks
Lettuce
Melons61
Mint (Peppermint & Spearmint)64
Onions
Parsnips68
Peas
Peppers70
Potatoes73
Pumpkins79
Radishes82
Rhubarb83
Rutabagas83
Spinach84
Squash85
Sweet Potatoes88
Tomatoes89
Turnips94
Appendix A - Seedbed Preparation95
Appendix B - Detecting and Avoid-
ing Nematode Problems97
Record Keeping Form103
CAT Alerts Subscription Form105
Pesticide Emergency Information (back cover)

Insect, Disease and Nematode Control for Commercial Vegetables

By Ed Grafius, Mary Hausbeck, Mel Lacy, George Bird, and Larry Olsen¹

This MSU Extension bulletin was prepared to help commercial vegetable producers make informed decisions on pest management.

How to Use This Bulletin

Recommendations are organized into sections by crop. Within a crop, specific pests are listed along with their control recommendations. Frequent users may want to insert tabs for easy location of each crop section.

This publication focuses on chemical tactics and should be used in conjunction with an overall sound program of integrated pest management. Chemical recommendations are included for insect, disease and nematode control, as well as handling pesticides safely to prevent human and environmental harm. The management suggestions in this bulletin are designed to help protect the grower's crop from the pre-plant stage to market and, in certain cases, through storage.

The suggestions include the basic information necessary for the chemical components of pest control. The majority of the suggested materials have been tested at Michigan State University to determine the most effective materials, rates of application, timing of applications, method of application and site of application on the plant or in the soil. When this information is coupled with week-to-week information on pest populations, as disseminated in **Crop Advisory Teams (CAT) Alerts,** the minimum number of chemicals and treatments need be applied to attain the desired level of control.

It is extremely important that growers **monitor (scout) each individual field** for potential pest problems. Pest populations (insects, nematodes, diseases) vary not only from year to year, but also from field to field and even within a given field. Pest populations vary in first appearance, number of individuals and severity of damage. These observations are the prime responsibility of observations are the prime responsibility of the grower. Growers should make them known to county and university Extension personnel. Through this type of two-way communication, Michigan agriculture will remain in the forefront in quality and quantity.

A grower's choice of a particular pesticide should be based on pests present, beneficial insects present (including honey bees and predators and parasites of pests), available materials, days to harvest, environmental and personal safety and cost.

Materials and rates of application listed in the tables on pages 22-94 are based on the latest information available at the time this publication went to press. Materials marked with an asterisk (*) are particularly recommended for problem infestations.

Recommendations are changed as products are removed from the market, new products introduced, new uses are found for old produor new restrictions are placed on their u.e.. Your county MSU Extension agent is informed of the changes as they occur through Crop Advisory Team (CAT) Alerts or CEENET, the MSU Extension computer network. Check with your Extension agent for updates that have occurred since the publication of this bulletin. Always read and follow the directions and limitations on the pesticide label.

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

Some of the more hazardous pesticides are on the Restricted Use Pesticide (RUP) list. You will need to be certified by the Michigan Department of Agriculture in order to buy and use these RUP's. Your county Extension agent has a current listing of the RUP's and will advise you on the procedures for certification.

Safety Tips and Special Warnings

Your county agricultural agent can supply information on the dangers of environment and personal safety with insecticit fungicides and nematicides. You can get help for insecticide, fungicide and nematicide

¹The authors are Extension specialists in Entomology, Botany and Plant Pathology, and Nematology, and Larry Olsen is MSU pesticide education coordinator.

poison cases by telephoning the nearest Poison Control Center (see back cover). A list of secticides and nematicides and their relative xicities (LD⁵⁰'s) is given on pages 14 and 15. Their potential to leach into the groundwater or runoff into surface waters is given on pages 18-20; and for fungicides on page 16.

Phosphate Insecticides. The phosphate group includes *Imidan*, *Guthion* and other similar materials. Many of these are extremely dangerous to users at the time of application. Read the label on the container for instructions for safe use. If any insecticide cannot be used according to those directions, do not use it at all.

Note to Aerial Applicators. Pilots and loading crews should know the dangers of applying methyl parathion and other hazardous insecticides. Take special care to avoid skin, respiratory and oral absorption.

• Always read the label before buying or using pesticides. Use pesticides only for the purpose(s) listed and in the manner directed.

• Pesticides that require special protective clothing or equipment should be used only by trained, experienced applicators.

• Do not apply more than the specified amount of pesticides; overdoses can harm you, the consumers and the environment.

Keep pesticides away from food and dishes.

Keep children and pets away from pesticides and sprayed areas.

• Do not smoke or eat while applying pesticides.

Avoid inhaling pesticides.

• Never spray outdoors on a windy day.

• When mixing pesticides, use care to avoid splashing.

• Avoid breaking or spilling pesticide containers.

• Avoid contact with skin and clothing.

• If you spill a pesticide on your skin, wash with detergent and water. If spilled on clothing, change clothing immediately.

• Store pesticides in their original containers with proper labels in a locked storage area. Never transfer a pesticide to a container that would attract children, such as a soft drink bottle.

• Dispose of empty containers safely. Refer to your dealer for directions for disposal of specific containers. Wrap single containers of home use products in several layers of newspaper, tie securely and place in a covered trash can. With farm use, after containers are triple rinsed (or equivalent) they can be posed of in sanitary landfills or offered for cling. • Wash with soap and water after using pesticides and launder clothes separately before wearing again.

Getting any pesticide into the eyes or mouth can be especially serious. Read and understand first aid instructions listed on the label BEFORE you use the pesticide. Follow instructions explicitly. Flush eyes or mouth with water as soon as possible after exposure. Do not induce vomiting unless it is specified on the label. See a doctor immediately if there is any chance of poisoning. Take the pesticide container or label with you so that the doctor can read the Instructions to the Physician that are included on the label. Many labels carry the telephone number of a 24-hour emergency service offered by the pesticide company. Call this number for authoritative advice on diagnosis and treatment. This service can be used by your physician if needed. The physician can also receive advice, when needed, by calling the nearest Poison Treatment Center listed on the back cover.

Pesticide Emergency Preparedness

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

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

Pesticide Registration

Recommendations in this bulletin are based on field trials conducted in Michigan and other North Central Region states over a period of several years. All pesticides must be currently registered with the U. S. Environmental Protection Agency (E.P.A.) and the Michigan Department of Agriculture before they can be used legally in Michigan.

The pesticide label is a legal document on pesticide use. Read the label carefully and follow all instructions closely. Use of any pesticide in a manner not consistent with the label can lead to civil or criminal punishment and/or condemnation of the illegally sprayed crop. Do not mix and apply together any pesticides and fertilizers if it is forbidden on either product label.

Pesticide Tolerances (Residues) on Vegetable Crops

Tolerances are established by the E.P.A. for every pesticide registered in the United States. These tolerances are the maximum allowable residues in parts per million (ppm) of a pesticide that may be on or in a specified crop at the time of harvest. If residues of a pesticide on a crop exceed the tolerance established for that pesticide, that crop may be seized and destroyed.

To keep below the tolerance levels established for a pesticide, apply only the formulated amount of pesticide per acre as instructed by the product label. Do not exceed this restriction. Also, to meet the labelrequired pre-harvest interval, discontinue the use of pesticides the number of days before harvest that the label specifies. Always remember the following restrictions on the use of all pesticides: 1) The legal amount of active material per acre that can be applied during a given growing season; and 2) The number of days before harvest that chemical application on a crop must be discontinued.

Use of Pesticides for Insects Not on Label

The law regulating pesticides in the United States is the Federal Insecticide, Fungicide and Rodenticide Act. or FIFRA. FIFRA is administered by the Environmental Protection Agency (EPA) and in Michigan by the Michigan Department of Agriculture (MDA). **FIFRA** governs the registration, distribution, sale and use of all pesticides. Within FIFRA there exists a provision that allows the use of a pesticide for a pest not noted on the label as long as the application is made to a crop specified on the label. This provision is referred to as 2(ee). All rates and restrictions, including preharvest intervals, for the labeled crop must be followed. Please note, however, that the manufacturer will not assume responsibility for product performance so 2(ee) applications are made at the grower's risk. For more information about 2(ee) applications, contact your local MSU Extension or Michigan Department of Agriculture office.

Record Keeping

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

- 1. brand or product name and the EPA registration number of the RUP that was applied;
- 2. total amount of product used of the RUP;
- 3. the location, size of area treated, and the crop, commodity or stored product to which the RUP was applied;
- 4. month, day and year on which the RUP application occurred; and
- 5. name and certification number (if applicable) of the certified applicator who applied or supervised the application of the RUP.

The revised spray record sheet at the end of this publication or E-2340 to E-2345 which includes directions and forms for a complete farm record keeping system can be used for recording your sprays. Penalties are up to \$500 for the first violation and up to \$1,000 for subsequent violations. Provisions for protecting the identity of individual producers are included in the law.

Agricultural Chemical Use Precautions

The use of any pesticide, especially a restricteduse-pesticide (RUP), entails a significant amount of responsibility and liability on the part of the grower. Therefore, handle pesticides with extreme caution and respect the following reasons:

- to protect yourself and others.
- to protect your crop and soil from chemical damage.
- to protect the environment from chemical damage.

These points cannot be emphasized enough. Pesticide accidents occur most often during mixing and tank filling operations. Although accidental ingestion of chemicals is considered to be the greatest health hazard, there is also great danger of poisoning when pesticides contact skin or eyes or when dust or vapors are inhaled. To prevent such accidents, wear protective clothing at all times when handling and applying pesticides and cleaning spray equipment. Such mandatory garments include chemical resistant rubber gloves and boots, splash-guard goggles and a respirator manufactured specifically for the type of chemical compound that is being used. Care for these items as you would your farm implements. They may save your life in case Always heed all the p. an accident. cautionary statements on the product label and cover-up to protect yourself. (See MSU

Extension Bulletins E-1546, Take Cover! otect Yourself from Exposure, E-2215, Using sticides Safely: A Guide for the Applicator; and NCR-204, Protective Clothing for Handling Pesticides, for more information.)

Protecting yourself during any application of an agricultural chemical is required. Give the same consideration to any field worker(s) you may employ. Farm workers assisting in the application of any pesticide should also wear protective clothing, as specified by the product label.

Protect your crops and land by applying any pesticide at the label-directed rate and under favorable environmental conditions. To do otherwise may be a violation of the label and could cause damage to the crop and carryover in the soil. Excessive pesticide residues in the soil may also leach into surface and groundwater. Overdosing will also increase residues on the crop and the number of days before the crop can be harvested legally. To avoid any pesticide damage and/or illegal residues on crops and in the soil, follow the recommended rates of application and use properly calibrated implements.

Pesticide drift from aerial and ground application is a serious problem. Drift can be a particular problem if houses, schools or urban

as are nearby. Drift can also contaminate Lisitive crops and the environment (crop land and surface water). Avoid pesticide drift from all pesticides. Because few chemicals are allowed on forage for all types of livestock, exercise extreme caution when using any pesticides to avoid contaminating hay, pasture and stover. Where problems with pesticide drift exist, use the least hazardous materials with additives labeled to reduce spray drift. These additives add elasticity to spray suspensions to reduce the shearing effect (break up of spray stream) caused by spray dispensing equipment and air movement.

Re-Entry into the Application Area

Read and follow the label instructions on Restricted Entry Intervals (REI) for every pesticide used. Post areas that have been treated to warn others not to enter until the specified REI has expired as required by the label. Take down the postings within 24 hours after the REI has expired. Any person who has to go into the treated area prior to the elapse of the REI must wear the personal protective equipment listed on the pesticide label. Farm porkers should not work in the treated area il the REI has expired.

SARA Title III Emergency Planning and Community Right to Know Act

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

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

This law also requires that, in the event of a spill, the SERC, LEPC and National Response Commission be notified. The reportable quantities for spills is much less than for storage and can be obtained from the above sources. See Extension Bulletin E-2173 for more details on SARA Title III and a list of commonly used extremely hazardous substances. Extension Bulletin E-2334 will also assist you in preparing an emergency response plan for your farm.

Worker Protection Standard

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

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

Protect Nontarget Organisms

Bees and other pollinating insects are essential for successful production of tree fruits, small fruits, most seed crops and certain vegetables. Many insecticides are highly toxic to pollinating honeybees and wild bees. Be aware of how bee poisonings can occur from applying pesticides and how to prevent them. Take the following precautions to reduce the chance of bee poisoning:

• Do not apply pesticides that are toxic to bees if the site contains a crop or weeds which are in bloom. This applies not only to the fruit bloom but also to dandelions and clovers that may be reached by the spray. Mow cover crops and weeds to remove the blooms prior to spraying.

• Select pesticides that are least harmful to bees and select the safest formulation. Dusts are more hazardous to bees than sprays. Wettable powders and microencapsulated products are more hazardous than emulsifiable concentrates or water soluble formulations because particulate pesticide material may be carried back to the hive. Granular insecticide formulations are generally the least hazardous to bees.

• Reduce drift during application. Use drift control materials whenever possible.

• Time pesticide applications carefully. Evening applications are less hazardous than early morning; both are safer than midday applications.

• Do not let puddles of spray accumulate on the ground where bees might drink it. Supplying fresh water near bees hives can reduce this hazard.

• Do not treat near hives. Bees may need to be moved or covered before using insecticides near colonies.

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

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

Bird kills from pesticides can occur when birds ingest the toxicant in granules, baits, or treated seed; are exposed directly to the spray; consume a treated crop; drink and use contaminated water; or feed on pesticidecontaminated prey.

Endangered Species Act

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

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

Right to Farm

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

Pesticide Name

The trade name (first letter capitalized; Lorsban, for example) is used when a pesticide is sold under only one well known brand name. The accepted common name of a pesticide is used when it is sold under several brand names. Some well known brand names may be given in parentheses following the common name; dimethoate (Cygon), for example.

Pesticide Formulations

Fungicides, insecticides and nematicides be purchased in a variety of formulations. Not

only is it important that a grower purchase the prect pesticide for the intended pest control e., pesticide product labeled for both the crop and the pest), but also that the grower chooses the formulation best suited for the particular job. Such a decision should be based on the pesticide product's effectiveness, cost, practicality and relative safety to the applicator, the crop and the environment. The following are some additional considerations worth remembering when choosing a specific formulation:

- Some formulations require constant spray tank agitation; others do not.
- Dusts and granules do not require water for application, but accurate calibration of equipment and uniform distribution are often difficult to achieve and maintain.
- The potential hazard to the applicator and the potential of drift and environmental contamination vary substantially among formulations.
- Dry formulations are generally less affected by subfreezing temperatures during storage than liquid formulations.
- Some crops may be treated with any formulation of a particular pesticide; others require using a specific formulation. The price per pound of active ingredient varies for different formulations.

Also remember that for two products with the same active ingredient but different formulation, the application rate to be used on a specific site and pest is different.

Restrictions

The pre-harvest interval, the minimum number of days required between last application and harvest or other use of the crop, is listed. Special limits on the use of the pesticide are also given when they apply. Follow these restrictions exactly to avoid possible deleterious residues on the crop at harvest. Pesticides that are relatively safe around honeybees are also noted when pertinent.

Compatibility

When two or more chemicals are mixed together in a spray tank, they may or may not mix well, or the mixture may cause injury to germinating seeds or plants. This relationship is called compatibility. The lack of compatity could affect the application and enectiveness of the chemical spray.

It is usually not advisable to mix different formulations such as wettable powders and

emulsifiable concentrates together in a spray tank. This is especially important if other materials, such as foliar nutrients, are included in the spray and applied in low gallonage per acre. Always be sure to read and follow the directions and limitations on the pesticide label before mixing.

Pesticide Additives

During the development of a pesticide, chemical companies attempt to formulate the active ingredient to optimize performance, mixing and handling under diverse conditions. Every commercially available pesticide formulation contains its own particular set of additives to accomplish this action. However, sometimes additional additives are required for specific applications or when compatibility or mixing problems occur. The pesticide label will describe the need and use of these additives because they may not improve pesticide performance and may actually reduce pest control or cause crop injury.

The following are some definitions of pesticide spray additives. For more information on types of spray additives and when to use them with herbicides, see MSU Extension Bulletin E-1858, Using Spray Additives with Herbicides.

- **Adjuvant**--any substance that enhances pesticide effectiveness, an added ingredient.
- **Surfactant**--a surface active material that can facilitate emulsifying, dispersing, spreading, wetting, sticking or other surface-modifying characteristics of a pesticide solution.
- **Emulsifier** -- an agent that promotes the dispersion of one liquid in another.
- Wetting Agent Spreader-- an ingredient that reduces water surface tension causing better contact between the spray solution and treated surfaces.
- **Soap**--sodium or potassium salts of fatty acids. These additives can form insoluble materials in hard water. Detergents are synthetic materials used for cleaning.
- **Sticker**--a deposit builder that increases pesticide adhesion to plant surfaces.
- **Defoaming Agent**--reduces or elimi-nates foaming in the spray tank.
- **Drift Control Agent**--an agent that prevents the formation of very fine spray droplets that are especially subject to drift; improves coverage.
- **Compatibility Agent or Co-solvent** -- an inert ingredient that may aid in the dispersion of otherwise incompatible mixtures.

Pesticides are applied in a number of ways, so adding and using an additive is up to the applicator. Sometimes, additives are only required for pest control treatments made during adverse climatic conditions. In other cases, the nature of the pesticide may require adding an additive to the spray mixture rather than the formulation. The pesticide label always gives directions for the use of additives, if they are required.

Soil Type Considerations

Soil texture (sand, silt, clay) and organic matter content influence the effectiveness of soil-applied pesticides. In general, lower rates of pesticides are required on sandy (coarsetextured) soils than on clays or soils with high organic matter content (fine-textured) to obtain the same level of control. Pesticide rate recommendations in this bulletin are given for medium-textured soils with greater than 3 percent organic matter content, unless otherwise noted. Clay and organic matter absorb pesticides, making them less available to kill soil-borne pests. Soils with high clay and organic matter content require greater herbicide rates for adequate pest control. Sandy soils with low organic matter content require careful pesticide rate selection to avoid crop injury.

Poor application of soil insecticides, such as plowing or drilling the insecticides deeper than about 4 in., or using sidedressings when broadcast treatments are best, reduces the value of pesticide treatments. Do not expect the impossible in your efforts to control soil-borne pests. As with foliar sprays, materials need to be carefully applied to achieve maximum effectiveness.

Protecting Groundwater

Most people who live in rural areas get their drinking water from wells. Since well water is groundwater, it is easy to see why you should be concerned about keeping pesticides out of groundwater. There are several processes that determine the fate of pesticides and whether they will end up in your drinking supply.

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

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

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

Surface water contamination is a major concern associated with the runoff of pesticides from treated fields, mixing and rinsing sites, waste disposal areas, and manufacturing facilities. In the 1988 inventory of water quality, pesticides were ranked sixth as river and stream pollutants, behind siltation, nutrients, pathogens, organic enrichment, and metals. Refer to the section "Groundwater and Surface Water Contamination" for information on how to prevent contamination.

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

Absorption is the process by which chemicals are taken up by plants. Once absorbed, most pesticides are degraded with plants. Residues may persist inside the plants. Residues may persist inside the plant tissues decay. **Crop removal** can transfer pesticides. en treated crops are harvested, the pesticide idues are removed with them and transferred to a new location. After harvest, many agricultural commodities are washed or processed, which can remove or degrade much of the remaining residue. However, the wash water may now be contaminated and should be disposed of as a potential contaminate.

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

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

Photodegradation is the breakdown of peses by the sunlight.

To learn how to protect groundwater when applying pesticides, some basic information on groundwater is helpful. **Groundwater** is the water beneath the earth's surface occupying the saturated zone (the area where all the pores in the rock or soil are filled with water). It is stored in geological formulations known as **aquifers**. Groundwater moves through aquifers and can be obtained at points of natural discharge such as springs or streams, or by drilling a well into the aquifer.

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

Both surface water and groundwater are subject to contamination by **nonpoint source pollution.** This type of pollution generally results from land runoff, precipitation, acid , or percolation rather than from a charge at a specific, single location (such as a single pipe or well head). Contamination from these single sites is known as **point source pollution**.

Keeping Pesticides Out of Groundwater and Surface Water

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

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

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

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

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

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

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

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

Select pesticides carefully -- Pesticides that are highly soluble, relatively stable, and not readily adsorbed to soil tend to be the most

likely to leach. Read labels carefully and consult a specialist from a Extension office, or your chemical dealer if necessary. The tables in this bulletin will also help you determine the best herbicides for your use.

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

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

Measure accurately -- Concentrates need to be carefully measured before they are placed into the spray tank. Do not "add a little extra" to ensure the pesticide will do a better job. Such practices only increase the likelihood of injury to the treated crop, the cost of pest control, and the chance of groundwater or surface water contamination.

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

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

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

Change the location of mixing areas -- Mix and load pesticides on an impervious pad if possible. If mixing is done in the field, change the location of the mixing area regularly. Do not mix pesticides adjacent to the water source, and do not let the water run inadvertently on the soil near the mixing area. This will increase pesticide leaching and/or runoff.

Dispose of wastes properly -- Obey laws regulating the disposal of pesticide wastes. Triple rinse or pressure rinse containers. Pour the rinsewater into the spray tank for use in treating the site or the crop. Do not pour rinsate on the soil, particularly repeatedly in the same location. This will saturate the soil and increase the potential for herbicide leaching.

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

Transporting Pesticides

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

Storing Pesticides

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

Do not store any feed, seed, food, or fertilizer with pesticides. Do not store any protective clothing or equipment in the pesticide storage facility. Store herbicides separately from insecticides and fungicides to avoid contamination of one material another and accidental misuse.

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

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

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

Handling and Mixing Pesticides

Always wear protective clothing and equipment when handling, mixing, and applying pesticides and during the cleanup of application equipment. Protective clothing should include full coverage clothing, chemical resistant gloves and boots, eye protection, hard hat, and a MSHA/NIOSH approved respira with a chemical absorbent material specified on the pesticide label. Mix pesticides downwind and below eye vel. Avoid excessive splashing and sloshing. If pesticides are spilled on you, wash them off immediately with lots of water and change clothing. Resume spraying only after cleaning up any spills. Try to use closed handling/mixing systems when appropriate.

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

Application Equipment

Efficient use of application machinery is very important to any pesticide application program. In many cases, improper use of machinery will result in poor pest control. With such occurrences, the grower may blame the efficacy of the pesticide for the failure of the control program when poor coverage is at fault.

Proper equipment and its maintenance is very important for any pesticide control program. Spray equipment should have the following features:

• The equipment should be made of noncorrodible materials.

• A tank with sufficient capacity so that the number of mixing and filling operations are minimized.

• A pump with a capacity of at least 5 gal/minute and pressure up to 100 psi.

• An agitation system from the pressure control to the bottom of the tank.

A plumbing system with 50-mesh screens in the intake line and at each nozzle.
A pressure gauge that accurately

measures pressures up to 100 psi.A spray boom that can be adjusted for

distance above application site and nozzle placement along the structure.

• Nozzles of the proper size, arrangement, airstream placement and dispersal pattern.

Pest control on vegetable crops has been applied successfully with standard lowpressure sprayers, air-blast sprayers, aircraft, irrigation systems and soil application equipment. Use the proper implements for the crop and soil situation. In the case of insect and disease control, the location of the pests on the plants determines how the machinery bould be adjusted and used. For example, if

applied on those areas. A general rule to follow with application implements is that the best control results when the chemical treatments are aimed directly at the pests.

Accurate Equipment Calibration

Accurate applicator calibration is essential for effective chemical pest control without crop injury and environmental injury. Always calibrate a new sprayer before use and routinely recalibrate the applicator implement during the growing season. If you have difficulty calibrating your applicator, contact your nearest county Extension Service agent and/or your chemical dealer for assistance.

Unused and Unwanted Pesticides

Pesticides that for some reason cannot be used on a crop must be disposed of as hazardous waste. To avoid the difficulty and expense of hazardous waste disposal, use your pesticides on labeled crops. If you have to dispose of some pesticides, contact the Michigan Department of Natural Resources Hazardous Waste Management Division for instructions on the legal disposal of pesticide waste.

Cleaning and Care of Pesticide Application Equipment

It is important to clean pesticide application equipment, especially if it is used for more than one crop and for applying insecticides, fungicides and herbicides. The need for extensive cleaning can be minimized if one sprayer is only used to apply herbicides and another is used for insecticide and fungicide applications.

When cleaning a sprayer that is used for applying only one type of pesticide, a thorough water rinse is necessary. Rinse the entire sprayer, inside and out, including the boom, hoses and nozzles. Partially fill the spray tank with water and keep the pump running so that the rinse water circulates throughout the entire system. Spray the water rinsate out through the nozzles, making sure to properly collect the rinsate. To save money and protect the environment, rinse the equipment in the field using a water-filled nurse tank and apply the collected water rinsate to the crop.

To clean application equipment used to apply a variety of pesticides, thoroughly wash the entire spray system with one of the following cleaning agents in 100 gal of water:

• 1 gal household ammonia. Allow to stand in the spray tank and system overnight. or

- 5 lb of sal soda.
- or
 - 8 lb trisodium phosphate.

Run the pump so that the cleaning solution circulates throughout the entire system. Leave the cleaning solution in the spray system for at least 2 hours, and do not apply it to any crop or crop land. Discard the cleaning solution in an appropriate pesticide rinsate degradation pit. Rinse the entire system with water at least three times after all the cleaning solution has drained from the sprayer. Do not leave pesticide solutions or cleaning solutions in the tank overnight unless otherwise instructed.

Corrosion and mechanical damage to pumps, tanks, nozzles, etc., may result from leaving water in the spray system over the winter. To prepare the spray equipment for storage, disconnect all hoses and allow all water to drain out. Coat all bare metal parts with oil or a rust inhibitor. Disassemble metal nozzles and store them in oil. Prepare the spray pump for storage based on the manufacturer's recommendations.

Handling and Disposing of Pesticide Containers

Pesticide containers are considered hazardous waste until they are cleaned or disposed of properly. When possible, reduce the number of pesticide containers by using bulk or returnable containers. Buy pesticides in larger volume containers, containers that may be recycled, or in water soluble bags to avoid disposal problems.

All pesticide containers can be rendered nonhazardous waste by triple rinsing (or equivalent). The rinsate should be added to the spray tank. After triple rinsing, perforate both ends so the container cannot be reused.

Recycle metal and plastic triple-rinsed containers, if possible. If not possible, dispose of them in a state-licensed sanitary landfill. Dispose of all paper containers in a sanitary landfill or municipal waste incinerator. Do not bury or burn any pesticide containers. Do not reuse any empty pesticide containers for any purpose.

Notes on Nematode Management

Nematodes are microscopic worms that live in the soil and roots of plants. A few species feed on foliage or modified tissue, like onion bulbs. Nematode-infected vegetables do not grow well, yields are low and quality is often poor. Some nematodes cause root swellings called knots or galls (root-knot nematode), while others cause necrosis (root-lesion nematode, onion bloat nematode), and still others cause root stunting (stubby-root nematode). During the pass several years, the carrot cyst nematode has been found in a number of locations in Michigan. All of these nematodes can cause reduced yields or quality of various vegetable crops.

Plant parasitic nematodes can be present in most soil types, but usually cause the greatest damage in sandy soils. Some species, however, cause serious problems in muck soils. Nematode damage is frequently blamed on other causes, such as nutrient deficiencies or disease-causing organisms, like fungi and bacteria. Nematodes can also reduce plant resistance to certain fungi and bacteria.

Most soil-borne nematodes are beneficial and help control insects, decompose organic matter and regulate soil nutrition. While plant-parasitic nematodes cannot be eliminated completely from a field, control measures such as crop rotation, fallowing and applying chemical nematicides help prevent nematode damage in vegetable production. The most current and detailed information about nematode management in Michigan vegetables, including thresholds, is presented in the MSU Muck Vegetable IPM Scouting Manual.

1. **Rotate** vegetable crops so that platinjured by nematodes are not grown on the same soil more often than once every 3 years. For example, Irish potatoes, tomatoes, peppers, carrots, celery and other crops are injured by root-knot nematodes. Sweet corn and onions are less susceptible to damage caused by this nematode, and are poor reproductive hosts for the nematode.

2. In some cases, **fallowing** can be used to reduce nematode populations. Fallowed ground must be worked several times to keep it dry and free of weeds.

3. Sudax is a good **cover crop** for lowering population densities of root-knot and root-lesion nematodes.

4. Whenever necessary, use an appropriate nematicide. Specific nematicide recommendations for each crop are presented in this bulletin. Information about how to submit soil and root samples for nematode analysis is given in MSU Extension Bulletin E-2199, *Detection and Control of Nematodes*. Use root and soil samples to identify nematode problem sites.

Use chemical nematicides only when nematode population densities exceed specific nematode-crop action thresholds. These thresholds are published in the MSU Vegetable 'M Scouting Manual, and will be included in a new muck vegetable nematology Extension bulletin being developed. The rate of nematicide selected for use should be based, in part, on the nematode type and population density present in a specific production site. The procedures for nematode analysis are

For More Information

presented in Appendix B.

For more information on the use of pesticides, see the following publications. All are available from your MSU Extension Service or the Michigan State University Bulletin Office.

AM-95	Rinsing & Recycling Pesticide
	Containers
E-584	European Corn Borer: Corn,
	Peppers, Potatoes, Snap Beans
E-890	Detection and Control of Carrot
	Weevil
E-959	Know Your Asparagus Pests
E-965	Potato Insect Pests
E-966	Snap Bean Insect Pests
E-967	Sweet Corn Insect Pests
E-968	Cole Crop Insect Pests
969	Cucumber, Melon, Sayash and
ALC -	Pumpkin Insect Pests
E-970	Celeru and Carrot Insect Pests
E-971	Tomato, Eganlant and Pepper
	Insect Pests
E-972	Lettuce and Onion Insect Pests
E-1427	Disease and Insect Pests of Celeru
E-1546	Take Cover: Protect Yourself from
1010	Fynosure
E-1668	Disorders of Cole Crons
E-1679	Disorders of Tomatoes
E-1720	Diseases of Carrots
E-1721	Diseases of Opions
E-1823	Fusarium Vellous of Coloru in
1020	Michigan
F-1858	Using Sprau Additives with
1000	Harbicidas
F-1943	Bacterial Canker of Tomatoos
E_{-1040} E_{-2067}	Vagetable Past Scouting
E-2007	Using Chamigation Safaly and
E-2033	Effectively
F-9140	Top Tips for Loundaring Desticide
6-2145	Soiled Clething
F 2150	Choosing Clothing for Desticide
E-2150	Safatu
F 2160	Commonoial Doctional Amplication
E-2100	Vogetable Crep Deet Management
	Catagorie LTOP Pest Management -
0172	SADA Title III. The Former
2173	Bannan ille III: Ine Farmers
	Responsibility under the Emer-
	gency Planning and Community
	Right-to-Know Law.

E-2174	SARA Title III: The Agricultural
	Businesses' Responsibilities under
	the Emergency Planning and
F 2105	Community Right-to-Know Law.
E-2195	cator Core Manuali Initial
	Certification
E-2195-SP	Manual Basico Para Anlicadores
	de pesticidas Comerciales 11
	Privados
E-2199	Detection and Control of Nema-
	todes
E-2200	Soybean Cyst Nematode
E-2215	Using Pesticides Safely: A Guide
	for the Applicator
E-2278	Managing Sweet Corn Pests in
	Massachusetts (with Michigan
E 0004	insert)
E-2334	Sara Title III Farm Response
	Planning: Information Needed to
	Frepure Offsue Response Plans for
E-2335	On-Farm Aarichemical Storage &
2000	Handling
E-2340	Record keeping Sustem for Cron
	Production
E-2341	Recordkeeping System for Crop
	Production, Annual Record Book
	(pocket size)
E-2342	Recordkeeping System for Crop
	Production, Annual Record Book
	(full size)
E-2343	Field File
E-2413	Read Before Washing Pesticide-
	Solled Clothing - Magnet in
F 9419 CD	English
E-2413-5P	Lea Esto Antes de Lavar la Ropa
	Manchada o Sucia con Pesticiaes - Magnet in Spanish
F-9434	Silver Sourf of Potato
E-2448	Diseases of Potato: Fusarium Dru
	Rot
E-2453	Biological Control of Insects
MWPS-37	Designing Facilities for Pesticide
	and Fertilizer Containment
NB-07	Michigan Onion Growers' Manual
NCR-126	Diseases of Radishes in the U.S.
NCR-261	Wilt Disorders of Cucurbits
VT-023	Vegetable Pest Scouting (video)
VT-036	Integrated Pest Management for
	Michigan Celery (video)
XXX-XXX	Vegetable Crop Advisory
	Team(CAT) Alerts Newsletter (see
	p. 103 of this bulletin)

LIST OF INSECTICIDES AND NEMATICIDES USED ON COMMERCIAL VEGETABLES

Trade Name	Common Name	Class ¹	LD5 Oral	0's 2 Dermal	Leaching Potential ³	Runoff Potential ³	Restrict Entry Interval ⁴
Admire	imidacloprid	10	450	5000			12 hrs.
Agree	Bacillus thuringiensis kurstaki	4	>10000	6280			12 hrs.
• Asana XL	esfenvalerate	5	458	> 2000	3	1	24 hrs
• Ambush	permethrin	5	> 430-4000	> 2000	3	1	12 hrs
• Ammo	cypermethrin	5	250	> 2000	3	1	12 hrs
Biobit	Bacillus thuringiensis kurstaki	4	>10000	6280			12 hrs
• Busan 1020	sodium methyl dithiocarbamate	3	1891	>3074	2	3	48 hrs
• Brom-o-gas	methyl bromide	6	214		1	3	48 hrs
Butacide	piperonyl butoxide	9	> 7500				12 hrs
Condor	Bacillus thuringiensis kurstaki	4	>10000	6280			12 hrs
• Counter	terbufos	2	1.3-1.74	1.1	3	2	48 hrs
Cutlass	Bacillus thuringiensis kurstaki	4	>10000	6280			12 hrs
Cygon	dimethoate	2	60-387	400	2	3	48hrs
 Diazinon 	diazinon	2	2.75-450	3600	3	1	12-24 hrs
Dibrom	naled	2	50-281	360	3	3	24 hrs
Dipel	Bacillus thuringiensis	4	>10000	6280			12 hrs
 DiSyston 	disulfoton	2	1.9-12.5	3.6-15.4	2	2	48 hrs
 Dyfonate 	fonofos	2	3.2-18.5	25	3	1	48 hrs
Dylox	trichlorfon	2	250	> 2100	1	3	24 h
Foil	Bacillus thuringiensis tenebrionis + BT	4	>10,000	6280			12 hrs
• Furadan	carbofuran	3	5	885	1	3	48 hrs
• Guthion	azinphosmethyl	2	4.4-16	200	3	2	48 hrs
Imidan	phosmet	2	113-364	1560-4640	3	2	24hrs
Javelin	Bacillus thuringiensis kurstaki	4	>10000	6280			12 hrs
Kelthane	dicofol	1	570-590	2000-5000	3	1	12 hrs
• Lannate	methomyl	3	12-48	5880	1	2	48 hrs
Larvin	thiodicarb	3	166	> 2000	3	2	12 hrs
Lorsban	chlorpyrifos	2	82-270	1000-2000	3	1	12-24 hrs
MVP	Bacillus thuringiensis san diego	4	>10000	6280			SL
M-Trak	Bacillus thuringiensis tenebrionis	4	>10000	6280	,		SL

¹ Classes: 1. chlorinated hydrocarbons

2. organophosphates 6. brominated hydrocarbons

3. carbamates 7. insect growth regulators 8. organic

5. pyrethroids 4. bacterials 9. synergist 10. Other

² The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD50 data have been obtained from Farm Chemical Handbook and Material Safety Data Sheets. ³ 1=high, 2=medium, 3=low. These leaching/runoff potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the SCS "Soil-Pesticide Interaction Ratings".

4 SL = See Label. Read and follow the label directions. Post areas that have been treated to warn others not to enter until the REI has elapsed as rec by the label. • Restricted Use Pesticides. All or certain formulations of these toxicants have been classified Restricted Use Pesticides.

LIST OF INSECTICIDES AND NEMATICIDES USED ON COMMERCIAL VEGETABLES (continued)

rade Name	Common Name	Class ¹	LD5 Oral	0's ² Dermal	Leaching Potential ³	Runoff adsorption/ Solution ³	Restricted Entry Internal4
Malathion	malathion	2	480-10700	>2000	3	3	12-24 hrs
Metaldehyde	metaldehyde	8	227-690	250-1000	3	2	48 hrs
Metasystox-R	oxydemetonmethyl	2	50	150	1	3	12 hrs
Methoxychlor	methoxychlor	1	5000-6000	>2800	3	1	48 hrs
Methyl Parathion	methyl parathion	2	20	491	3	2	48 hours
• Mocap	ethoprop	2	61	2	1	2	48 hrs
Monitor	methamidophos	2	20	118	2	3	48 hrs
• Nemacur	fenamiphos	2	2-19	200	1	2	12 hrs
Novodor	Bacillus thuringiensis tenebrionis	4	>10000	6280			24 hrs
Orthene	acephate	2	980	> 10250	3	3 .	24 hrs
• Oxamyl	oxamyl	3	37	2960	S	S	48 hrs
• Penncap-M	methyl parathion (encapsulated)	2	220	5400	3	2	24 hrs
• Phaser	endosulfan	2	18-220	200-359	3	1	24 hrs
Pounce	permethrin	1	> 430-4000	> 2000	3	1	
Provado	imidacloprid	5	450	5000			12 hrs
Pyrellin	pyrethrin + rotenone + piperonyl butoxide	10	1500				12 hrs
Pyrenone	pyrethrin + piperonyl butoxide	8,9	1500				12 ms
Cotacide	rotenone	8,9	246-283	2000			12 mrs
Sevin	carbaryl	8	250-850	>2000	3	2	24 mrs
Telone II	1,3-Dichloropropene	3	224	333	2	3	40 ms
• Thimet	phorate	1	1.0	5.2	3	1	12 hrs
Thiodan	endosulfan	2	18-220	200-359	3	1	12 1115
Trigard	cyromazine	1	3387	> 3100	1	2	12 hrs
• Vapam	metam sodium	7	1700		2	3	12 ms
Vault	Bacillus thuringiensis kurstaki	3	>10000	6280			24 hrs
Vorlex	methyl isothiocyanate + 1,3-D	4	489	961	1	3	12 hrs
• Vydate	oxamyl	3	5.4	2960	3	3	12 1115
Xentari	Bacillus thuringiensis aizawai	3	>10000	6280	*		
		4					

¹ Classes: 1. chlorinated hydrocarbons

2. organophosphates

3. carbamates 4. bacterials

5. pyrethroids 6. brominated hydrocarbons

7. insect growth regulators 9. synergist 10. Other 8. organic

² The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD50 data have been obtained from Farm Chemical Handbook and Material Safety Data Sheets. ³ 1=high, 2=medium, 3=low. These leaching/runoff potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the SCS "Soil-Pesticide Interaction atings".

L = See Label. Read and follow the label directions. Post areas that have been treated to warn others not to enter until the REI has elapsed as required by the label. • Restricted Use Pesticides. All or certain formulations of these toxicants have been classified Restricted Use Pesticides.

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LIST OF FUNGICIDES USED ON COMMERCIAL VEGETABLES

		LD50 r	ng/kg ¹	Leaching	Runoff	Restricted Entry
Fungicide	Common Name	Oral	Dermal	Potential ²	Potential ²	Interval ³
Apron 25W	metalaxyl	669	> 3100	1	2	12 hrs
Bayleton 50 WP	triadimefon	569	2000	2	2	12 hrs
Benlate 50 W	benomyl	>10000	> 10000	3	1	24 hrs
Bravo	chlorothalonil	> 10000	> 10000	3	1	48 hrs
Captan 50 W	captan	8400-15000		3	2	4 days
Copper Count N	copper ammonium carbonate					12 hrs
Dithane M-45 80 W	mancozeb	4500-11200	5000-15000	3	1	24 hrs
Kocide	copper hydroxide	1000				48 hrs
Manex 4F	maneb	3000-7990	5000	3	1	24 hrs
Manex II 4F	mancozeb	4500-11200	5000-15000	3	1	24 hrs
Maneb 80 W	maneb	3000-7990	5000	3	1	24 hrs
Manzate 200 DF	mancozeb	4500-11200	5000-15000	3	1	24 hrs
Mertect 340	thiabendazole	3100-3600		3	1	12 hrs
Penncozeb 80 W	mancozeb	4500-11200	5000-15000	3	1	24 hrs
Polyram	metiram	2850-10000	> 2000	3	1	24 hrs
Ridomil 2 E	metalaxyl	669	>3100	1	2	12 hrs
Ronilan 50 W	vinclozolin	> 10000	>2000	2	2	12 hrs
Rovral 50 W	iprodione	3500	>2000	3	2	12 hrs
Super Tin	triphenyltin hydroxide	156	1600	3	1	24 hrs
Terraclor 75 W	PCNB	1500-5000	2000-4000	3	1	12 hrs
Terranil 6 FL	chlorothalonil	>10000	>10000	3	1	48 hrs
Thiram 50 WP Dyed	thiram	560-1000	>5000	3	2	
Tilt 3.6 E	propaconazole	1517	>4000	2	1	24 hrs
Top Cop with sulfur	copper sulfate	30				SL
Topsin M	thiophanate-methyl	7500		3	2	12 hrs

¹ The LD₅₀ is a standard toxicological term which indicates the number of milligrams (mg) of pesticide per kilogram (kg) of test animal body weight required to kill 50 percent of a test animal population. Values less than 10 indicate extremely high toxicity to mammals. The LD₅₀ data have been obtained from Farm Chemical Handbook and EXOTXNET notebook. ² 1=high, 2=medium, 3=low. These leaching/runoff potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCS soils ratings for water quality in the SCS "Soil-Pesticide Interaction Ratings".

³ SL=See Label. Read and follow label directions. Post areas or give oral warnings that areas have been treated to warn workers not to enter until the REI has elapsed as required by the label.

Compatibility of **Insecticides and Fungicides**

The following chart is only a guide to mixing spray materials. Consult the manufacturer's label regarding compatibility of products with other pesticides. The compatibility of some materials depends upon solvents and emulsifiers used by the manufacturer. Because all manufacturers do not use the same solvents and emulsifiers, be sure to check the label of the compatibility agent.

This chart applies only to the use of twomaterial spray combinations. When three or more materials are tank-mixed together, further incompatibility may develop.

Ambush

Special Notes

- Do not mix pesticides with foliar fertilizers.
- Do not allow spray mixtures to stand overnight before use.
- Fixed copper and bordeaux are generally not compatible with OP compounds.
- Thuricide and Diper (Bacillus thuringiensis) are generally compatible with most insecticides and fungicides if mixed in the tank just prior to application.
- Rotenone breaks down in sunlight.
- When mixing a wettable powder and an emulsifiable concentrate, put the powder into solution first.

Compatibility Chart Key

When a blank appears on the chart, the materials usually are not used together or the compatibility is not known.

- May be used together +
- Do not use together
- OP Organo-phosphorus compound
- 1 Use WP formulations
- 2 Apply immediately with tank agitation
- 3 Use with caution; may injure plants



INSECTICIDE EFFECTIVENESS

Most insecticides are not equally effective against all groups of insects. The following table categorizes the insecticides that are registered for use on vegetable crops on the basis of general effectiveness against broad groups of insects (for example, effectiveness

18

against beetles or aphids, F = fair, G = good), relative length of residual activity, estimated mammalian toxicity, etc. These generalities will not hold true under all conditions (such as particular host crops or pests, weather conditions, soil conditions, etc.) but they should help the grower choose materials. Materials listed with a "dash" under effectiveness are ineffective or there was no data available (presumed to be ineffective).

General Insecticide Effectiveness

Common Name	Treatment Type	Aphids	Leaf- hoppers	Plant Bugs	Thrips	Cater- pillars	Beetles	Root Maggots	Residual Activity	Mammalian Toxicity	Bee Toxicity ¹	Runnoff/ Leaching Potential ²	Restricted Use Pesticide	Comments
acephate (Orthene)	foliar spray	G	G	G	G	G	F		long	low	HT	S/S	no	
azinphosmethyl (Guthion)	foliar spray or soil treatment	F	G	G	G	G	G	F-G	short	high oral, moderate dermal	HT	M/S	yes, except soluble packages	
Bacillus thuringiensis (Agree, Dipel, Condor, Cutlass, Biobit, Javelin, Larvo-BT, MVP, Xentari)	foliar spray					G			short	none	NT		no	biological insecticide, good selective treatment
Bacillus thuringiensis tenebrionis (Novodor Foil, M-Trak)	foliar spray								short	none	NT		no	small Colorado potato beetle larvae, only
carbaryl (Sevin)	foliar spray		G	G	G	G	G		short	low	HT	M/S	no	may cause aphid build-up
carbofuran (Furadan)	foliar spray	F	G	G	G		G		very long	very high oral, low dermal	HT	S/L	yes	some nematicidal properties
chlorpyrifos (<i>Lorsban</i>)	soil treatment, foliar spray					G		G	moderate	moderate oral, lov dermal	HT	L/S	no	
cypermethrin (Ammo, Cymbush)	foliar spray		G	G	G	G	G		moderate	moderate	HT	L/XS	yes	
cyromazine (<i>Trigard</i>)	foliar spray for leaf miners								moderate	/ low		M/L	yes	insect growth regulator
diazinon (Diazinon)	foliar spray, soil treatment	G	G		G	G	G	F	moderate	moderate	HT	L/S	no	
dicofol (Kelthane)	foliar spray								short	low	LT	L/XS	no	specific miticide
dimethoate (Cygon)	foliar spray	G	G	G	G				moderate	moderate	HT	S/M	no	good selective insecticide, miticide
disulfoton (Di-Syston)	soil systemic or foliar spray	G	G		G		G		very long	very high	MT	M/S	yes	
endosulfan (Phaser, Thiodan, Tiovel)	foliar spray	G	G	G		G	G		moderate	high	MT	L/XS	no	

General Insecticide Effectiveness, continued.

Common Name	Treatment Type	Aphids	Leaf- hoppers	Plant Bugs	Thrips	Cater- pillars	Beetles	Root Maggots	Residual Activity	Mammalian Toxicity	Bee Toxicity ¹	Runnoff/ Leaching Potential ²	Restricted Use Pesticide	Comments
esfenvalerate (Asana)	foliar spary	F	G	G	G	G	G		moderate	low	HT	M/S	yes	
ethoprop (Mocap)	soil treatment					G	G	G	long	high	MT	M/L	yes	good nematicide
fonophos (Dyfonate)	soil treatment		-		-	G	G	G	long	very high oral, moderate dermal	MT	L/S	yes	
imidacloprid (Admire, Provado)	foliar spray or in-furrow	G	G			F	G		long	low	MT	unknown	no	
malathion	foliar spray	G	G	G	G	G	G		short	low	MT	S/S	no	
metaldehyde	bait								moderate	moderate	LT	M/S	no	effective for controlling slugs and snails
methamidophos (Monitor)	foliar spray	G	G	G	G	G	G		long	high		S/M	yes	
methomyl (Lannate)	foliar spray	G	G	G	G	G	F		moderate	high oral, low dermal	U HT	M/L	yes (except soluble package)	
methoxychlor (Marlate)	foliar spray		G			F	F		short	low	NT	L/XS	no	
methyl parathion (encapsulated, Penncap-M)	foliar spray	G	G	G	G	G	G		moderate	high	HT	M/S	yes	
methyl parathion (encapsulated, Penncap-M)	foliar spray	G	G	G	G	G	G		long	moderate oral, low dermal	HT	M/S	yes	
naled (Dibrom)	foliar spray	G	G	G		G	F		short	moderate		S/S	no	good miticide
Oxamyl (Vydate)	foliar spray	G	G				G		moderate	high oral, low dermal	MT	S/S	yes	good miticide & nematicide; good for leafminers
oxydemeton.nethyl (Meta-Systox R)	foliar spray	G	G	G	F				moderate	high oral, moderate dermal	MT	S/L	yes	good miticide, good selective insecticide
parathion (ethyl)	foliar spray	G	G	G	G	G	G	G	short	very high	HT	L/S	yes	All uses on vege- tables cancelled execpt aerial applications on sweet corn
permethrin (Ambush, Pounce)	foliar spray	F	G	G	G	G	G	G	long	low	HT	L/XS	yes	*
phorate (Thimet)	soil systemic	G	G		G	G	G		very long	very high	MT	L/S	yes	
phosmet (Imidan)	foliar spray	G	G	G				G	moderate	moderate oral, low dermal	HT	M/S	no	

19

General Insecticide Effectiveness, continued.

Common Name	Treatment Type	Aphids	Leaf- hoppers	Plant Bugs	Thrips	Cater- pillars	Beetles	Root Maggots	Residual Activity	Mammalian Toxicity	Bee Toxicity ¹	Runnoff/ Leaching Potential ²	Restricted Use Pesticide	Comments
phosphamidon	foliar spray	G	G					G	short	high oral, moderate dermal	HT	S/L	yes	-
piperonyl butoxide (<i>Butacide, PBO-8</i>)	foliar spray								short	none	NT		no	not directly toxic, blocks some resistance mechanisms
rotenone (Rotenox, Rotacide)	foliar spray	G				G	G		short	moderate oral, low dermal	NT		no	excellent for resistant Colorado potato beetles
terbufos (Counter)	soil treatment						G	G	long	very high	MT	M/S	yes	good nematicide
thiodicarb (Larvin)	foliar spray		F	F		G	G		short	moderate oral, low dermal	HT	M/S	no	
trichlorfon (Dylox)	foliar spray		G	G	G	G	G	G	short	low	NT	S/L	no	

¹HT = HIGHLY TOXIC: This group includes materials that kill bees on contact during application and for one or more days after treatment. Bees should be moved from the area if highly toxic materials are used on plants the bees are visiting.

MT = MODERATELY TOXIC: These materials can be used with limited danger to bees if not applied over bees in the field or the hives. Correct dosage, timing, and method of application are essential.

NT = RELATIVELY NONTOXIC: Materials in this group can be used with few precautions and a minimum of injury to bees.

²XS = extra small, S = small, M = medium, L = large. These leaching/runoff potential ratings are from the ARS/SCS pesticide properties database and were developed for use with the SCWS soils ratings for water quality in the SCS "Soil-Pesticide Interaction Ratings".

20

Conversion Equivalents and Abbreviations

Measurements

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Label Key

1 fluid ounce (fl oz)	= 2	2 tablespoons (Tos) =	В	means	Bait
		6 teaspoons	D	means	Dust
		-	DF	means	Dry Flowable
1 cup (c)	=	8 fluid ounces (fl oz)	DG	means	Dispersable Granule
			EC	means	Emulsifiable Concentrate,
1 pint (pt)	=	16 fluid ounces (fl oz) =		or Emuls	ion
		32 tablespoons (Tbsp)	F	means	Flowable
			G	means	Granule
1 quart (qt)	=	2 pints (pts) = 32 fluid	L or LC	means	Liquid Concentrate
		ounces (fl oz)	LS	means	Liquid Solution
			S	means	Sprayable
1 gallon (gal)	=	4 quarts (qt) = 12 fluid	SC	means	Suspension Concentrate
		ounces (fl oz)	SP	means	Soluble Powder
			μ	means	micro
1 pound (lb)	=	16 ounces (oz)	μm	means	micrometer
			W or WP	means	Wettable Powder
1 Acre (A)	=	43,560 square feet (sq ft)	RUP	means	Restricted Use Pesticide
		= 17,424 row feet (ft) for			
		30 in. rows			
The					

Calculation of Banded Rates

To calculate a banded rate from a given broadcast rate, use the following formula:

= parts per million

Rate/A needed for banded application = <u>Band width in inches</u> x Broadcast Rate/A

Row spacing in inches

ASPARAGUS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

FOLIAR TREATMENT

INSECTS

Cutworms, apply as needed.

*Permethrin

- -- Ambush 2 EC, 6.4 oz (1 day) (RUP).
- -- *Pounce* 3.2 EC, 4 oz (1 day) or 25 WP, 3.2 oz (3 days) (RUP).

or

**Dyfonate II* 10 G, 20 lb (fall treatment for white cutworms only) (RUP).

or

Lorsban 4 E, 2 pt (1 day) (limited to 1 preharvest application per season).

or

Carbaryl (Sevin) 5 B, 40 lb (1 day).

or

Lannate, 90 S, 1 lb or 1.8 L, 4 pt (1 day) (RUP).

Asparagus beetles, early control is necessary to prevent egg laying and damage to spears during harvest season; additional treatments may be needed to prevent damage to fern growth.

Carbaryl (*Sevin*) 80 S, 1 1/4 to 2 1/2 lb or XLR Plus, 1 to 2 qt (1 day). Apply treatments no closer than 3 days apart. Apply 2 1/2 to 5 lb of 80 S or 2 to 4 qt of XLR Plus on ferns postharvest.

or

Permethrin

- -- Ambush 2 EC, 3.2 to 6.4 oz (1 day) (RUP).
- -- Pounce 3.2 EC, 2 to 4 oz (1 day) or 25 WP, 3.2 oz (1 day) (RUP).

or

Lannate 90 SP, 1/2 to 1 lb or 1.8 L, 2 to 4 pt (1 day) (RUP).

or

Methoxychlor 50 WP, 2 lb (3 days if washed or blanched).

or

Lorsban 4 E, 2 pt (1 day) (limited to 1 preharvest application per season).

or

Malathion 5 EC, 2 pt (1 day).

Asparagus aphids, apply as needed to prevent injury to fern.

**Di-Syston* 8 EC, 1 pt (120 days). Do not apply when bees are active. (Special Michigan SLN label.)

or

O

Malathion 5 EC, 2 pt (1 day).

Plant bugs.

- Permethrin
- -- Ambush 2 EC, 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 oz (1 day) or 25 WP, 3.2 oz. (3 days) (RUP).

DISEASES

Rust (*Puccinia asparagi*), apply every 7 to 10 days beginning 10 to 14 days after harvest (fern growth only). Note: Fungicides applied for control of rust are also helpful in controlling purple spot (*Stemphylium vesicarium*).

Manex II 4 F, 1 3/5 qt.

or

Manzate 200 DF, 2 lb.

or

Dithane M-45 80 W, 2 lb.

or Dithane DF, 2 lb.

or

Penncozeb 80 W, 2 lb.

or

Penncozeb 75 DF, 2 lb.

or

Dithane F-45 4 F, 1 3/5 qt.

Phytophthora spear and crown rot. Apply 30 to 60 days before first cutting, and another application just before harvest in a minimum of 10 gal of water.

Ridomil 2 E, 2 qt.

BEANS, SNAP

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particular recommended for problem infestations.

SOIL TREATMENT

EMATODES

ee E-2200, Soybean Cyst Nema&de).

Mocap 10 G, broadcast 60 to 80 lb from 3 days prior to planting to at-planting time and incorporate to a depth of 4 inches (RUP).

- or
 - *Mocap* 6 EC, broadcast 1 to 1 1/3 gal from 3 days prior to planting to at-planting time. Immediately incorporate to a depth of 4 inches (RUP).

SEED TREATMENT

Treatments are applied to seed prior to planting. Insecticide and fungicide treatments can be combined according to directions. Handle seed carefully to prevent cracking.

INSECTS

Seed corn maggot (bean maggot), adults are attracted to rotting organic matter and freshly plowed soil for egg laying. Plow sod and green manure crops under thoroughly and use the seed treatment suggestions below.

Lindane (Isotox Seed Treater F), 2 oz/100 lb seed as planter box treatment.

UĽ

Lorsban 50 SL, 2 oz/100 lb seed as slurry treatment only.

or

Lindane/diazinon/captan (*Triple Seed Protectant*) 3 oz/bushel as a planter box treatment.

DISEASES

Damping off (*Pythium* spp., *Rhizoctonia solani*, early season *Phytophthora*, Furarium spp.)

Terraclor 10 G, 10 to 15 lb (*Rhizoctonia*). Infurrow application. Do not feed treated vines to livestock.

or

Ridomil PC 11 G, 12 oz/1,000 linear feet of row at the time of planting (*Pythium* and *Phytophthora* only).

or

Ridomil 2 E. Preplant incorporated 2 to 4 pt or surface application (if natural rainfall is not expected before the seeds start germinating, *Ridomil* 2 E should be incorporated mechanically before planting or moved into the seed zone after planting with 1/2 to 1 inch sprinkler irrigation) (*Pythium* and *Phytophthora* only).

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or
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Thiram 50 WP Dyed, 2 oz/100 lb of seed.

or

or

or

or

or

or

Captan 75 W, 1 oz/bu.

Apron 25 W, 2 oz/lb seed (for Pythium only).

Apron-Terraclor, 2 oz/bu seed.

Captan 300, 2 1/4 oz/100 lb seed.

Captan 30-DD, 2 1/4 oz/100 lb seed.

Captan 400, 2 to 3 oz/100 lb seed.

or

Captan 400 D, 2 to 3 oz/100 lb seed. or

Captan 75%, 1 3/4 oz/100 lb seed.

42-S Thiram, 2 oz/100 lb seed.

or

or

Apron FL, 0.75 to 1.5 oz/seed (*Pythium* and *Phytophthora* only).

or

Apron, 4 oz/100 lb seed (*Pythium* and *Phytophthora* only).

or

Apron + Captan, 4 oz/100 lb seed.

Note: If possible, buy seed treated with a combination insecticide-fungicide or use a commercial seed treatment formulation containing a combination insecticide-fungicide. Use only as directed; over-treatment may cause injury.

PLANTING TREATMENT

NEMATODES

Mocap 6 EC, 1.3 to 2 qt (36 in. row spacing) or Mocap 10 G, 20 to 30 lb (36 in. row spacing) in a 12- to 15-inch band over the row. Do not allow spray or granules to contact the seed (RUP).

INSECTS

APPLY AS A SIDE-DRESSING BAND ONLY (do not allow contact with seed) at planting time.

Mexican bean beetle, leafhoppers, aphids, mites.

Di-Syston 15 G, 6 to 12 oz/1,000 ft (RUP). or

Phorate (*Thimet*) 20 G, 6 to 9 oz/1,000 ft. Do not feed foliage of treated beans for 60 days (RUP).

FOLIAR TREATMENT

Snap Beans

INSECTS

Cutworms feed on plants close to soil surface. Control may be applied when the crop first comes up and as needed.

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Carbaryl (*Sevin*) 80 S, 1 7/8 lb or 5 B, 40 lb or 20B, 10 lb (0 days).

or

Lannate 1.8 L, 4 pt or 90 SP, 1 lb (3 days) (RUP).

Mexican bean beetle, apply as needed.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 pt (0 days). Also registered for bean leaf beetle.

or

Malathion 5 EC, 1 1/2 pt (1 day). Also registered for bean leaf beetle.

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP). Do not graze or feed treated bean vines to livestock within 3 days, nor bean hay within 7 days of last application.

or

or

Diazinon 4 EC, 1 pt (7 days) (RUP).

or

Penncap-M 2 F, 2 pt (3 days) (RUP). Do not apply during bloom.

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (3 days). Apply only 3 times per season. Do not feed threshings to livestock or allow them to graze. See label for further restrictions.

or

Leafhoppers, apply when 5 or more are seen per plant, or at first sign of leaf cupping.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP). or

Dibrom 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP). Do not graze or feed treated bean vines to livestock within 3 days, nor bean hay within 7 days of last application.

Methoxychlor 50 WP, 2 lb (3 days; 7 days if vines are fed to livestock).

or

Dimethoate (*Cygon*) 4 EC, 1 pt (0 days). Do not feed treated forage to livestock.

or

Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Do not feed treated vines to livestock.

or

Penncap-M 2 F, 2 pt (3 days) (RUP). Do not apply during bloom.

Green cloverworm, apply when damage to leaves is seen.

Penncap-M 2 F, 2 pt (3 days) (RUP). Do not apply during bloom.

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Aphids, apply when first seen and continue as needed.

*Dimethoate (*Cygon*) 4 EC, 1 pt (0 days). Do not feed treated forage to livestock.

or

**Orthene* 75 S, 2/3 to 1 1/3 lb (14 days). Do not feed treated vines to livestock.

or

Diazinon 4 EC, 1 pt (7 days) (RUP).



Malathion 5 EC, 2 pt (1 day).

or

or

Penncap-M 2 F, 2 pt (3 days) (RUP). Do not apply during bloom.

or

Dibrom 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

Mites, apply to underside of leaves as needed. Most serious in dry years.

*Kelthane MF, 3/4 to 1 pt (7 days).

or

- Dimethoate (*Cygon*) 4 EC, 1 pt (0 days). Do not feed treated forage to livestock.
- or

Dibrom 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

European corn borer, treat during pod formation. Use higher rates and/or more frequent application during periods of high adult activity and egg laying.

*Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Do not feed treated vines to livestock.

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Methoxychlor 50 WP, 2 lb (3 days); 7 days if vines are fed to livestock.

Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Do not feed treated vines to livestock. Also registered for bean leaf beetle.

Carbaryl (*Sevin*) 80 S, 1 1/2 lb or XLR Plus, 1 to 1 1/2 qt (0 days).

or

Lannate 1.8 L, 4 pt or 90 SP, 1 lb (3 days) (RUP). Do not graze or feed treated bean vines to livestock within 3 days nor bean hay within 7 days of last application.

or

Penncap-M 2 F, 2 to 4 pt (3 days) (RUP). Do not apply during bloom. Do not apply more than 3 times per season.

DISEASES

Bacterial blight (*Pseudomonas phaseolicola*), apply as a protective spray and continue at 7- to 10-day intervals through harvest. The treatment is particularly important during wet weather.

Tenn-Cop 5 E, 3 pt (0 days).

or

Copper sulfate 53 WP, 3 to 4 lb (0 days).

Kocide DF, 1 to 3 lb (0 days).

or

Champ F, $1 \frac{1}{3}$ to 4 pt (0 days).

or

Champ Formula 2 Copper 37.5% F, 2/3 to 2 pt (0 days).

or

Kocide LF, 1 1/3 to 4 pt (0 days).

Anthracnose(*Colletotrichum lindemuthianum*), apply when disease first appears and repeat every 7 days.

Copper sulfate 53 WP, 2 to 3 lb (0 days). or

Copper oxide 80 W, 1 to 3 lb (0 days).

Rust (*Uromyces phaseoli typica*), apply when there are fewer than 10 pustules per plant and repeat every 7 days.

Bravo 720, 1 3/8 to 3 pt or Bravo W 75, 3 lb or Bravo 90 DG, 1 1/8 to 2 1/2 lb (7 days).

or

Terranil 6 L, 1 3/8 to 3 pt (7 days).

or

Copper sulfate 53 W, 2 to 3 lb (0 days).

Copper oxide 80 W, 1 to 3 lb (0 days).

or

Top Cop with sulfur, 2 qt (0 days).

te: Rust is not commonly observed in chigan.

Gray mold (Botrytis cinerea).

Benlate 50 W, 1 1/2 to 2 lb (14 days). Apply at

25-50% bloom, repeat at peak bloom.

or *Topsin M* 70 WP, 1 to 2 lb or *Topsin M* 4.5 F, 20 to 40 oz (14 days). Apply once using the higher rate at 50-70% of full bloom or apply twice using the lower rate with first application at 10 to 30% of full bloom and a second application 4 to 7 days later or at peak bloom.

or

Terranil 6 L, 3 pt. Begin applications during early bloom stage and repeat every 7 days.

or Bravo 720, 3 pt or Bravo 90 DG, 2 1/2 pt (7 days). Begin applications during early bloom stage and repeat every 7 days.

- or
 - *Roural* 4 F, 1.5 to 2.0 pt (14 days). Apply at early bloom and again at peak bloom if conditions are favorable for disease development.

White mold (Sclerotinia sclerotiorum).

Benlate 50 W, 1 1/2 to 2 lb (14 days). Apply at 25 to 50% bloom, repeat at peak bloom.

or

Topsin M 70 WP, 1 to 2 lb or *Topsin M* 4.5 F, 20 to 40 oz (14 days). Apply once using the higher rate at 50 to 70% of full bloom or apply twice using the lower rate with first application at 10 to 30% of full bloom and a second application 4 to 7 days later or at peak bloom.

or

Terraclor 75 W, 2 3/4 lb or 2 E, 4 qt as a band spray per 14,500 ft of row. Apply at 2 to 3 week intervals, but not after first bloom. Soil should remain undisturbed after application. Do not feed treated vines to livestock.

or

or

- *Rovral* 4 F, 1 1/2 to 2 pt (14 days). Apply at early bloom and again at peak bloom if conditions are favorable for disease development.
- Botran 75W, 2 1/4 lb (2 days). Begin applications when disease is anticipated and continue at 7-day intervals during periods favorable to development of disease.

BEETS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide. *Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Sugar beet cyst and northern root-knot nematodes can reduce red beet yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for red beets, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of sugar beet cyst and northern rootknot nematodes in red beet production.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil) .

or

1,3-D and chloropicrin

--*Telone C-17*, 40 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations, soil fumigants can be applied in the spring in Michigan.

SOIL TREATMENT AT PLANTING

NEMATODES

Phenamiphos (*Nemacur*) 3 S, 4-6 fluid oz/ 1,000 row feet in an 8- to 12-inch band over the row before or at seeding. Incorporate immediately by shallow cultivation or by sprinkler irrigation. Do not apply within 90 days of harvest. Apply only once per season.

INSECTS

Cabbage maggot.

Dyfonate II 10 G, 20 lb or 15 G, 13.4 lb broadcast and incorporated prior to planting (RUP).

SEED TREATMENT

Treatments are applied to seed prior to planting. Rates given are amount of formulation per 100 lb. unless otherwise indicated.

DISEASES

Damping off (*Pythium* spp., *Rhizoctonia solani*).

Thiram 50 WP Dyed, 8 oz.

or Captan 75 W, 8 oz.

or

Apron 25 W (Pythium only), 2 oz.

or *Captan* 30-DD, 9 1/2 oz.

or

Captan 300, 9 1/2 oz.

Captan 400, 8 to 12 oz.

or

or

Captan 400-D, 8 to 12 oz.

or

Captan 75%, 8 oz. or

42-S Thiram, 8 oz.

Use *Thiram* and *Captan* as seed treatments or Use only as directed; over-treatment may cause injury.

PLANTING TREATMENT

DISEASES

Damping off (*Pythium*, *Phytophthora* and *Rhizoctonia* spp.)

Apron, 4 oz/100 lb seed (*Pythium* and *Phytophthora* spp. only).

or

Apron + Captan, 4 oz/100 lb seed.

FOLIAR TREATMENT

INSECTS

Cutworms, usually damage plants soon after they come up. Apply if damage is observed.

**Dylox* 80 SP, 1 1/4 lb (28 days). Do not use tops for feed or food.

or

Carbaryl (Sevin) 5 B, 40 lb; 20 B, 10 lb, (3 day 14 days if tops are eaten or fed to livestock.

'lea beetles, apply if damage is noted on leaves.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days; 14 days if tops are eaten or fed to livestock).

or

Methoxychlor 50 WP, 2 lb (14 days).

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

Aphids, apply as soon as they appear.

Diazinon 4 EC, 1 pt (14 days) (RUP).

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

or

Malathion 5 EC, 2 pt (7 days).

DISEASES

Cercospora leaf spot (*Cercospora beticola*), apply every 7 to 10 days.

Copper sulfate 53 W, 2 to 3 lb (0 days).

or

Super-Cu, 1/3 gal (0 days).

Tenn-Cop 5 E, 3 pt (0 days).

BROCCOLI

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Sugar beet cyst, root-knot and lesion nematodes can reduce broccoli yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic preshold for broccoli, crop rotation or pplication of a nematicide is recommended. The following nematicides are suitable for control of sugar beet cyst, root-knot and lesion nematodes in broccoli production.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

SEED TREATMENT

DISEASES

Damping off, wire stem, (*Pythium* spp., *Rhizoctonia* spp.).

Thiram, 1 1/3 tsp/lb of seed. Use only as directed; over-treatment may cause injury.

or or

or

or

or

or

or

Anchor, 1.5 oz/100 lb seed (Pythium only).

Captan 300, 1 1/4 oz/100 lb seed.

Captan 30-DD, 1 1/4 oz/100 lb seed.

Captan 400, 1 to 2 oz/100 lb seed.

Captan 400-D, 1 to 2 oz/100 lb seed.

or

Captan 75%, 4 oz/100 lb seed.

42-S Thiram, 8 oz/100 lb seed.

Thiram 50 WP Dyed, 8 oz/100 lb seed.

Black leg (Phoma lingam).

There is presently no fungicide treatment available for this disease.

SEEDBED TREATMENT

Apply treatments to soil according to directions to protect young seedlings in the seedbed before transplanting in field.

INSECTS

Cabbage maggot, apply to seedbed surface and incorporate to 3 to 4 inches.

Broccoli

Diazinon 14 G, 21 lb or 4 EC, 3 qt (RUP). Apply only as directed.

DISEASES

Clubroot (Plasmodiophora brassicae).

Terraclor 10 G, 200 lb (40 inch row spacings). Row application: apply in a 12 to 15 inch band and rototil to a depth of 4 to 6 inches immediately prior to planting, or, Broadcast application: apply 300 lb/acre to the soil surface prior to planting. Disc and cross disc to a depth of 4 to 6 inches.

or

Terraclor 75 W. Band application: apply 30 lb in 25 gal water (40 inch row spacing). Spray as a 12- to 15-inch band centered on the row and incorporate to a depth of 4 to 6 inches immediately prior to planting. Broadcast application: apply 40 lb in 30 gal of water as a preplant broadcast prior to planting. Thoroughly incorporate to a depth of 4 to 6 inches using a disc harrow or other suitable equipment.

Wire stem or black root (Corticium solani).

Row drench treatment: Spray as an 8-inch band centered on the row at the time of or immediately after seeding.

Terraclor 75 W, 10 to 15 lb. Apply in 35 gallons water (40 inch row spacings).

Broadcast drench application: Apply as a soil drench at the time of or immediately after seeding.

Terraclor 75 W, 15 to 20 lb. Apply in 50 gal water. For smaller areas use 1 level teaspoon/gal water as a soil drench per 50 sq ft of seedbed. Apply with watering can or similar equipment.

Damping off (*Pythium* spp.) **and basal rot**, (*Phytophthora* spp.), apply prior to planting as a broadcast spray.

Ridomil 2 E, 4 to 8 pt in 50 gal of water. For control of *Pythium* only use 1 to 2 pt. If natural rainfall is not expected before the seeds start germinating, *Ridomil* 2 E should be incorporated mechanically before planting or be moved into the seed zone after planting with 1/2 to 1 inch sprinkler irrigation.

or

Captan 75 W, 1 oz/100 lb seed.

or

Thiram 50 WP Dyed, 8 oz/100 lb seed.

PLANTING TREATMENT

Treatments applied at seeding.

INSECTS

Cabbage maggot.

Lorsban 15 G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.75 fl oz per 1,000 ft of row. Apply in a 4-inch band over row at time of seeding. Use only as directed.

or

Dyfonate II, 10 G, 40 lb or 15 G, 27 lb, broadcast prior to planting (or band with proportionate reduction in rate) (RUP).

Aphids and flea beetles, apply as band on each side of seed row or transplant row at time of planting or sidedressed after plants become established. Treatments applied at seeding or transplanting are translocated into foliage systemically.

Di-Syston 15 G, 7.4 oz/1,000 or 8 E, 1.1 fl oz/1,000 ft (14 days) (RUP). Use only as directed.

TRANSPLANT WATER TREATMENT

Treatments applied in water around roots at time plants are being set in the field. **Note**: Treatment rates are given in amount of formulation per 100 gal of water. Apply at rate of 1 cup solution per plant. Frequent agitation is needed with wettable powders.

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DISEASES

Clubroot (Plasmodiophora brassicae).

Terraclor 75 WP, 2 to 6 lb. Apply in 100 gal water. Use 1/2 to 3/4 pt solution/plant.

INSECTS

Cabbage maggot.

Diazinon 50 WP, 1 lb. or AG 500, 1/2 to 1 pt/100 gal (RUP). Use only as directed.

or

Guthion 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

SOIL TREATMENT AFTER TRANSPLANTIN

Apply to the soil at the base of plants after transplanting. Adequate water is needed to wet the soil surface.

SECTS

Cabbage maggot.

Dyfonate 4 EC, 1 to 2 qt (RUP).

- or
 - Lorsban 4 EC, 1.6 to 2.75 fl oz per 1,000 ft of row.
- or
 - Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply as needed soon after plants come up.

Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, $1 \frac{1}{2}$ lb (7 days). Consult label for rotation restrictions.

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

Asana XL, 5.8 oz (3 days) (RUP).

Lorsban 4E, 1 qt or 50 W, 2 lb (21 days).

- or
- Methyl parathion 7.5 EC, 1 to $1 \frac{1}{2}$ pt (21 days).

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days).

Cutworms, apply when damage is first seen. Repeat as needed.

*Asana XL, 9.6 oz (3 days) (RUP).

or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). or

- Endosulfan (Phaser, Thiodan) 3 EC, 2 2/3 pt or 50 WP, 2 lb (7 days). Consult label for rotation restrictions.
- or

Carbaryl (Sevin) 5 B, 40 lb or 20 B, 10 lb (3 days).

Imported cabbageworm, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms.

Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

- or
 - Carbaryl (Sevin) 80 S, 1 1/2 lb or XLR Plus 1 to 2 qt (3 days).

- or
 - Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

or

Lorsban 4 E, 1 gt or 50 W, 2 lb (21 days).

Monitor 4 EC, 1 pt (14 days) (RUP).

or

or

- Permethrin
- --Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- or

or

Asana XL, 2.9 to 5.8 oz (3 days) (RUP).

- Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days). or
 - Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP).

or

or

or

Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 pt, (15 days). Do not exceed more than 3 applications per season.

Dibrom 8 EC, 1 pt (1 day).

- Malathion 5 EC, 2 pt (3 days). or
 - Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Diamondback moth, apply treatments when worms are first seen and repeat as needed.

*Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

or

or

- Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.
- Carbaryl (Sevin) 80 S, 1 1/2 lb or XLR Plus 1 to 2 qt (3 days).
- or Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days). (RUP).
- or

Permethrin

- --Ambush 2 EC 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

Monitor 4 EC, 1 pt (14 days) (RUP).

or

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days). or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP).

Broccoli

or Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt, (15 days). Do not exceed more than 3 applications per season. or Dibrom 8 EC, 1 pt (1 day). Cabbage loopers, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms. Lannate 1.8 L, 4 pt or 90 SP, 1 lb (3 days) (RUP). or Larvin (thiodicarb) 3.2 EC, 24 to 40 oz (7 days). or Asana XL, 2.9 to 5.8 oz (3 days) (RUP). or Permethrin --Ambush 2 EC, 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP). --Pounce 3.2 EC, 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP). or Monitor 4 EC, 1 pt (14 days); 2 pt (21 days) (RUP). or Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, $1 \frac{1}{2}$ lb (7 days). Consult label for rotation restrictions. or Dibrom 8 EC, 2 pt (1 day). or Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days). Aphids, apply when they first appear, to prevent later infestations on edible parts. *Monitor 4 EC, 1 pt (14 days) (RUP). or

*Dimethoate (*Cygon*) 4 EC, 1 pt (7 days). or

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP).

or Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (7 days).

Dibrom 8 EC, 1 pt (1 day).

or

or

Malathion 5 EC, 2 pt (3 days).

DISEASES

Black rot (*Xanthomonas campestris*), apply treatment (lowest rates) in transplant beds and start weekly treatments in fields as soon as transplants are established.

Copper sulfate 53 W, 1 to 3 lb (0 days).

Kocide DF, 2 lb (0 days).

or

or

Champ Formula 2 Copper 37.5% F, 1/3 to 2/3 pt (0 days). Note: Reddening of older leaves may occur at the higher rate.

or

Kocide LF, 2 2/3 pt (0 days).

Alternaria leaf spot (Alternaria brassicae), apply when conditions favor disease and repeat every 7 to 10 days.

*Manex 4 F, 1 1/5 to 1 3/5 qt (7 days).

or

*Maneb 80W, 1 1/2 to 2 lb (7 days).

or *Maneb + zinc F4, 1 1/5 to 1 3/5 qt (7 days).

or *Bravo 90 DG, 1 1/4 lb (0 days).

or

*Bravo 720 4 F, 1 1/2 pt (0 days).

or

**Terranil* 6 L, 1 1/2 pt (0 days).

Copper-Count-N, 1 to 2 pt (0 days).

or *Kocide* DF, 2 lb (0 days).

or

or

Kocide LF, 2 2/3 pt (0 days).

Black leg (*Phoma lingam*), apply immediately after thinning (2 to 4 leaf stage) as a directed spray to the base of the plant and adjacent soil surface. If disease persists or reoccurs a second application may be made up to day of harvest.

Roural 50 W, 2 lb (0 days).

or

Rovral 4 F, 2 pt (0 days).

Downy mildew (*Peronospora parasitica*). Begin applications when conditions are favorable for disease but before infection.

Apply at 7- to 21-day intervals. **Note**: Do not tank mix with copper fungicides.

Aliette 80 W, 2 to 5 lb (3 days) or Aliette WDG

or

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (7 days).



Apply at 14 day intervals (maximum 4 applications/crop).

Note: Fungicides that protect against *Alternaria* also provide limited downy mildew protection.

BRUSSELS SPROUTS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Sugar beet cyst, root-knot and lesion nematodes an reduce Brussels sprouts yield. Fields with bil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for Brussels sprouts, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of sugar beet cyst, root-knot and lesion nematodes in Brussels sprouts production.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

- 1,3-D
- --*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject fumigant to a soil depth of 6 to 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants may be applied in the spring in lichigan.

SOIL TREATMENT AT PLANTING

NEMATODES

Phenamiphos (*Nemacur*) 15 G, 35 lb. Broadcast and incorporate to 2 to 6 inches. For transplants only.

- or
 - Phenamiphos (*Nemacur*) 15 G, 15 lb for 36 inch rows. Apply in 12- to 15-inch band and incorporate to 2 to 6 inches. For transplants only.

SEED TREATMENT

DISEASES

Damping off, wire stem (*Pythium* spp., *Rhizoctonia* spp.).

Captan, 75 W, 1 oz/100 lb seed.

Captan 300, 1 1/4 oz/100 lb seed.

Captan 30-DD, 1 1/4 oz/100 lb seed.

or *Captan* 400, 1 to 2 oz/100 lb seed.

Captan 400-D, 1 to 2 oz/100 lb seed.

Captan 75%, 4 oz/100 lb seed.

or

or

or

or

or

or

or

42-S Thiram, 8 oz/100 lb seed.

Thiram 50 WP Dyed, 8 oz/100 lb seed.

Anchor, 1.5 oz/100 lb seed (Pythium only).

SEEDBED TREATMENT

Apply treatments to soil according to directions to protect young seedlings in the seedbed before transplanting in field.

INSECTS

Cabbage maggot, apply to seedbed surface and incorporate to 3 to 4 inches.

Diazinon 14 G, 21 lb or 4 EC, 3 qt (RUP). Apply only as directed.

DISEASES

Clubroot (*Plasmodiophora brassicae*). Before planting, sterilize seedbeds (p. 95) or apply to soil surface as a drench.

Terraclor 10 G. Row application: apply 200 lb/acre (40 inch row spacings). Spray as a 12- to 15-inch band and rototil to a depth of

4 to 6 inches immediately prior to planting, or Broadcast application: apply 300 lb/acre to the soil surface prior to planting. Disc and cross disc to a depth of 4 to 6 inches.

or

Terraclor 75 W. Band application: apply 30 lb in 25 gal water (40 inch row spacing). Spray as a 12- to 15 inch band centered on the row and incorporate to a depth of 4 to 6 inches immediately prior to planting, or Broadcast application: apply 40 lb in 30 gal of water as a preplant broadcast prior to planting. Thoroughly incorporate to a depth of 4 to 6 inches using a disc or other suitable equipment.

Wire stem or black root (Corticium solani).

Row drench treatment: Spray as an 8 inch band centered on the row at the time of or immediately after seeding.

Terraclor 75 W, 10 to 15 lb. Apply in 35 gallons water (40 inch row spacings).

Broadcast drench application: Apply as a soil drench at the time of or immediately after seeding.

Terraclor 75 W, 15 to 20 lb. Apply in 50 gal water. For smaller areas use 1 level teaspoon/gal water as a soil drench per 50 sq ft of seedbed. Apply with watering can or similar equipment.

PLANTING TREATMENT

Treatments are applied at seeding.

INSECTS

Cabbage maggot, apply in a 4-inch band over row at time of seeding.

Lorsban 15 G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row, use only as directed.

or

Dyfonate II 10 G, 40 lb or 15 G, 27 lb, broadcast prior to planting (or band with proportionate reduction in rate) (RUP).

Aphids, flea beetles and thrips, apply as band on each side of seed row or transplant row at time of seeding or sidedressed after plants become established. Treatments applied at seeding or transplanting are translocated into foliage systemically.

Di-Syston 15 G, 7.4 oz/1,000 ft or 8E, 1.1 fl oz/1,000 ft (30 days) (RUP). Use only as directed.

TRANSPLANT WATER TREATMENT

Treatments applied in water around roots at time plants are set in the field. **Note**: Treatment rates are given in amount of formulation per 100 gal of water. Apply at rate of 1 cup of solution per plant. Frequent agitation is needed with wettable powders.

DISEASES

Clubroot (Plasmodiophora brassicae).

Terraclor 75 W, 2 to 6 lb. Apply in 100 gal water, use 1/2 to 3/4 pt solution per plant.

INSECTS

Cabbage maggot.

Diazinon 50 WP, 1 1b/100 gal or AG 500, 1/2 to 1 pt/100 gal (RUP). Use only as directed.

or

Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

Clubroot (Plasmodiophora brassicae)

Terraclor 75 W, 2 to 6 lb. For best results use with seedlings free from club root. Use only as directed.

SOIL TREATMENT AFTER TRANSPLANTING

Apply to the soil at base of plants after transplanting. Apply water to wet soil surface.

INSECTS

Cabbage maggot.

Dyfonate 4 EC, 1 to 2 qt (RUP).

or

Lorsban 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row. or

Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply as needed soon after plants come up when field seeded.

- Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.
- or
 - Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

or

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR 1/2 to 1 qt (3 days).

or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days).

Cutworms, apply when damage is first seen. Repeat as needed.

- *Permethrin
- --Ambush 2 EC, 6.4 oz or 25 WP, 6.4 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 oz or 25 WP, 6.4 oz (1 day) (RUP).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

or

- Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). or
 - Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2 2/3 pt or 50 WP, 2 lb (14 days). Consult label for rotation restrictions.

Imported cabbageworms, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms.

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.

or

Orthene 75 S, 1 1/3 lb (14 days). Consult label for restrictions.

or

Carbaryl (Sevin) 80 S, 1 1/2 lb or XLR Plus, 1 to 2 qt (3 days).

or

Malathion 5 EC, 2 pt (7 days).

or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). or

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Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

or

- Permethrin
- --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

Monitor 4 EC, 1 pt (14 days) (RUP).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

- Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt, (7 days). Do not exceed more
- than 3 applications per season.

Dibrom 8 EC, 1 pt (1 day).

or

or

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Diamondback moth, apply treatments when worms are first seen and repeat as needed.

*Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

- or
 - Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.
- or

or

- Malathion 5 EC, 2 pt (7 days).
- Sevin XLR Plus, 1 to 2 qt (3 days).
- or
 - Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).
- or Permethrin
 - --*Pounce* 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

--*Ambush* 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

- Monitor 4 EC, 1 pt (14 days) (RUP). or
 - Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).
- or
 - *Guthion* Solupak 50 WP, 1 to 1 1/2 lb or 2L (RUP), 2 to 3 pt (7 days). Do not exceed more than 3 applications per season.

or

Dibrom 8 EC, 1 pt (1 day). **Cabbage loopers**, apply treatments when worms

controls are less effective on larger worms.

*Lannate 1.8 L, 4 pt or 90 SP, 1 lb (3 days) (RUP).

are first seen and repeat as needed. Most

or *Permethrin

- --*Ambush* 2 EC, 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 oz or 25 WP, 3.2 to 6.4 oz (1day) (RUP).

or

**Monitor* 4 EC, 1 pt (14 days); 2 pt (21 days) (RUP).

or

Brussels Sprouts to Cabbage

**Orthene* 75 S, 1 1/3 lb (14 days). Consult label for further restrictions.

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.

or

Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (7 days). Do not exceed more than 3 applications per season.

or

Dibrom 8 EC, 2 pt (1 day).

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply when they first appear to prevent later infestations on edible parts.

Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Consult label for restrictions.

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

or

Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (10 days). Maximum of 3 applications.

or

Dibrom 8 EC, 1 pt (1 day).

or Monitor 4 EC, 1 pt (14 days) (RUP).

or

Malathion 5 EC, 2 pt (7 days).

DISEASES

Black rot (*Xanthomonas campestris*) apply treatment (lowest rate) in transplant beds and start weekly treatments in fields as soon as transplants are established.

Kocide DF, 2 lb (0 days).

Black leg (Phoma lingam).

There are presently no chemicals registered for use on this disease.

Alternaria leaf spot (Alternaria brassicae), apply when conditions favor disease development and repeat every 7 to 10 days.

Manex 4 F, 1 1/5 to 1 3/5 qt (7 days).

or

or

or

Maneb 80 W, 1 1/2 to 2 lb (7 days).

Maneb + *zinc* F 4, $1 \frac{1}{5}$ to $1 \frac{3}{5}$ qt (7 days).

Bravo 7206 F, 1 1/2 pt (0 days).

or

Bravo 90 DG, 1 1/4 lb.

Terranil 6 L, 1 1/2 pt (0 days).

Downy mildew (*Peronospora parasitica*), apply when conditions favor disease development and repeat every 7 to 21 days.

Aliette 80 W, 2 to 5 lb (3 days). **Note**: Do not tank mix with copper fungicides.

Note: Fungicides that protect against *Alternaria* also provide limited downy mildew protection.

White Mold (Sclerotinia sclerotiorium).

There are presently no chemicals registered for use on this disease.

CABBAGE

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Sugar beet cyst, northern root-knot and rootlesion nematodes can reduce cabbage yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plantparasitic nematodes are present in population densities above the economic threshold for cabbage, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of sugar beet cyst, root-knot and lesion nematodes in cabbage production. It is best not to plant cabbage on land infested with sugar beet cyst nematodes.

FALL SOIL FUMIGATION (Broadcast)
Nematodes

1.3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

PREPLANT SOIL TREATMENT

Nematodes

Mocap 6 EC, 3.3 qt or 10 G, 50 lb, applied prior to one week before planting and incorporated to a depth of 3 inches (incorporate 6 EC immediately) (RUP).

or

Nemacur 15 G, 35 lb, broadcast and incorporated to a depth of 2 to 6 inches.

DIL TREATMENT AT PLANTING

<u>Nematodes</u>

Phenamiphos (*Nemacur*) 15 G, 15 lb for 36 inch rows. Apply in a 12- to 15-inch band and incorporate 2 to 6 inches. Planting time application only. May be used on seeded or transplanted cabbage.

or

Mocap 6 EC, 1.3 to 2 qt (36 in. row spacing) or 10 G, 20 lb (36 in. row spacing) applied in a 12- to 15-inch band over the row. Do not allow material to contact the seed (RUP).

SEED TREATMENT

DISEASES

Damping off, wire stem (*Pythium* spp., *Rhizoctonia solani*).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

or

Captan 75 W, 1 oz/100 lb seed.

or

Captan 30-DD, 1 1/4 oz/100 lb seed.

Captan 300, 1 1/4 oz/100 lb seed.

or or

Captan 400, 1 to 2 oz/100 lb seed.

Captan 400-D, 1 to 2 oz/100 lb seed.

Captan 75%, 1 oz/100 lb seed.

42-S Thiram, 8 oz/100 lb seed.

Anchor, 1.5 oz/100 lb seed (*Pythium* only).

Black leg (Phoma lingam).

There are presently no chemicals registered for use on this disease.

SEEDBED TREATMENT

Apply treatments to soil according to directions to protect young seedlings in the seedbed before transplanting in field.

INSECTS

or

or

Cabbage maggot, apply to seedbed surface and incorporate to 3 to 4 inches.

Diazinon 14 G, 21 lb or 4 EC, 3 qt (RUP). Apply only as directed.

DISEASES

Clubroot (*Plasmodiophora brassicae*), sterilize seedbed before planting (p. 95) or apply to soil surface as a drench.

Terraclor 10 G. Row application: apply 200 lb in a 12 to 15 inch band by means of a suitable applicator and rototil to a depth of 4 to 6 inches. Broadcast application: apply 300 lb, disc and cross disc to depth of 4 to 6 inches.

or

Terraclor 75 W, 30 lb. Band application: apply in 25 gal water; spray as a 12 to 15 inch band centered on the row and incorporate to a depth of 4 to 6 inches. Broadcast application: apply 40 lb in 30 gal water; thoroughly incorporate to a depth of 4 to 6 inches.

Damping off (*Pythium* spp.) and **basal stem rot** (*Phytophthora* spp.).

Ridomil 2 E, apply 4 to 8 pt (1 to 2 pt *Pythium* only). Band application: apply in a 7 inch band. Broadcast soil application: incorporate in top 2 inches of soil.

Wire Stem or Black Root (Corticium solani).

Terraclor 75 W. Broadcast drench: apply 15 to 20 lb in 50 gal water.

or

Cabbage

Row drench treatment: apply 10 to 15 lb in 35 gal spray as an 8 inch band centered on the row.

PLANTING TREATMENT

Treatments applied at seeding.

INSECTS

Cabbage maggot, apply in a 4-inch band over row at time of seeding.

Lorsban 15 G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row. Use only as directed.

or

Dyfonate II 10 G, 40 lb or 15 G, 27 lb broadcast prior to planting (or band with proportion-ate reduction in rate) (RUP).

Aphids and flea beetles, apply as band on each side of seed row or transplant row at time of seeding or sidedressed after plants become established. Treatments applied at seeding or transplanting are translocated into foliage systemically.

Di-Syston 15 G, 7.4 oz/1,000 ft or 8 E, 1.1 fl oz/1,000 ft (42 days) (RUP). Use only as directed.

TRANSPLANT WATER TREATMENT

Treatments are applied in water around roots at time plants are set in field. **Note**: Treatment rates are given in amount of formulation per 100 gal of water. Apply at rate of 1 cup solution per plant. Frequent agitation is needed with wettable powders.

INSECTS

Cabbage maggot.

Diazinon 50 WP, 1 1b/100 gal or AG 500, 1/2 to 1 pt/100 gal (RUP). Use only as directed.

or Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

DISEASES

Clubroot (Plasmodiophora brassicae).

Terraclor 75 W, 2 to 6 lb. For best results use with disease free (clubroot) seedlings. Use only as directed. Use 1/2 to 3/4 pt solution per plant.

Damping off (*Pythium* spp.) **and basal stem rot**. (*Phytophthora* spp.).

Ridomil 2 E. Apply 4 to 8 pt. If natural rainfall is not expected before the seeds start germinating, *Ridomil* 2E should be incorporated mechanically before planting or be moved into the seed zone after planting with a 1/2 to 1 inch sprinkler irrigation.

SOIL TREATMENT AFTER TRANSPLANTING

Apply to the soil at base of plants after transplanting. Apply water to wet soil surface.

INSECTS

Cabbage maggot.

Dyfonate 4 EC, 1 to 2 qt (RUP).

or

Lorsban 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row. or

Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt, in 50 gal of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply as needed soon after plants come up.

Ammo 2.5 EC, 2 1/2 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

or

or

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1/2 to 1 qt (3 days).

or Asana XL, 5.8 (3 days) (RUP).

or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). or

Penncap-M 2 F, 2 to 4 pt (21 days) (RUP).

Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

or

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days)

Cutworms, apply when damage is first seen. Repeat as needed. *Ammo 2.5 EC, 2 1/2 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).

*Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP).

or

- * Asana XL, 5.8 to 9.6 oz (3 days) (RUP). or
- *Lorsban* 4 E, 1 qt or 50 W, 2 lb (21 days). or
 - Endosulfan (*Thiodan*) 3 EC, 2 2/3 pt or 50 WP, 2 lb (7 days). Consult label for rotation restrictions.

Imported cabbageworm, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms.

*Ammo 2.5 EC, 2 1/2 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).

or

Pay-off 2.5 EC, 1.3 to 2 oz (3 days) (RUP). Do not apply more than 16 oz per season.

or

- Permethrin
- --*Ambush* 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days). or
- Asana XL, 2.9 to 5.8 oz (3 days) (RUP).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP). or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days).

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 l/2 lb (7 days). Consult label for rotation restrictions.

or

Carbaryl (Sevin) 80 S, 1 1/2 lb or XLR Plus, 1 to 2 qt (3 days).

or

Monitor 4 EC, 1 pt (35 days) (RUP). Includes tight-heading varieties of chinese cabbage only, not loose-heading varieties such as bok choy.

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or
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- Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).
- or
 - *Guthion* Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 pt (21 days). Do not exceed more than 3 applications per season.

Penncap-M 2 F, 4 to 6 pt (21 days) (RUP).

Dibrom 8 EC, 1 pt (1 day).

or

Malathion 5 EC, 2 pt (7 days).

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Diamondback moth, apply treatments when worms are first seen and repeat as needed.

*Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

or

or

- Ammo 2.5 EC, 2 1/2 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).
- or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

or

Pay-off 2.5 EC, 1.3 to 2 oz (3 days) (RUP). Do not apply more than 16 oz per season.

or Permethrin

- --*Pounce* 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --*Ambush* 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- or

Lannate 1.8 L, 2 pt or 90 SP, 1 1/2 lb (1 day) (RUP).

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days). or

Sevin XLR Plus, 1 to 2 qt (3 days).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Monitor 4 EC, 1 pt (35 days) (RUP). Includes tight-heading varieties of chinese cabbage only, not loose-heading varieties such as bok choy.

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

or

- *Guthion* Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (21 days). Do not exceed more than 3 applications per season.
- or

Penncap-M 2 F, 2 to 4 pt (21 days) (RUP).

or

Dibrom 8 EC, 1 pt (1 day).

Cabbage loopers, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms.

Ammo 2.5 EC, 3 3/4 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).

or

Cabbage

Permethrin

- --Ambush 2 EC, 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

- Asana XL, 5.8 to 9.6 oz (3 days) (RUP).
- Lannate 1.8 L, 4 pt or 90 SP, 1 lb (1 day) (RUP).

Larvin (thiodicarb) 3.2 EC, 24 to 40 oz (7 days). or

Monitor 4 EC, 2 pt (35 days) (RUP). Includes tight-heading varieties of chinese cabbage only, not loose-heading varieties such as bok choy.

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

or

Dibrom 8 EC, 2 pt (1 day).

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply if necessary to prevent damage or infestations on edible parts.

Dimethoate (*Cygon*) 4 EC, 1 pt (3 days). or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (7 days). Consult label for rotation restrictions.

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

or

or Dibrom 8 EC, 1 pt (1 day).

or

Monitor 4 EC, 1 pt (35 days) (RUP). Includes tight-heading varieties of chinese cabbage only, not loose-heading varieties such as bok choy.

or

Malathion 5 EC, 2 pt (7 days).

Thrips.

*Ammo 2.5 EC, 3 3/4 to 5 oz or WSB, 1 to 2 bags (1 day) (RUP).

or Methyl parathion, 7.5 EC, 1 to 1 1/2 pt (21 days).

Slugs.

Metaldehyde 2.75% bait, 70 to 72.5 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Black rot, (*Xanthomonas campestris*) apply treatment (lowest rate) in transplant beds and start weekly treatments in the field as soon as transplants are established.

Copper sulfate 53 W, 1 to 3 lb (0 days).

or

Copper oxide 80 W, 1 1/2 to 3 lb (0 days). or

Kocide DF, 0.5 to 1 lb (0 days).

or

Champ F, 2 2/3 pt (0 days). (Flecking of wrapper leaves may occur).

or

Champ Formula 2 Copper, 1/3 to 2/3 pt (0 days). (Flecking of wrapper leaves may occur.)

or

Kocide LF, 2 2/3 pt (0 days).

Alternaria leaf spot (Alternaria brassicae) apply when conditions favor diseas development and repeat every 7 to 10 days.

*Manex 4 F, 1 1/5 to 1 3/5 qt (7 days).

or

*Maneb 80 W, 1 1/2 to 2 lb (7 days).

or *Maneb + zinc F4, 1 1/5 to 1 3/5 qt (7 days).

or *Terranil 6 L, 1 1/2 pt (0 days).

or

*Bravo 720, 1 1/2 pt (0 days).

or *Bravo 90 DG, 1 1/4 lb (0 days).

or

Kocide DF, 2 lb (0 days).

or Champ F, 2 2/3 pt (0 days). (Flecking of wrapper leaves may occur).

or

Kocide LF, 2 2/3 pt (0 days).

White mold (Sclerotinia spp.).

There are presently no chemicals registered for use on this disease.

Downy mildew (*Peronospora parasitica*), apply when disease first appears and repeat every 1 days.

*Metasystox-*R 2 SC, 1 1/2 to 3 pt (7 days). Maximum of 3 applications.

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (7 days). Apply at 7 to 21 day intervals.

or

Aliette 80 W, 2 to 5 lb (3 days). **Note**: Do not tank mix with copper fungicides.

or

Aliette WDG, 2 to 5 lb (3 days). Note: Do not tank mix with copper fungicides.

Note: Fungicides that protect against *Alternaria* also provide limited downy mildew protection.

CARROTS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

EMATODES

Northern root-knot, pin and carrot cyst nematodes severely reduce carrot quality and yields. Crop rotation is an essential part of nematode management in carrot production in Michigan. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plantparasitic nematodes are present, crop rotation application of a nematicide will be or recommended. The following nematicides are suitable for control of root-knot nematodes in carrot production. Nematicide failures have been observed with increasing frequency in sites with very high population densities, or where the carrot cyst nematode is the major problem.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a i-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations, soil fumigants can be applied in the spring in Michigan.

Metham (*Busan* 1020 or *Vapam*) 75 to 100 gal (muck soil) injected with shanks spaced 5 inches apart or to a depth of 4 to 10 inches in well prepared soil. If shanked, roll and irrigate treated surface to prevent escape of gas.

PREPLANT TREATMENT

NEMATODES

Vydate 2 L, Broadcast, apply 2 to 4 gal in a minimum of 20 gal of water as a broadcast treatment. Apply within one week of planting and thoroughly incorporate to a depth of 4 to 6 inches.

PLANTING TREATMENT

NEMATODES

Vydate 2 L, in-row, apply 1 to 2 gal in a minimum of 20 gal of water in the seed furrow at planting.

POST-PLANT TREATMENT

NEMATODES

No nematicides are registered; however, it has been shown that the *Vydate* L carrot weevil larvae recommendation also provides some control of northern root-knot nematode.

INSECTS

Wireworms, may be found in grassy or weedy fields. If wireworms are present, apply evenly to the soil surface and incorporate 4 to 6 inches deep prior to planting.

Diazinon 14 G, 28 lb or 4 EC, 4 qt for muck soils (RUP). Preplant soil application only.

DISEASES

Damping Off, Root Forking and Stubbing (*Pythium* spp.).

Ridomil 2 E, 4 - 8 pt in a minimum of 20 gal water in a 7 inch band over the row.

SEED TREATMENT

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

or

Captan 75 SP, 6 oz/100 lb seed.

Use only as directed; overtreatment may cause injury.

FOLIAR TREATMENT

INSECTS

Cutworms, apply when cutworms are first seen.

*Asana XL, 5.8 to 9.6 oz (7 days) (RUP). Ground application only.

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP).

Carrot weevil adults, apply early in the spring when adults are first detected. Repeat weekly as needed.

*Asana XL, 9.6 oz (7 days) (RUP). Ground application only.

or

Malathion 5 EC, 2 1/2 pt (7 days).

Carrot weevil larvae, apply when larvae are first seen or 3 to 5 days after appearance of first eggs. Repeat in 2 to 3 weeks, up to 3 applications.

Vydate L, 4 pt (14 days). (Special Michigan SLN label.)

Leafhoppers (aster yellows), treat fields when plants are coming up. Repeat as needed (every 3 to 6 days) depending on the number of leafhoppers.

*Asana XL, 5.8 to 9.6 oz (7 days) (RUP). Ground application only.

or

Carbaryl (Sevin) 80 S, 1 1/4 lb (0 days).

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 2/3 to 1 1/3 qt or 50 WP, 1 to 2 lb (7 days) (RUP). (Only 1 application per year.)

or

or

Methyl parathion 7.5 EC, 3/4 to 1 pt (15 days). or

Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (1 day) (RUP).

Malathion 5 EC, 2 1/2 pt (7 days).

Aphids, apply when they appear.

Methyl parathion 7.5 EC, 3/4 to 1 pt (15 days) or

Diazinon 4 EC, 1 pt (10 days) (RUP).

or Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2/3 to 1 1/3 qt or 50 WP, 1 to 2 lb (7 days) (RUP). (Only 1 application per year.)

or

Malathion 5 EC, 1 1/4 pt (7 days).

DISEASES

Alternaria leaf spot (*Alternaria dauci*), apply every 7 to 10 days after emergence.

Rovral 50 W, 1 to 2 lb (0 days). See label for permissible rotation crops.

or

Rovral 4 F, 1 to 2 pt (0 days). See label for permissible rotation crops.

or

Bravo 720, 1/2 to 2 pt (0 days). May be used through irrigation equipment.

or

Terranil 6 L, 1 1/2 to 2 pt (0 days).

White mold (*Sclerotinia sclerotiorum*), apply when disease first appears and repeat every 7 10 days.

Benlate 50 W, 1/4 to 1 lb (4 days).

Cercospora leaf spot (*Cercospora carotae*) apply every 7 to 10 days after emergence.

Bravo 720, 1 1/2 to 2 pt (0 days).

or

Terranil 6 L , 1 1/2 to 2 pt (0 days).

or Kocide DF, 2 lb (0 days).

or

Kocide 606, 2 2/3 pt (0 days).

Bacterial blights (*Xanthomonas carotae*), apply every 7 to 10 days after first appearance.

Copper sulfate 53 W, 2 to 4 lb (0 days).

Kocide 101 50 W, 2 lb (0 days).

or

or

Copper oxide 80 W, $1 \frac{1}{2}$ to 3 lb (0 days).

or

Champ 2 Copper 37.5% F, 2 2/3 pt (0 days).

Cavity spot (*Pythium violae*), apply 2 to 4 times at 14-day intervals beginning 40-50 day following Ridomil 2E at-planting treatment (above).

Ridomil/Copper 70 W, 2 lb (7 days).

CAULIFLOWER

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Sugar beet cyst, root-knot and lesion nematodes can reduce cauliflower yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for cauliflower, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for introl of sugar beet cyst, root-knot and lesion matodes in cauliflower production.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

- 1,3-D
- --*Telone* II, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some situations soil fumigation can be applied in the spring in Michigan.

SEED TREATMENT

DISEASES

Damping off, wire stem (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

or

Captan 75 W, 1 oz/100 lb seed.

or

Captan 30-DD, 1 1/4 oz/100 lb seed. or

Captan 300, 1 1/4 oz/100 lb seed.

Captan 400, 1 to 2 oz/100 lb seed.

Captan 400-D, 1 to 2 oz/100 lb seed.

Captan 75%, 4 oz/100 lb seed.

42-S Thiram, 8 oz/100 lb seed.

or

or

or

or

or

Anchor, 1.5 oz/100 lb seed (Pythium only).

Black leg (Phoma lingam).

There are presently no chemicals registered for use on this disease.

SEEDBED TREATMENT

Apply treatments to the soil according to directions to protect young seedlings in the seedbed before transplanting in field.

INSECTS

Cabbage maggot, apply equivalent amount to seedbed surface and incorporate to 3 to 4 inches.

Diazinon 14 G, 21 lb or 4 EC, 3 qt (RUP). Apply only as directed.

DISEASES

Clubroot (*Plasmodiophora brassicae*), sterilize seedbed before planting (p. 95) or apply to soil surface as a drench.

Terraclor 10 G. Row application: apply 200 lb in a 12- to 15-inch band by means of a suitable applicator and rototil to a depth of 4 to 6 inches. Broadcast application: apply 300 lb, disc and cross disc to depth of 4 to 6 inches.

or

Terraclor 75 W. Band application: apply 30 lb as a band application in 25 gal water; spray as 12- to 15-inch band centered on the row and incorporate to a depth of 4 to 6 inches. Broadcast application: apply 40 lb in 30 gal water; thoroughly incorporate to a depth of 4 to 6 inches.

Wire Stem or Black Root (Corticium solani).

Terraclor 75 W. Broadcast drench: apply 15 to 20 lb in 50 gal water. Row drench treatment: apply 10 to 15 lb in 35 gal spray as an 8 inch band centered on the row.

Damping off (*Pythium* spp.), apply prior to planting as a broadcast spray.

Ridomil 2 E, 2 to 4 pt in 50 gal of water.

PLANTING TREATMENT

Treatments applied at seeding.

INSECTS

Cabbage maggot, apply in a 4 inch band over row at time of seeding.

Lorsban 15 G, 4.6 to 9.2 oz or 4 EC, 1.6 to 2.4 fl oz/1,000 ft of row.

or

Dyfonate II 10 G, 40 lb or 15 G, 27 lb broadcast prior to planting (or band with proportionate reduction in rate) (RUP).

Aphids and flea beetles, apply as a band on each side of seed row or transplant row at the time of planting or sidedressed after plants are established. Treatments applied at seeding or transplanting are translocated into foliage systemically.

Di-Syston 15 G, 7.4 oz/1,000 ft or 8 E, 1.1 fl oz/1,000 ft (40 days) (RUP). Use only as directed.

TRANSPLANT WATER TREATMENT

Treatments are applied in water around roots at time plants are being set in the field. **Note:** Treatment rates are given in the amount of formulation per 100 gals of water. Apply at rate of 1 cup solution/plant. Frequent agitation is needed with wettable powders.

INSECTS

Cabbage maggot.

Diazinon 50 WP, 1 lb/100 gal or AG 500, 1/2 to 1 pt/100 gal (RUP). Use only as directed.

or

Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt in 50 gallons of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

DISEASES

Clubroot (Plasmodiophora brassicae).

Terraclor 75 W, 2 to 6 lb. For best results, use with disease free (clubroot) seedlings. Use only as directed.

SOIL TREATMENT AFTER TRANSPLANTING

Apply to the soil at base of plants after transplanting. Apply water to wet soil surface.

INSECTS

Cabbage maggot.

Dyfonate 4 EC, 1 to 2 qt (RUP).

or Lorsban 4 EC, 1.6 to 2.75 fl oz/1,000 ft of row. or

Guthion Solupak 50 WP, 1/4 to 3/8 lb or 2 L (RUP), 3 pt in 50 gallons of water. Apply 4 to 6 oz of solution per plant at or immediately after planting.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply as needed soon after plants come up.

Endosulfan (Thiodan) 3 EC, 2 pt or 50 WP, 1

1/2 lb (14 days). Consult label for rotation restrictions.

or

Asana XL, 5.8 oz (3 days) (RUP).

or

or

Lorsban 4 E, 1 gt or 50 W, 2 lb (21 days).

Methyl parathion 7.5 EC, 1 to $1 \frac{1}{2}$ pt (21 days).

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days).

Cutworms, apply when damage is first seen. Repeat as needed.

*Permethrin

--Ambush 2 EC, 6.4 oz (1 day) (RUP).

--Pounce 3.2 EC, 4 oz (1 day) (RUP).

or

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP). or

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days).

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or
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Endosulfan (*Thiodan*) 3 EC, 2 2/3 pt or 50 WP, 2 lb (14 days). Consult label for rotation restrictions.

or

Lannate 1.8 L, 2 pt, or 90 SP, 1/2 lb (3 days) (RUP).

Imported cabbageworm, apply treatments where worms are first seen and repeat as needed. Most controls are less effective on larger worms.

Endosulfan (Thiodan) 3 EC, 2 pt or 50 WP, 1

1/2 lb (14 days). Consult label for rotation restrictions. or Orthene 75 S, 1 1/3 lb (14 days). Consult label for restrictions. or Carbaryl (Sevin) 80 S, 1 1/2 lb (3 days). or Permethrin --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP). --Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to or 6.4 oz (1 day) (RUP). or Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP). or Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days). or Lorsban 4 E, 1 gt or 50 W, 2 lb (21 days). or Asana XL, 2.9 to 5.8 oz (3 days) (RUP). or Monitor 4 EC, 1 pt (14 days) (RUP). or Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP). Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (15 days). Do not exceed more than 3 applications per season. or *Dibrom* 8 EC, 1 pt (1 day). or Malathion 5 EC, 2 pt (7 days). or **Bacillus** thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days). **Diamondback moth**, apply treatments when worms are first seen and repeat as needed. *Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days). or Permethrin --Ambush 2 EC, 3.2 to 6.4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP). --Pounce 3.2 EC, 2 to 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP). or Endosulfan (Thiodan) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions. Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (**RUP**).

or

Larvin (thiodicarb) 3.2 EC, 16 to 32 oz (7 days).

or

Monitor 4 EC, 1 pt (14 days) (RUP).

- or,
 - Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP).

or

Dibrom 8 EC, 1 pt (1 day).

Cabbage loopers, apply treatments when worms are first seen and repeat as needed. Most controls are less effective on larger worms.

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Permethrin
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- --Pounce 3.2 EC, 4 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Ambush 2 EC, 6.4 or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

- Lannate 1.8 L, 4 pt or 90 SP, 1 lb (3 days) (RUP).
- or

or

Larvin (thiodicarb) 3.2 EC, 24 to 40 oz (7 days).

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or Monitor 4 EC, 2 pt (14 days) (RUP).

- or
 - *Orthene* 75 S, 1 1/3 lb (14 days). Consult label for restrictions.

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.

or

or

Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (15 days). Do not exceed more than 3 applications per season.

Dibrom 8 EC, 2 pt (1 day).

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply when they first appear to prevent later infestations on edible parts.

Dimethoate (Cygon) 4 EC, 1 pt (7 days).

or

Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Consult label for restrictions.

or

Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for rotation restrictions.

or

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (5 days) (RUP).

Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

Cauliflower to Celery

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (7 days).

or

Dibrom 8 EC, 1 pt (1 day).

or

Monitor 4 EC, 1 pt (14 days) (RUP).

DISEASES

Black rot (*Xanthomonas campestris*), apply treatment (lowest rates) in transplant beds and start weekly treatments in the field as soon as transplants are established.

Copper sulfate 53 W, 2 to 4 lb (0 days). or

Kocide DF, 2 lb (0 days).

or

Kocide LF, 2 2/3 pt (0 days).

Alternaria leaf spot (*Alternaria brassicae*), apply when conditions favor disease and repeat every 7 to 10 days.

Manex 4 F, 1 1/5 to 1 3/5 qt (7 days).

or Maneb 80 W, 1 1/2 to 2 lb (7 days).

or

Maneb + zinc F4, 1 1/5 to 1 3/5 qt (7 days). Apply at 7- to 21-day intervals.

or

Bravo 720 4 F, 1 1/2 pt (0 days).

or

Terranil 6 L, $1 \frac{1}{2}$ pt (0 days).

Downy mildew (*Peronospora parasitica*), apply when conditions favor disease.

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (7 days). Apply at 7 to 14 day intervals.

or

Apply at 7- to 21-day intervals. **Note**: Do not tank mix with copper fungicides.

Aliette 80 W, 2 to 5 lb (3 days).

or

Aliette WDG, 2 to 5 lb (3 days).

Note: Fungicides that protect against *Alternaria* also provide limited downy mildew protection.

CELERY

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide. *Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Root-knot, pin, needle and root-lesion nematodes can reduce celery yields. Fields with root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for celery, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of root-knot, pin, needle and lesion nematodes in celery production. Nematode-free transplants must be used to prevent serious losses.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures a $\frac{1}{100}$ 6-inch depth are above 50°F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

Metham (*Busan* 1020 or *Vapam*) 75 to 100 gal. injected with shanks spaced 5 inches apart or to a depth of 4-10 inches in well prepared soil. If shanked, roll and irrigate treated surface to prevent escape of gas.

SEED TREATMENT

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

No fungicides are presently labeled for this use. Use seed 2 years old or older or soak new seed in hot water (118°F) for 30 minutes and dry at room temperature. Do not exceed temperature limits or extend time of treatment. See seedby treatment.

SEEDBED TREATMENT

ISEASES

Damping off (*Pythium* spp., *Rhizoctonia solani*), seedbed sterilization before planting is essential for the production of healthy seedlings (see p. 95.)

COC5 89 WDG, 2 oz per 3 gal water. Spray plants and surrounding soil lightly but thoroughtly as soon as seedlings have emerged.

SOIL TREATMENT

INSECTS

Wireworms and cutworms, apply to soil surface and incorporate to 4 inches before planting if needed.

FOLIAR TREATMENT

INSECTS

tworms, apply as needed.

- *Permethrin
- --*Ambush* 2 EC, 6.4 to 12.8 oz (3 days) (RUP). --*Pounce* 3.2 EC, 4 to 8 oz (3 days) (RUP).
- or
 - Lannate 1.8 L, 4 pt or 90 SP, 1 lb (7 days) (RUP).

Carrot weevil larvae, apply as a directed spray. Start when eggs or larvae are first seen and continue treatments as needed, 2 to 3 weeks apart (maximum of 3 treatments).

Vydate 2 L, 4 pt (14 days). May also be used for nematode control at same rate.

Carrot weevil adults, apply when adults are first caught in traps or eggs are first seen.

No materials are labeled specifically for this area, however, permethrin or Guthion at the rates given below will give some control of carrot weevil adults.

Aster leafhopper (aster yellows), apply when leafhoppers are first detected. Repeat as needed, pending on number of leafhoppers.

*Permethrin

--*Ambush* 2 EC, 6.4 oz to 12.8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

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--Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
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or

Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (7days) (RUP).

or

or

Sevin 80 S, 1 1/4 to 1 7/8 lb or XLR Plus, 1 to 1 1/2 qt (14 days).

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (14 days). Do not exceed more than 3 applications per season.

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

Tarnished plant bug, apply as needed.

Sevin 80 S, 1 1/2 to 2 1/2 lb or XLR Plus, 1 to 2 qt (14 days).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (14 days). Do not exceed more than 3 applications per season.

Aphids, apply as needed (over-treatment with permethrin or Guthion may cause increased aphid problems).

Orthene 75 S, 2/3 to 1 1/3 lb (21 days). Consult label for restrictions.

or

- Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days). or
 - Diazinon 8 EC, 1 pt or 50 WP, 1 lb (10 days) (RUP). Do not use tops for food or feed.

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 1 1/3 to 2 2/3 pt or 50 WP, 1 to 2 lb (4 days, limited to 1 application per year).

or

Dibrom 8 EC, 1 pt (1 day). Ground application only.

or

Malathion 5 EC, 1 1/2 pt (7 days).

Pyrenone, 2 to 12 oz (0 days).

or

or

Pyrellin EC, 1 to 2 pt (0 days).

Loopers (celery and cabbage), apply when first seen. Continue as needed to prevent damage to plants.

*Permethrin

- --*Ambush* 2 EC, 6.4 oz to 12.8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
- --*Pounce* (3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

or

Diazinon 14 G, 28 lb or 4 EC, 4 qt for muck soils; 14 G, 21 lb or 4 EC, 3 qt for mineral soils (RUP). Preplant treatment only.

Celery to Sweet Corn

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 2/3 pt or 50 WP, 2 lb (4 days, limited to 1 application per year).

or

Lannate 1.8 L, 4 pt or 90 SP, 1 lb (7 days) (RUP).

or

Guthion Solupak 50 WP, 1 lb or 35 WP, 1 3/8 lb or 2 L (RUP), 2 pt (14 days). Do not exceed more than 3 applications per season.

or

Orthene 75 S, 1 1/3 lb (21 days). Consult label for further restrictions.

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

or

Pyrenone, 2 to 12 oz (0 days).

or

Pyrellin EC, 1 to 2 pt (0 days).

Vegetable leafminer, apply as soon as visible mines appear and repeat every 7 days as needed.

Trigard 75 WP, 1/6 lb (7 days). Aerial application only.

DISEASES

Rhizoctonia stalk rot (*Rhizoctonia solani*), **and pink rot** (*Sclerotinia sclerotiorum*), apply as a basal spray after each cultivation.

Bravo 720 4F, 2 to 3 pt (7 days).

Early blight (*Cercospora apii*) treat every 7 to 10 days beginning after transplanting.

Bravo 7204 F, 1 1/2 to 2 pt (7 days).

or

Terranil 6 L, 1 1/2 to 3 pt (0 days).

or

Tilt 3.6 EC, 4 fl oz (14 days), maximum of four applications per season.

or

Benlate 50 W, 1/4 to 1/2 lb (7 days).

or

Benlate 50 DF, 1/4 to 1/2 lb (7 days).

or

Topsin-M 4.5 F, 10 oz (7 days).

Late blight (*Septoria apii*), treat every 7 to 10 days, beginning after transplanting.

Bravo 720 4 F, 1 1/2 to 2 pt (7 days). or

Tilt 3.6 EC, 4 fl oz (14 days), maximum of four applications per season.

or

Terranil 6 L, 1 1/2 to 3 pt (7 days).

or

or

Benlate 50 W, 1/4 to 1/2 lb (7 days).

Topsin-M 4.5 F, 10 oz (7 days).

Bacterial blight (*Pseudomonas apii*), treat every 7 to 10 days, beginning after transplanting.

Copper sulfate 53 W, 2 to 4 lb (0 days).

Kocide DF, 2 lb (0 days).



Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Root-lesion, stunt, stubby-root, lance and dagger nematodes can reduce sweet corn yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for sweet corn, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of root-lesion, lance, stunt, dagger and stubby-root in sweet corn production.

FALL SOIL FUMIGATION

NEMATODES

1,**3**-D

Telone II, 10 gal broadcast for mineral soil.

or Telone II, 3 gal in-row for mineral soil.

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use fumigants only as directed on the label. Extension Bulletin E-1025b for details about soil fumigation. In some limited situations, soil

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migants can be applied in the spring in chigan.

PREPLANT NEMATICIDE TREATMENT (Broadcast).

NEMATODES

Mocap 10 G, apply 60 lbs from 3 days before planting to at planting time and incorporate to 2 to 4 inches (RUP).

or

Mocap 6 EC, 1 gal (3 oz/1,000 sq ft) (RUP). Preplant treatment only.

PREPLANT NEMATICIDE TREATMENT (Inrow)

NEMATODES

Mocap 10 G, apply 1 1/8 - 1 1/2 lb per 1,000 feet of row in a 12- to 15-inch band on the row at time of planting. Mix with top 2 to 4 inches of soil immediately after application. Rate per acre dependent on row spacing (RUP).

locap 6 EC, 1 to 1 1/3 qt (40 inch rows) (RUP). Must not contact seed.

INSECTS

Wireworms, broadcast evenly on soil surface and incorporate to 4 to 6 inches or band over the row at planting at reduced rate. **Note**: Consult the labels for other uses of these materials.

Diazinon 14 G, 28 lb or 4 EC, 4 qt (RUP).

or

Dyfonate II 10 G, 40 lb; 15 G, 27 lb; 20 G, 20 lb. or

Dyfonate 4 EC, 4 qt (RUP).

or

Mocap 10 G, 40 lb (RUP).

or Counter 15 G, 8 to 16 oz/1,000 row ft, banded (RUP).

Seed corn maggot.

Counter 15 G, 8 oz/1,000 row ft, banded. Also controls wire worms and white grubs.

or

Thimet (phorate) 15 G, 8 oz/1000 row ft or 20 G, 6 oz/1000 row ft. Do not apply in-furrow. May help control flea beetles.

Corn rootworms are a problem only when rotation of crops is not practiced. Apply treatments in a band above seed at time of planting. Use special equipment for correct placement of granules. Consult label for other uses and directions.

- Thimet (phorate) 15 G, 8 oz/1000 row ft or 20 G, 6 oz/1000 row ft. Do not apply in-furrow. May help control flea beetles.
- *Counter* 15 G, 8 oz/1,000 row ft (RUP). May help control flea beetles.

Dyfonate II 10 G, 12 oz/1,000 row ft; 15 G, 8 oz/1000 row ft; or 20 G, 6 oz/1,000 row ft (RUP).

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or
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or

or

Mocap 10 G, 12 oz/1,000 row ft (RUP). or

Lorsban 15 G, 6 to 8 oz/1,000 ft of row.

SEED TREATMENT

Treatments applied to seed prior to planting. Insecticide and fungicide treatments can be combined according to directions.

INSECTS

Seed corn maggot.

Lorsban 50-SL, 2 oz/100 lb seed. Use as a slurry treatment.

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Captan 75 WP, 2 oz/100 lb seed.

or

or

or

or

or

or

- *Thiram* 50 WP, 3 oz/100 lb seed. Use as a slurry treatment.
- Apron 25 W, 1 to 2 oz/100 lb seed. (Pythium spp. only).

Captan 300, 3 1/4 oz/100 lb seed.

- Captan 30-DD, 3 1/4 oz/100 lb seed.
- or Captan 400, 2 to 4 oz/100 lb seed.
 - Captan 400-D, 2 to 4 oz/100 lb seed.
 - Captan 75%, 2 2/3 oz/100 lb seed.
- or
- 42-S'Thiram, 5 oz/100 lb seed. or
- Vitaflo 280, 4.5 oz/100 lb seed.
- or

or

Apron FL, 0.75 to 1.5 oz/100 lb seed (*Pythium* spp. only).

47

Anchor, 0.75 to 1.5 oz/100 lb seed (*Pythium* spp. only).

Systemic Downy Mildew.

Apron 25 W, 4 oz/100 lb seed.

Pythium and Rhizoctonia Seedling Disease Complex, Common Smut (Ustilago maydis).

Apron-Terraclor, 2 oz/bu. Do not use treated seed for food, feed or oil purposes.

Use only as directed; over-treatment may cause injury. If possible, buy insecticide-fungicide treated seed instead of treating seed on the farm.

PLANTING TREATMENT

DISEASES

Damping off (Pythium, Phytophthora and Rhizoctonia spp.).

Apron, 3 to 4 oz/100 lb seed (*Pythium* and *Phytophthora* spp. only).

or

Apron + Captan, 3 to 4 oz/100 lb seed.

FOLIAR TREATMENT

INSECTS

Cutworms, armyworm, apply when they appear. Repeat as needed.

*Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

or

*Permethrin

- --Ambush 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

Dylox 80 SP, 1 1/4 lb (0 days). Maximum of 3 applications.

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (0 days; 3 days if forage is fed to livestock) (RUP).

or

or

- Larvin 3.2 EC, 20 to 30 oz (0 days). Fresh market only. (Special Michigan label.)
- or Malathion 5 EC, 2 pt (5 days) (armyworm only).
- or Parathion 8 EC, 1/2 pt (12 days) (RUP). Aerial application only.

or Carbaryl (Sevin) 80 S, 2 lb (0 days). *Penncap-M* 2 F 4 pt (3 days). Do not apply during pollination.

Corn flea beetle, apply when damage is first seen, especially if Stewart's disease has been a problem.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 to 2 qt (0 days).

Diazinon 4 EC, 1 pt (0 days) (RUP).

or

or

Methoxychlor 50 WP, 2 lb (7 days).

or Permethrin

- --*Ambush* 2 EC, 6.4 oz or 25 WP, 3.2 oz (1 dav)(RUP).
- --Pounce 3.2 EC, 4 oz or 25 WP, 3.2 oz (1 day)(RUP).

or

Asana XL, 5.8 to 9.6 oz (1 day).

European corn borer, for **early season control**, prior to tasseling. Direct granules into corn whorls.

Lorsban 15 G, 6 to 8 oz/1,000 ft of row (35 days).

Dyfonate 20 G, 5 lb or 10 G, 10 lb (30 days)

(RUP).



or

or

or

or

Dipel 10 G, 12 1/4 oz/1,000 ft of row.

Pounce 1.5 G, 6.7 to 13.3 lb (1 day).

European corn borer, apply at 3- to 5-day intervals beginning at tassel stage.

*Permethrin

--Ambush 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

--Pounce 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP)

or

or

* Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

Furadan 4 F, 1 pt (7 days) (RUP). Machine harvest corn only. Do not make more than 4 applications in 1 season.

or

Carbaryl (*Sevin*) 80 S, 1 1/4 to 2 1/2 lb or XLR Plus, 1 1/2 to 2 qt (0 days).

or

- Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (0 days; 3 days if forage is fed to livestock) (RUP). or
 - Larvin 3.2 EC, 20 to 30 oz (0 days). Fresh market only. (Special Michigan label.)

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Penncap-M 2 F, 2 to 4 pt (3 days) (RUP). Do not apply during pollination.

Corn earworm, apply to silks when moths are active to prevent ear damage.

- --Ambush 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- or

* Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

or

- *Larvin 3.2 EC, 20 to 30 oz (0 days). Fresh market only. (Special Michigan label.) or
 - Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (0 days; 3 days if forage is fed to livestock) (RUP).

or

Endosulfan (*Thiodan*) 3 EC, 4 pt (1 day). Maximum of 3 applications. Do not use for processing corn. Do not feed forage to livestock.

or

[•] *Penncap-M* 2 F, 2 to 4 pt (3 days) (RUP).

or

Diazinon 4 EC, 1 pt (0 days) (RUP).

Corn rootworm adults, apply as needed to protect silks, when beetles are active and feeding on silks.

Carbaryl (Sevin) 80 S, 1 1/4 lb (0 days).

or

Malathion 5 EC, 1 1/2 pt or ULV, 4 oz (5 days). or

Diazinon 4 EC, 1 pt (0 days) (RUP).

or

- Permethrin
- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

or

Penncap-M 2 F, 1 to 2 pt (3 days) (RUP).

or

Metasystox-R 25 C, 2 pt (7 days for 1 application, 21 days for 3 applications).

brn leaf aphids, apply when populations start to build, prevents sooty mold on ears at harvest.

Diazinon 4 EC, 1 pt (0 days) (RUP).

Malathion 5 EC, 1 1/2 pt (5 days).

or Ender

Endosulfan (*Thiodan*) 3 EC, 2 2/3 pt (1 day). Maximum of 3applications. Do not use for processing corn. Do not feed forage to livestock.

or

Penncap-M 2 F, 2 pt (3 days) (RUP). Do not apply during pollination.

or

*Metasystox-*R 25 C, 1 1/2 to 2 pt (7 days for 1 application, 21 days for 2 or 3 applications).

DISEASES

Helminthosporium leaf blight (*Helminthosporium maydis*, *H. turcicum*), apply when conditions favor disease and repeat every 4 to 7 days.

Terranil 6 L, 3/4 to 2 pt (14 days).

or Bravo 720 6 F, 3/4 to 2 pt.

or

or

Bravo W 75, 1 1/2 to 2 lb (14 days).

Note: Do not apply to sweet corn to be processed. Do not allow livestock to feed on treated corn or graze in treated fields.

Apply at first sign of disease and repeat every 7 to 10 days.

Maneb 80 W, 1 1/2 lb.

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Maneb + *zinc* F4, 2 1/2 pt.

Apply at first sign of disease and repeat every 4 to 7 days.

Penncozeb, 1 1/2 lb (7 days).

or Penncozeb, 75 DF, 1 1/2 lb (7 days).

or Dithane M-45 80 W, 1 1/2 lb (7 days).

or

Dithane F-45 4 F, 1 1/5 qt (7 days).

Manex II 4 F, 1 1/5 qt (7 days).

or Manex 4 F, 1 1/5 qt (7 days).

or

or

Dithane 75 DF, 1 1/2 lb (7 days).

Manzate 200 DF, 1 1/2 lb (7 days).

Note: Do not feed treated forage to livestock.

Corn Rust (*Puccinia sorghi*), apply at first sign of disease at 4- to 7-day intervals.

^{*} Permethrin

Carbaryl (Sevin) 80 S, $1 \frac{1}{4}$ to $2 \frac{1}{2}$ lb or XLR Plus, 1 to 2 qt (0 days).

Sweet Corn to Cucumber

Terranil 6 L, 3/4 to 2 pt (14 days).

or

Bravo 720 6 F, 3/4 to 2 pt (14 days). Apply when conditions favor disease.

or

Dithane M-45 80W, 1 1/2 lb (7 days).

Dithane F-45 4 F, 1 1/5 qt (7 days).

or

or

Manex II 4 F, 1 1/5 qt (7 days).

or

Manex 4 F, 1 1/5 qt (7 days).

or Dithane 75 DF, 1 1/2 lb (7 days).

or

Manzate 200 DF, 1 1/2 lb (7 days).

Apply at first sign of disease and continue on a 7- to 14-day interval.

*Tilt, 4 oz (14 days).

CUCUMBER

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Root-knot and root-lesion nematodes can reduce cucumber yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for cucumber, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of root-knot and root-lesion nematodes in cucumber production. Recent observations indicate that cucumber planting the year following a chemigated (metham) potato crop may provide benefits to the cucumber crop.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D --*Telone II*, 15 gal (mineral soil). Fumigate in the fall when soil temperatures at 6-inch depth are above 50°F. Inject the fumigan, to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

SEEDBED PREPARATION

DISEASES

Damping off, root rots (Fusarium solani, F. cucurbitae, Pythium spp., Rhizoctonia solani), grow transplants in disease free soil (sterilized) and fumigate fields before planting. To sterilize soil, use steam or fumigate with chemicals suggested for seedbed sterilization on page 94. Follow manufacturer's recommendations for use with particular crops. Avoid planting until the soil is free of fumigant.

PREPLANT SOIL FUMIGATION

DISEASES

Fusarium wilt or root rots (Fusarium solani, r. cucurbitae, Rhizoctonia solani), this method protects plants grown from seed or transplanted in the field.

CHEMIGATION TREATMENT

See Bulletin E-2099.

Metham (Busan 1020 or Vapam) 75 to 100 gal.

SOIL INJECTION (BROADCAST)

Inject and seal soil surface by mechanical compaction or with water (irrigation).

Vapam, 75 to 100 gal.

PREPLANT NEMATICIDE TREATMENT (Inrow)

Mocap 10 G at 20 lbs/A (7-foot row spacing) or 3.2 lbs/1000 linear row feet in a band 12 to 15 inches on the row at or just before planting. Mix with top 2 to 4 inches of soil immediately after application. Do not allow granules to contact seed.

or

Mocap 6 EC at 1 1/3 qt/A (7-foot row spacing) or 6.8 fl oz/1000 linear feet of row in a band 5

12-15 in. wide on the row at or just before planting. Incorporate into top 2-4 in. immediately after application. Do not allow spray to contact the seed.

PREPLANT TREATMENT

INSECTS

Cucumber beetles.

*Furadan 4 F, 2.4 oz/1000 ft of row. Apply at planting or transplanting in a 7-inch band, incorporate into the top 3 inches of soil, or apply in furrow and mix with the covering soil. Use lower rate for short-season, machine-harvested cucumbers. (Special Michigan SLN label.)

DISEASES

Pythium damping off and cottony leak, apply at planting.

Ridomil 2 E, 4 to 8 pt.

SEED TREATMENT

Thiram 50 WP Dyed, 4.5 oz/100 lb seed.

or Anchor, 1.5 oz/100 lb seed.

or

Apron FL, 1.5 oz/100 lb seed.

or

Captan 300, 2 1/3 oz/100 lb seed.

or

Captan 30-DD, 2 1/3 oz/100 lb seed.

or

Captan 400, 2 1/2 to 3 oz/100 lb seed.

or

Captan 400-D, 2 1/2 to 3 oz/100 lb seed. or

Captan 75%, 2 oz/100 lb seed.

or

42-S Thiram, 4 1/2 oz/100 lb seed.

Use only as directed; overtreatment may cause injury.

INSECTS

Seed corn maggot.

Lindane (*Isotox Seed Treater F*), 4 oz/100 lb seed as planter box treatment only.

Lorsban 50 SL, 2 oz/100 lb seed as slurry treatment only.

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram, 3/4 tsp/lb seed.

FOLIAR TREATMENT

Cucumber plants may be sensitive to certain insecticide formulations. Make certain a problem exists before treatment. Read and observe restrictions on the label. To avoid killing bees, do not treat cucumbers during bloom. If treatment is necessary, see pages 18-20 for relative safety of materials to bees.

INSECTS

or

Cutworms, apply if needed.

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

*Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

Striped and spotted cucumber beetles, apply as soon as damage is seen. Repeat as needed. Use preplant treatment in fields with severe problems.

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 3.2 to 6.4 oz (1 day) (RUP).

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 1/3 pt or 50 WP, 1 lb (2 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (1 day). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

or

Malathion 5 EC, 3 pt (1 day).

or

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Flea beetles, apply when damage is present.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

Endosulfan (Phaser, Thiodan) 3 EC, 1 1/3 pt

Cucumber

or 50 WP,1 lb (2 days).

Methoxychlor 50 WP, 2 lb (1 day).

or

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP).

Aphids, apply when first seen to avoid disease transmission to plants. Repeat as needed.

Endosulfan (*Phaser, Thiodan*) 3 EC, 1 1/3 pt or 50 WP, 1 lb (2 days).

or

Malathion 5 EC, 1 1/2 pt (1 day).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (3 days) (2 applications maximum).

or

Methyl parathion 7.5 EC, 1/2 pt (15 days). or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP).

or

Trithion 8 EC, 1/2 to 1 pt (7 days).

Mites, apply when needed. Usually a problem only in hot, dry weather.

Kelthane 35, 1 to 1 1/2 lb (2 days).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (3 days) (2 applications maximum).

or

Trithion 8 EC, 1/2 to 1 pt (7 days).

Thrips, apply when damage is seen. Repeat as needed.

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days) (RUP).

or Methyl parathion 7.5 EC, 1/2 pt (15 days).

DISEASES

Powdery mildew (*Sphaerotheca fuliginea* or *Erysiphe cichoracearum*), treat every 14 days after disease appears.

**Bayleton* 50 DF, 2 to 4 oz (0 days). Maximum of 16 oz per season.

or

*Bayleton 50 WP, 2 to 4 oz (0 days). Maximum of 16 oz per season.

Note: *Bayleton* treatments will not give commercially acceptable control of *Sphaerotheca fuliginea*. *Benlate* 50 W, 1/4 to 1/2 lb (0 days). Apply at 7-day intervals after disease appears.

Terranil 6 L, 2 to 3 pt (0 days).

or

or

or Bravo 720 6 F, 2 to 3 pt (0 days).

or

Copper sulfate 53 W, 2 to 4 lb (0 days). or

Tenn-Cop 5 E, 3 pt (0 days).

Scab (*Cladiosporium cucumerinum*), treat every 7 days after plants are 2 to 3 inches tall.

Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

or Dithane F-45 4 F, 1 3/5 to 2 2/5 qt (5 days). or

Dithane 75 DF, 2 to 3 lb (5 days).

Dithane M-45 80 W, 2 to 3 lb (5 days). or

Bravo 720, 2 to 3 pt (0 days).

or Terranil 6L, 2 to 3 pt (0 days).

Alternaria leaf spot (Alternaria cucumerina), treat plants after vine tip when conditions fav disease and continue at 7- to 10-day intervals.

Terranil 6 L, 2 to 3 pt, 7 day intervals (0 days). or

Bravo 720, 2 to 3 pt, 7 day intervals (0 days). or

Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

Penncozeb 75 DF, $1 \frac{1}{2}$ to 3 lb (5 days).

or

or

or

Penncozeb 80 W, 1 1/2 to 3 lb (5 days).

Maneb 80 W, 1 1/2 to 2 lb (5 days).

or

Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

Anthracnose (*Colletotrichum lagenarium*), treat after flowering when conditions are favorable for disease development.

Terranil 6 L, 1 1/2 to 2 pt, 7 day intervals (0 days).

or Bravo 720, 1 1/2 to 2 pt, 7 day intervals (0 days).

or

Benlate 50 W, 1/4 to 1/2 lb, 7 to 14 day intervals (0 days).

Apply at 7- to 10-day intervals.

Topsin M, 8 oz, 7 to 10 day intervals (0 days).

or

Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

or

Dithane F-45 4 F, 1 3/5 to 2 2/5 qt (5 days). or

Dithane 75 DF, 2 to 3 lb (5 days).

or

Dithane M-45, 2 to 3 lb (5 days).

or or

Penncozeb 75 DF, 1 1/2 to 3 lb (5 days).

Penncozeb 80 W, 1 1/2 to 3 lb (5 days).

or

Maneb 80 W, 1 1/2 to 2 lb (5 days).

or

Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

Angular leaf spot (*Pseudomonas lachrymans*), spray every 7 days, starting before the first fruit form. The disease is likely to be more serious in high-population plantings (40,000 plants/A or more). Under these conditions spray every 3 or 4 days to protect fruit at all stages of development.

Copper sulfate 53 W, 2 lb (0 days).

or

Kocide DF, 1 1/2 to 2 lb (0 days).

[•] Champ F, 2 to 2 2/3 pt (0 days).

or

Champ Formula 2 Copper, 1 to 1 1/3 pt (0 days).

or

Kocide LF, 2 to 2 2/3 pt (0 days).

Fruit Rot (*Rhizoctonia solani*), make a single application when vines begin to form.

Bravo 720, 8 1/2 pt (0 days).

Downy mildew (*Pseudoperonospora cubensis*), treat plants at first sign of disease and repeat at 14-day intervals.

Ridomil/Bravo 81 W, 1 1/2 to 2 lb, 14 day intervals (7 days).

or

Ridomil/Copper 70 W, 1 1/2 to 2 lb (5 days).

Ridomil MZ 58, 1 1/2 to 2 lb (5 days).

or

or

Aliette WDG, 2 to 5 lb (0 days).

or

Aliette 80 W, 2 to 5 lb (0 days).

Iternaria and gummy stem blight also provide limited downy mildew protection.

Gummy stem blight or black rot (*Didymellabryoniae*; also called *Mycosphaerella melonis*), begin treatment at the 2-leaf stage.

Terranil 6 L, 2 to 3 pt, 7 day intervals (0 days). or

Bravo 720, 2 to 3 pt, 7-day intervals (0 days).

Benlate 50 DF, 1/4 to 1/2 lb, 7- to 14-day intervals.

Apply at 7- to 10-day intervals.

Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

Dithane F-45 4 F, 1 3/5 to 2 2/5 gt (5 days).

or

or

or

Dithane 75 DF, 2 to 3 lb (5 days).

Dithane M-45, 2 to 3 lb (5 days).

Fruit rot (*Phytophthora* spp., *Pythium* spp.) initiate treatment at flowering.

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (7 days).

EGGPLANT

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

DISEASES

Fusarium and Verticillium wilt, preplant treatment (production fields). Most fumigants applied to the soil to control disease organisms will also control soil insects, nematodes and weed seeds.

Methyl bromide, 175 to 240 lb broadcast application. See manufacturer's recommendations for method of application and covering treated soil. Aerate 2 weeks before setting transplants.

or

Metham (*Busan* 1020 or *Vapam*) 75 to 100 gal chemigated or injected, shanks spaced 5 inches apart or to a depth of 4 to 10 inches. If shanked, roll and irrigate treated surface to prevent escape of gas.

Eggplant

Soil should be thoroughly cultivated and free of clods before treating. Do not apply when soil temperatures are below 50°F (40°F for metham) or closer than 3 feet from roots of living plants. Do not plant for 14 to 30 days after treatment (the wetter the soil, the longer the waiting period).

SOIL TREATMENT AT PLANTING

NEMATODES

Phenamiphos (Nemacur) 3 S, 5.9 fl oz/1000 row feet (or 2 2/3 qt/A on 36 inch rows) in a 12-inch band over the row at transplanting. Incorporate immediately into the soil. Note: on narrow row crops, do not allow bands to overlap.

SEED TREATMENT (Pre-emergence)

DISEASES

Damping off (Pythium spp., Phytophthora spp., Rhizoctonia solani), apply to seed as slurry or dust.

Thiram 50 WP Dyed, 6 oz/100 lb seed. Use only as directed; overtreatment may cause injury.

or

Captan 75%, 4 oz/100 lb seed.

or

42-S Thiram, 6 1/2 oz/100 lb seed.

or

Anchor, 1.5 oz/100 lb seed (Pythium spp. only).

SEEDBED TREATMENT

Damping off (Pythium spp.) and crown rot (Phytophthora capsici). (Ridomil 2 E must be applied to the soil before the plants are infected with Phytophthora to obtain satisfactory disease control.)

After initial application, 2 supplemental postdirected applications at 4 pt should be made at 30-day intervals. Spray should be directed at the base of the plants and cover 6 to 8 inches of soil on either side of the plants. Ridomil must be moved into the root zone mechanically or by sprinkler irrigation. Spray may be applied with liquid fertilizer shanked in as a band treatment to either side of the plant. The foliar blight phase of Phytophthora cannot be controlled with foliar applications of *Ridomil* E 3.

FOLIAR TREATMENT

INSECTS

Cutworms, apply when damage is first seen, usually soon after transplanting.

Carbaryl (Sevin) 80 S, 2 1/2 lb or XLR Plus, 2 qt (0 days).

Colorado potato beetle.

Asana XL¹, 5.8 to 9.6 oz (7 days) (RUP).

or

- Permethrin¹
- --Ambush 2 EC or 25 WP, 12.8 oz (3 days) (RUP).
- --Pounce 3.2 EC, 8 oz or 25 WP, 12.8 oz (3 days) (RUP).

or

Vydate L, 1 to 2 qt (1 day). Repeat in 1 to 3 weeks if needed.

or

Carbaryl (Sevin) 80 S, 2/3 to 1 1/4 lb or XLR Plus, 1/2 to 1 qt (0 days).



Bacillus thuringiensis tenebrionis Novodor, M-Trak, or Foil (0 days). Small larvae only. Do not mix Foil with Bravo.

(Guthion¹ used at rates labeled for Flea beetles may also be effective.)

Flea beetles, apply when damage is first seen.

Methoxychlor 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Endosulfan (Thiodan) 3 EC, 1 1/3 pt or 50 WP, 1 lb (1 day). Consult label for rotation limitations.

or

Dibrom 8 EC, 1 pt (1 day).

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (21 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

Ridomil E 2, 4 to 8 pt at time of planting in 20 to 50 gal water or liquid fertilizer. Incorporate mechanically before planting or move into root zone after planting with 1/2 to 1 inch sprinkler water. For banded applications, use 12 to 16 inch band.

¹ Piperonyl butoxide (Incite, PBO-8, Butacide) may increase effectiveness of resistant beetles.

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

Aphids, apply when needed.

Endosulfan (*Thiodan*) 3 EC, 1 1/3 pt or 50 WP, 1 lb (1 day). Consult label for rotation limitations.

or

Dibrom 8 EC, 1 pt (1 day).

or

Metasystox-R 2 S, 2 pt (7 days) (3 applications maximum).

or

Malathion 5 EC, 1 pt (3 days).

or

Vydate L, 1 to 2 qt (1 day). Repeat in 1 to 3 weeks if needed.

Mites, apply if needed to avoid foliar injury.

Trithion 8 EC, 1/2 to 1 pt (7 days).

or

Metasystox-R 2 S, 2 pt (7 days) (3 applications maximum).

or

Vydate L, 1 to 2 qt (1 day). Repeat in 1 to 3 weeks if needed.

ISEASES

Alternaria blight (Alternaria melongenae) or Anthracnose (Colletotrichum melongenae), treat every 7 to 10 days after disease first appears.

Kocide DF, 2 lb (0 days).

or

Champ F, 22/3 pt (0 days).

or

**Maneb* + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

or **Maneb* 80 W, 1 1/2 to 2 lb (5 days).

or

*Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

or

Champ Formula 2 Copper, 1 to 1 1/3 pt (0 days).

or

Kocide LF, 2 2/3 pt (0 days).

Phomopsis blight (*Phomopsis vexans*), treat every 7 to 10 days after disease first appears.

Kocide DF, 2 lb (0 days).

or

br

or

Champ F, 2 2/3 pt (0 days).

Champ Formula 2 Copper, 1 to 1 1/3 pt (0 days).

Kocide LF, 2 to 2 2/3 pt (0 days).

GARDEN GREENS

(Collards, Kale, Mustard Greens, Swiss Chard, Endive & Escarole)

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SEED TREATMENT

DISEASES

Damping off (Rhizoctonia spp., Pythium spp.).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

FOLIAR TREATMENT

INSECTS

Mites, may be a problem in hot, dry weather.

Dibrom 8 EC, 1 pt (1 day). Collards and kale.

Flea beetles, apply when damage is first seen on young plants. Repeat as needed.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (14 days).

or

Malathion 5 EC, 2 pt (7 days).

or Asana XL, 5.8 to 9.6 oz (7 days) (RUP). Collards only.

or Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). Collards, kale and kohlrabi only.

or Pyrenone, 2 to 12 oz (0 days).

or

Pyrellin EC, 1 to 2 pt (0 days).

or Methyl parathion 7.5 EC, 1/2 to 1 1/2 pt (21 days). Collards, kale and mustard only.

Cutworms and loopers, apply as needed.

*Asana XL, 5.8 to 9.6 oz (7 days) (RUP). Collards only.

or

Eggplant to Garlic

*Permethrin

- --*Ambush* 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP). Chard and non-Brassica greens only.
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP). Chard and non-Brassica greens only.
- or
 - Endosulfan (*Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (21 days) (RUP). (Collards, kale and mustard greens only.)

or

- *Larvin* (thiodicarb), 3.2 EC, 16 to 30 oz (14 days). Cress, dandelion, endive, parsley and swiss chard (consult label for a complete list).
- or

Cabbage worms (not a problem on chard), apply when feeding damage is first seen. Repeat as needed.

*Asana XL, 5.8 to 9.6 oz (7 days) (RUP). Collards only.

or

*Permethrin

- --*Ambush* 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP). Chard and non-Brassica greens only. --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8
- oz (1 day) (RUP). Chard and non-Brassica greens only.
- or
 - *Lorsban* 4 E, 1 qt or 50 W, 2 lb (21 days). Collards, kale and kohlrabi only.

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (14 days).

or

Larvin (thiodicarb), 3.2 EC, 16 to 30 oz (14 days). Cress, dandelion, endive, parsley and swiss chard (consult label for a complete list).

or

Endosulfan (*Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (21 days (RUP). (Collards, kale and mustard greens only.)

or

Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 lb (3 days) (RUP).

or

Malathion 5 EC, 1 qt (7 days).

- or
 - Dibrom 8 EC 1 pt (1 day). Collards and kale only.

or

- Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days; 12 days, Swiss Chard) (RUP).
- or
 - Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel,

Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply when first seen to avoid infestations on leaves at harvest.

Dimethoate (Cygon) 4 EC, 1/2 pt (14 days).

or

Endosulfan (*Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (21 days (RUP). (Collards, kale and mustard greens only.)

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days; 12 days, Swiss chard) (RUP).

or

Malathion 5 EC, 1 qt (7 days).

or Dib

Dibrom 8 EC, 1 pt (1 day). Collards and kale only.

or

Pyrenone, 2 to 12 oz (0 days).

or

Pyrellin EC, 1 to 2 pt (0 days).

or

Methyl parathion 7.5 EC, 1/2 to 1 1/2 pt (21 days). Collards, kale and mustard only.

Slugs.

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Downy mildew (*Peronospora parasitica*), apply as needed to maintain control.

TopCop Tribasic, 1 to 2 qt (0 days). There is no label for use on endive or escarole.

Apply as a foliar spray when conditions favor disease development and continue on a 7- to 21-day interval.

Aliette 80 W, 2 to 5 lb (3 days). **Note**: Labeled for use on Collards, Kale, Mustard Greens and Rape Greens. Do not tank mix with copper fungicides.

Cercospora leaf spot (*Cercospora beticola*), apply as needed.

Top Cop with sulfur, 3 to 4 pt (0 days).

GARLIC

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days

Lorsban 4 E, 1 qt or 50 W, 2 lb (21 days). Collards, kale and kohlrabi only.

Extension Bulletin E-1025b for details about oil fumigation. In some limited situations, soil fumigants can be applied in the spring in Michigan.

Metham (*Busan* 1020 or *Vapam*) 75 to 100 gal injected with shanks spaced 5 inches apart or to a depth of 4 to 10 inches in well prepared soil. Follow immediately with a roller to smooth and compact surface. Light watering to the treated surface helps to prevent escape of gas.

SEEDBED TREATMENT

DISEASES

Damping off, seed and crown rots (*Rhizoctonia* spp., *Pythium* spp., *Botrytis* spp., *Sclerotinia sclerotiorum*).

Note: For seedbed protection programs, sterilize seedbed with steam or chemicals (see page 94). Follow recommended procedures carefully.

SEED TREATMENT

<u>DISEASES</u>

Damping off (*Rhizoctonia* spp., *Pythium* spp. *Botrytis* spp.).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

Damping off (*Pythium* spp. only), apply at seeding.

Apply as a band with fertilizer (not in contact with seed) using granular applicator at planting time.

Ridomil 5 G, 20 to 40 lb either pre-plant incorporated or applied to the soil surface at planting, either banded or broadcast (see application formula on label).

PLANTING TREATMENT

DISEASES

Pythium damping off.

Ridomil 2 E, 4 to 8 pt in 20 to 50 gal water. Apply as a banded treatment (7 to 8 inch band) at seeding. One acre using an 8 inch band equals 65,000 linear ft.

or

Ridomil 5G, 20-40 lb per treated acre as a broadcast incorporated in the upper 2 inches of soil, or as a 7 inch banded

application. Avoid placing granules in direct contact with seed.

INSECTS

Aphids, leafhoppers, mites and thrips.

Di-Syston 15 G, 4 to 8 oz/1,000 ft, or 8 E, 0.6 to 1.2 fl oz/1,000 ft (60 days) (RUP).

Note: This treatment is translocated in the plant and aids in leafhopper control, but does not necessarily replace foliar treatments for the insect later in the season.

FOLIAR TREATMENT

INSECTS

Cutworms and armyworm, apply when damage is first seen and repeat as needed.

*Ammo 2.5 EC, 2.5 to 5 oz or WSB, 1 to 2 bags (RUP). Head lettuce only.

or

*Permethrin --*Ambush* 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

--*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Lannate 1.8 L, 4 pt or 90 SP, 1 lb (10 days); 1.8 L 2 pt or 90 SP, (7 days). Head lettuce only. (RUP).

Aster leafhoppers, apply treatments on a regular schedule to prevent transmission of aster yellows. Intensity of schedule will depend on leafhopper population pressure on the crop.

*Ammo 2.5 EC, 2.5 to 5 oz or WSB, 1 to 2 bags (RUP). Head lettuce only.

*Permethrin

- --Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for number of applications and other limitations.

or

Dimethoate (*Cygon*) 4 EC, 1/2 pt (7 days for head lettuce; 14 days for leaf lettuce).

or

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days for head; 14 days for leaf and bibb).

or

59

Lettuce

Methyl parathion 7.5 EC, 1 to 2 pt (21 days).

Malathion 5 EC, 2 pt (7 days for head; 14 days for leaf).

Aphids.

Orthene 75 S 2/3 to 1 1/3 lb (21 days). Head lettuce only.

or

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days) (RUP).

or

Dimethoate (*Cygon*) 4 EC, 1/2 pt (7 days for head; 14 days for leaf).

or

MetaSystox-R 2 S, 1 1/2 to 2 pt (14 days for 1 application, 21 days for 2 or 3 applications). Head lettuce only. Maximum 3 applications.

or

Malathion 5 EC, 2 pt (7 days for head; 14 days for leaf and bibb).

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for number of applications and other limitations.

or

or

Pyrenone, 2 to 12 oz (0 days).

Methyl parathion 7.5 EC, 1 to 2 pt (21 days).

Tarnished plant bug.

*Ammo 2.5 EC, 2.5 to 5 oz or WSB, 1 to 2 bags (RUP). Head lettuce only.

or

Carbaryl (*Sevin*) 80 S, 1 1/4 to 2 1/2 lb or XLR Plus, 1 to 2 qt (3 days for head; 14 days for leaf and bibb).

or

Methyl parathion 7.5 EC, 1 to 2 pt (21 days).

Caterpillars (mainly cabbage loopers), are usually controlled with aster leafhopper program, but damage potential may require additional treatments.

*Ammo 2.5 EC, 2.5 to 5 oz or WSB, 1 to 2 bags (RUP). Head lettuce only.

or

*Permethrin

--Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

--*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

or

**Larvin* (thiodicarb) 3.2 EC, 16 to 30 oz (14 days).

Carbaryl (Sevin) 80 S, 1 1/4 to 2 1/2 lb or XLP Plus; 1 to 2 qt (3 days for head; 14 days for leaf and bibb).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (7 days) (RUP). Head lettuce only.

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (14 days). Consult label for numbers of applications and other restrictions.

or

Orthene 75 S, 2/3 to 1 1/3 lb (21 days). Head lettuce only.

or

Bacillus thuringiensis Agree, Biobit, Cutlass, Dipel, Javelin, MVP or Thuricide (0 days).

Vegetable leafminer, apply as soon as visible mines appear and repeat every 7 days as needed.

Trigard 75 WP, 1/6 lb (7 days). Aerial application only.

Slugs.

Metaldehyde 2.75% bait, 70 to 72.5 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Drop (Sclerotinia sclerotiorum) **and bottom rot** (*Rhizoctonia solani*).

Roural 50 W, 1 1/2 to 2 lb (14 days). Head lettuce only. Apply at 3-leaf stage and again in 10 days. Apply a third treatment 10 days later, if conditions for disease remain favorable.

or

Ronilan 50 W, 1 to 2 lb (28 days). Make first application immediately after thinning (direct-seeded lettuce) or 7 to 10 days after transplanting. Repeat in 14 days. Apply a third treatment 14 days later, if cool conditions continue (direct seeded lettuce only).

Note: For best results, cultivate just prior to treatment; do not disturb until just prior to next treatment.

Downy mildew (*Bremia lactucae*), apply when disease first appears and repeat every 7 to 10 days as needed.

Manex 4 F, 1 1/5 to 1 3/5 qt (10 days). Do not apply more than 9.6 qt per season.

Maneb + zinc 4F, 1 1/5 to 1 3/5 qt (14 days). Do not apply more than 9.6 qt per season.

or

or

Maneb 80 W, 1 1/2 to 2 lb (14 days). Do not apply more than 12 lb product per season.

Aliette 80 W, 2 to 5 lb (3 days). Do not make more than 7 applications per season. Do not tank mix with copper fungicides.

or

Kocide DF, 1 to 2 lb (0 days).

or

Kocide 606, 1 1/3 to 2 2/3 pt (0 days).

or

Champ Formula 2 Copper 37.5 F, 1 1/3 to 2 2/3 pt (0 days).

Root rot (*Pythium* spp.).

Ridomil 5 G, 20 to 40 lb per treated acre as a banded soil application incorporated prior to planting.

or

Ridomil 2 E, 4 to 8 pt per treated acre applied as a band, preplant incorporated, or as a band sprayed over the row after planting. Post-plant applications should be moved into the seed zone with 1/2 to 1 inch water as rain or irrigation.

MELONS Muskmelons and Watermelons)

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infesta-tions.

SEED TREATMENT

If possible, buy treated seed.

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 4.5 oz/100 lb seed.

Ridomil 2 E, 4 to 8 pt.

or *Captan* 300, 1 2/3 oz/100 lb seed. or Captan 30-DD, 1 2/3 oz/100 lb seed.

Captan 400, 1 1/2 to 2 oz/100 lb seed.

Captan 400-D, 1 1/2 to 2 oz/100 lb seed.

or Captan 75%, 8 oz/100 lb seed (watermelon). or

Captan 75%, 1 1/3 oz/100 lb seed (muskmelon).

or

or

or

42-S Thiram, 4 1/2 oz/100 lb seed.

or Anchor, 1.5 oz/100 lb seed (*Pythium* spp. only).

Use only as directed; overtreatment may cause injury.

INSECTS

Seed corn maggot.

Lindane (*Isotox Seed Treater F*), 4 oz/100 lb seed. Use as planter box treatment only.

SEEDBED PREPARATION

DISEASES

Damping off, root rot (*Pythium* spp., *Rhizoctonia solani*), grow transplants in disease-free soil (sterilized) and fumigate fields before planting. To sterilize soil use steam or fumigate with chemicals suggested for seedbed sterilization on page 95. Follow manufacturer's recommendations for use with particular crops. Avoid planting until soil is free of fumigant.

PREPLANT SOIL FUMIGATION

DISEASES

Fusarum wilt or root rot (*Fusarium oxysporium*). This protects plants grown from seed or transplanted in the field.

CHEMIGATION TREATMENT

See Bulletin E-2099.

Metham (Vapam or Busan 1020), 75 to 100 gal (for seedbed use 2 1/2 gal in 150 to 200 gal of water/100 sq yd).

SOIL INJECTION (BROADCAST)

Inject and seal soil surface by mechanical compaction or with water (irrigation).

Melons

Vapam, 75 to 100 gal.

Inject and cover with plastic.

Bromo-O-Gas, 180-240 lb/A.

or

Terr-O-Gas 67, 225-350 lb/A.

SOIL INJECTION (In-row)

Inject and cover treated area immediately with clear plastic mulch.

Methyl Bromide and Chloropicrin (Bromo-O-Gas or Terr-O-Gas).

Do not fumigate if the soil is below 50°F. Apply gas to a depth of 6 inches. Rate is dependent on row spacing. Be aware that fumigation may temporally reduce nitrification in soil.

PREPLANT TREATMENT

INSECTS

Cucumber beetles.

*Furadan 4 F, 2.4 oz/1000 ft of row (RUP). Apply at planting or transplanting in a 7inch band, incorporated into the top 3 inches of soil, or apply into the furrow and mix with the covering soil. (Special Michigan SLN registration.)

DISEASES

Pythium damping off, apply prior to planting as a broadcast spray.

Ridomil 2 E, 2 to 4 pt in 50 gal of water.

FOLIAR TREATMENT

Melon plants may be sensitive to certain insecticide formulations. Make certain a problem exists before treatment. Read and observe restrictions on the label. To avoid killing bees, do not treat melons during bloom.

INSECTS

Cutworms, apply as needed.

*Permethrin (muskmelons only).

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

or

* Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (3 days) (RUP).

Striped and spotted cucumber beetles, apply as soon as beetles are seen to prevent transmission of bacterial wilt. Repeat as needed. Use preplant treatment in fields with severe problems.

Endosulfan (Phaser, *Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (2 days).

or

or

Methoxychlor 50 WP, 2 lb (1 day).

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 5 days between applications.

or

Lannate, 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

or *

* Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Permethrin (muskmelons only).

- --Ambush 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

or

Malathion 5 EC, 2 pt (1 day).

Flea beetles, apply when damage is present.

Endosulfan (*Phaser, Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (2 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

Leafhoppers, apply if insects and damage are present.

Dimethoate (Cygon) 4 EC, 1/2 to 1 pt (3 days).

or

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 5 days between applications.

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1

qt (0 days).

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (3 days) (RUP).

or

Dibrom 8 EC, 1 pt (1 day).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Aphids, apply when first seen to prevent disease transmission to plants. Repeat as needed.

Dimethoate (Cygon) 4 EC, 1 pt (3 days).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (3 days) (RUP).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (14 days; 7 days on watermelons).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (3 days) (RUP).

or

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Malathion 5 EC, 1 1/2 pt (1 day).
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Mites, apply when needed. Watermelons are particularly susceptible. Usually a problem only in hot, dry weather.

*Kelthane 35, 1 to 1 1/2 lb (2 days).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (3 days) (RUP).

or

Metasystox-R 2 SC, 2 pt (14 days; 7 days watermelons).

or

Dibrom 8 EC, 1 pt (1 day).

Thrips, apply when damage is seen. Repeat as needed.

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (3 days) (RUP).

Slugs.

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Powdery mildew (Sphaerotheca fuliginea, Erysiphe cichoracearum) treat every 14 days after disease appears.

*Bayleton 50 DF, 2 to 4 ounces (0 days). A maximum of 16 oz may be applied per season. Will not give commercially acceptable control of Sphaerotheca fuliginea.

or

*Bayleton 50 WP, 2 to 4 ounces (0 days). A maximum of 16 oz may be applied per season. Will not give commercially acceptable control of Sphaerotheca fuliginea.

or

*Benlate 50 W, 1/4 to 1/2 lb (0 days).

or Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days). Treat when conditions favor disease and at 7-day intervals.

or

Bravo 720 6 F, 2 to 3 pt (0 days). Treat when conditions favor disease and at 7-day intervals.

or

Terranil 6 L, 2 to 3 pt (0 days). Treat when conditions favor disease and at 7-day intervals.

Alternaria leaf spot (*Alternaria cucumerina*), treat every 7 to 10 days after vine tip.

Terranil 6 L, 2 to 3 pt, 7-day intervals (0 days).

or Bravo 720, 2 to 3 pt (0 days).

or Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

Maneb 80 W, 1 to 2 lb (5 days).

or Penncozeb 80 W, 2 to 3 lb (5 days).

Penncozeb 75 DF, 2 to 3 lb (5 days).

or

or

or

Dithane F-45 4 F, 1 3/5 to 2 2/5 qt (5 days).

or

Dithane 75 DF, 2 to 3 lb (5 days).

Dithane M-45, 2 to 3 lb (5 days).

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or
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Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

or Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

Scab (*Cladosporium cucumerinum*) treat every 7 days beginning after the plants have flowered.

Terranil 6 L, 2 to 3 pt (0 days).

or

Bravo 720, 2 to 3 pt (0 days).

Anthracnose (*Colletotrichum lagenarium*), treat every 7 to 14 days after flowering.

Terranil 6 L, 1 1/2 to 2 pt, 7-day intervals (0 days).

Bravo 720, 1 1/2 to 2 pt (0 days).

or

Melons to Mint

	<i>Benlate</i> 50 W, 1/4 to 1/2 lb (0 days).
or	$T_{\text{res}} = (0, 1_{\text{res}})$
or	Topsin M, 8 oz (0 days).
01	Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).
or	Manah 90 W 1 to 2 lb (5 days)
or	Marled 80 W, 1 to 2 lb (5 days).
	Penncozeb 80 W, 2 to 3 lb (5 days).
or	Penncozeh 75 DF 2 to 3 lb (5 days)
or	1 childozeb 10 b1, 2 to 0 ib (0 days).
	<i>Dithane</i> F-45 4 F, 1 3/5 to 2 2/5 qt (5 days).
or	Dithane 75 DF. 2 to 3 lb (5 days).
or	
0.12	<i>Dithane</i> M-45, 2 to 3 lb (5 days).
01	<i>Manex</i> II 4 F, 1 3/5 to 2 2/5 qt (5 days).
or	
	Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

Angular leaf spot (*Pseudomonas lachrymans*). Copper may be used for control of this bacterial disease. Spray every 7 days, starting before the first fruit form and continue to protect fruit at all stages of development. **Note**: Soil application after planting (before emergence) may help decrease infestation.

Copper sulfate 53 W, 2 to 4 lb (0 days). or

Copper oxide 80 W, $1 \frac{1}{2}$ to 3 lb (0 days).

Downy mildew (*Pseudoperonospora cubensis*), treat plants when in the 2-leaf stage and continue at 14-day intervals.

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (5 days). or

Ridomil/Copper 70 W, 1 1/2 to 2 lb (5 days). or

Ridomil MZ 58, 1 1/2 to 2 lb (5 days).

or Aliette WDG, 2 to 5 lb (0 days).

or

Aliette 80 W, 2 to 5 lb (0 days).

Note: Fungicides that protect against *Alternaria* also provide limited downy mildew protection.

Gummy stem blight or black rot (*Didymella bryoniae*; also called *Mycosphaerella melonis*), begin at the 2-leaf stage and apply every 7 days.

Terranil 6 L, 2 to 3 pt (0 days).

or

Bravo 720, 2 to 3 pt (0 days).

or Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days). or *Maneb* 80 W, 1 to 2 lb (5 days). or

Penncozeb 80 W, 2 to 3 lb (5 days). or

Penncozeb 75 DF, 2 to 3 lb (5 days).

Dithane F-45 4 F, 1 3/5 to 2 2/5 qt (5 days).

Dithane 75 DF, 2 to 3 lb (5 days).

or

or

or

or

Dithane M-45, 2 to 3 lb (5 days).

Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

MINT

(Peppermint and Spearmint)

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SOIL TREATMENT

NEMATODES

Root-lesion, false root-lesion and needle nematodes can cause reduction in yields, especially in the presence of the Verticillium wilt fungus. Fields should be tested for nematodes prior to planting. If more than 20 of the above nematodes per 100 cc of soil are found, a fall soil fumigation prior to planting in the spring is recommended.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

1,3-D

--Telone II, 36 gal (muck soil).

Fumigate in the fall when soil temperatures at an 8-inch depth are above 50° F. Inject the fumigant to a depth of 6 inches and seal the soil with a drag immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for further details about fumigation.

Metham (Busan 1020 or Vapam) 75 to 100 gal injected with shanks spaced 5 inches apart T

or to a depth of 4 to 10 inches in well prepared soil. Follow immediately with a roller to smooth and compact surface. Light watering to the treated surface helps to prevent escape of gas.

FALL PREPLANT TREATMENT FOR NEW MINT

NEMATODES

Vydate L Insecticide/Nematicide is recommended for use in peppermint and spearmint to control of the root-lesion nematode (*Pratylen-chus penetrans*) except in heavy soils. Apply 1.5 gal in 20 gal of water per acre on a preplant, broadcast basis and incorporate to a depth of 6 to 8 inches. *Vydate* will not provide adequate control of the common needle nematode or the mint needle nematode.

SPRING TREATMENT FOR EXISTING MINT

NEMATODES



Rainfall or sprinkler irrigation (1/2 to 1 inch) is needed within 7 days of treatment to move *Vydate* into the root zone.

Note: Do not apply within 21 days of harvest. Do not rotate to crops other than apples, canteloupe, celery, cotton, cucumber, eggplant, honeydew, ornamentals, pears, peppers, root crop vegetables, soybeans, summer squash, tomatoes, watermelon and winter squash within 4 months after the last application.

FOLIAR TREATMENT

INSECTS

See NCR-155, Mint Production in the Midwestern United States (Price \$1.25, for sale only) for pictures and descriptions of insect pests and damage.

Mint root borer.

Lorsban 4 E, 2 to 4 pt. Apply post-harvest when larvae are present. Follow with at least 1 inch of irrigation.

Mint flea beetles, apply prior to egg-laying activity (July 20 to August 10) if needed to control adult stage, which will reduce root-damaging populations of larvae the following year. Three applications, 7 to 10 days apart, may be needed to control severe infestations (common only in older fields). <u>Timing is critical</u>.

Malathion 5 EC, $1 \frac{1}{2}$ pt (7 days).

or

or

or

or

Lannate 1.8 L, 3 to 4 pt or 90 SP, 3/4 to 1 lb (14 days) (RUP).

Lorsban 4 E, 2 to 4 pt (90 days). One application only.

Cutworms and loopers, apply before worms are 3/4 in. long for best results.

Lannate 1.8 L, 4 pt or 90 SP, 1 lb (14 days) (RUP).

Orthene 75 S, 1 1/3 lb (14 days).

Lorsban 4 E, 2 to 4 pt (90 days). One application only.

or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply when damage is first seen or when insects are noticeable.

Malathion 5 EC, $1 \frac{1}{2}$ pt (7 days).

or

Metasystox-R 2 SC, 3 pt (14 days).

or

Orthene 75 S, 1 1/3 lb (14 days).

Mites, apply if needed.

Kelthane MF, 1 3/4 to 2 1/2 pt (30 days). Limited to one application per season.

or

Metasystox-R 2 SC, 3 pt (14 days).

DISEASES

Mint Rust (Puccinia menthae).

Bravo 720, 1 3/8 pt (80 days). Apply to plants 4 to 8 inches tall at 5- to 10-day intervals. Do not apply more than 3 times. Do not feed hay to livestock.

Powdery mildew (Erysyphe cichoracearum).

THAT 8F flowable sulfur, 3 3/4 to 6 1/4 pt (0 days). Do not apply unless buyer of oil has authorized use.



Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Northern root-knot, root-lesion, onion bloat, common needle and stubby-root nematodes can reduce onion yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economic threshold for onions, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of northern root-knot, root-lesion, onion bloat and stubbyroot nematodes in onion production.

FALL SOIL FUMIGATION (Broadcast)

NEMATODES

- 1,3-D
- --*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).
- Metham (Busan 1020 or Vapam), 75 to 100 gal injected with shanks spaced 5 in apart to a depth of 4 to 10 in. in well-prepared soil. Material should be applied with adequate water and the soil surface sealed (light watering) after the application.

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 6 to 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025(b) for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

AT-PLANTING TREATMENT

DISEASES

Smut (*Urocytis cepulae*), apply in planter box at seeding or purchase treated seed.

- *Thiram* 50 WP Dyed, 1 1b/4 lb of seed in planter box (seeded onions) (State label for Michigan only).
- or Captan 75 SP Dust, 1 lb per 3 lb seed in planter box.
- or
 - *Manzate* 200 75 DF, 3 lb per acre applied as an in-furrow drench at planting in 75 to 125 gal water per acre (field-seeded onions only).
- or
 - Dithane DF 75 DF, 3 lb per acre applied as an in-furrow drench at planting in 75 to 125 gal water per acre (field-seeded onions only).

Note: Use only as directed; overtreatment may cause injury.

Damping off (*Pythium* spp. only), apply at seeding.

Ridomil 2 E, 4 to 8 pt as a broadcast application in 20 to 30 gal of water. For banded application, 7-inch bands are recommended. See page 24to calculate banded rate.

INSECTS

Onion maggot, apply to open furrow immediately after seeding but before furrow is closed. Use on dry bulb onions only.

Dyfonate II 10 G, 3/8 1b/1,000 ft of row (10 lb for 20 inch rows) or 15 G, 8 oz/1000 ft of row or 4 E, 1 1/4 oz/1,000 ft of row (1 qt for 20-inch rows). Organic soils only.

or

Lorsban 15 G, 3.7 oz or 4 E, 1.1 oz per 1,000 ft of row.

FOLIAR TREATMENT

INSECTS

Onion maggot, apply as a directed spray or drench in a minimum of 100 gal of water to the base of onion seedlings or transplants during peak egg laying of the onion maggot adults Proper timing is critical.

Lorsban 4 E, 1 qt (60 days). Use on dry bulb onions only. Maximum of 2 applications,

maximum of 1 application if *Lorsban* 4 E or 15 G was used at planting.

Cutworms, apply in late evening when first seen. Repeat treatments if needed.

*Ammo 2.5 EC, 2 to 5 oz or WSB, 1 to 2 bags (7 days) (RUP). (Bulb onions).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (7 days, 28 days for green onions) (RUP).

or

Carbaryl (Sevin) 5 B, 40 lb or 20 B, 10 lb (0 days).

Thrips, usually appear around mid-summer. Damage is most severe at the base of leaves. Dry growing conditions usually intensify the problem. Treat when damage becomes visible or numbers average 10 to 15 per plant. Repeat as needed. Consult county extension office for additional information.

*Ammo 2.5 EC, 4 to 5 oz or WSB, 1 to 2 bags (7 days) (RUP). (Bulb onions).

or

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

or

Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 pt. (Green onions - 14 days. Allow at least 10 days between applications.) (Dry bulb onions - 28 days. Allow at least 7 days between applications.) See label for further restrictions.

or

Methyl parathion 7.5 EC, 1/4 pt (15 days). or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days) (RUP).

or

Malathion 5 EC, 1 1/2 pt or 25 WP, 4 lb (3 days).

or

Penncap-M 2 F, 2 pt (15 days) (RUP).

or

Vydate 2 L, 1 to 2 pt (14 days).

DISEASES

Botrytis leaf blight (*Botrytis squamosa*), apply every 7 to 10 days after the 4-leaf stage or according to the onion leaf blight predictor.

Bravo 720, 1 1/2 to 2 pt (7 days for dry bulbs;

14 days for green onions). Do not use on Spanish onions. Applications of more than 10 ptof *Bravo* 720 per season may result in yield reductions.

or

or

Terranil 6 L, $1 \frac{1}{2}$ to 2 pt (7 days for dry bulbs; 14 days for green onions).

Manzate 200 80 W, 2 to 3 lb (0 days).

or Dithane M 45, 80 W, 2 to 3 lb (7 days).

or

Manex 4 F, 2 2/5 qt (7 days).

Penncozeb 80 W, 2 to 3 lb (7 days).

or

or

Roural 50 W, 1 1/2 lb (7 days). Apply every 7 to 14 days.

or

Ronilan 50 WP, 1 1/2 to 2 lb (18 days). Apply every 10-14 days beginning 6 weeks after seedling emergence. Do not apply more than 10 lb in any year.

Downy mildew (*Peronospora destructor*), apply the following chemicals every 14 days after the 4-leaf stage. Do not apply more than 12 1/2 lb per season.

*Ridomil MZ-58, 1 1/2 to 2 lb (7 days).

or

**Ridomil/Bravo* 81 W, 1 1/2 to 2 lb (7 days). Do not apply to Sweet Spanish onions if they have or will receive additional *Bravo* applications. Do not apply more than 3 times per year to green onions, or closer than 21 days to harvest.

Note: It is not legal to plant any crop not on the Ridomil MZ-58 label for 12 months following the last application, except that wheat, barley, or oats may be planted 40 days after the last application. It is not legal to plant any crop not on the *Ridomil-Bravo* label for 12 months following the last application. This restriction includes celery and carrots. See label.

Apply the following chemicals every 7 days (except where noted) after the 4-leaf stage.

Dithane M-45 80 W, 2 to 3 lb (7 days).

or Manzate 200 75 DF, 2 to 3 lb (7 days).

or

or

Manex 4 F, 2 2/5 qt (7 days).

Penncozeb 80 W, 2 to 3 lb (7 days).

or

Bravo 720, 1 1/2 to 2 pt (suppression only; 7 days, for dry bulbs; 14 days for green onions). Do not use on Spanish onions.

^{*}Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (7 days, 28 days for green onions) (RUP).

Onions to Parsnips

or

Kocide DF, 2 lb (0 days).

or

Aliette 80 W, 2 to 3 lb (7 days). Do not make more than 7 applications per season.

Purple blotch (*Alternaria porri*), apply every 7 to 10 days after the 4-leaf stage.

Rovral 50 W, 1 1/2 lb (7 days).

or

Rovral 4 F, 1.5 pt (7 days).

or

Bravo 720, 1 1/2 to 2 pt (7 days for dry bulbs; 14 days for green onions). Do not use on Spanish onions.

or

Terranil 6 L, 1 1/2 to 2 pt (7 days for dry bulbs; 14 days for green onions).

or

Champ Formula 2 Copper 37.5% F, 1 1/3 pt after plants are 4-6 inches high (0 days).

or

Manzate 200 80 W, 2 to 3 lb (7 days).

or

Dithane M-45 80 W, 2 to 3 lb (7days). or

Manex 4 F, 2 2/5 qt (7 days).

or

Penncozeb 80 W, 2 to 3 lb (7 days).

Neck rot (Botrytis spp.).

Effective chemical control is not available at this time. However, treatments for onion leaf blight may retard or prevent symptomless spread in the field prior to harvest.

PARSNIPS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SOIL TREATMENT

NEMATODES

Northern root-knot nematodes can reduce parsnip yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plantparasitic nematodes are present in population densities above the economic threshold for parsnips, crop rotation or application of a nematicide is recommended. The following nematicide is suitable for control of root-knot nematodes in parsnip production.

FALL SOIL TREATMENT (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6 inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

SEED TREATMENT

DISEASES

Damping off (*Pythium* spp.).

Anchor, 1.5 oz/100 lb seed.

FOLIAR TREATMENT

INSECTS

Flea beetle, apply as needed, usually soon after plants come up.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

Leafhoppers, apply when first seen. Repeat as needed.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

Armyworm, cutworms, apply if needed. Repeat as needed.

Carbaryl (Sevin) 80 S, 2 1/2 lb or 5 B, 40 lb or XLR Plus, 2 qt (3 days).

Aphids, apply if necessary.

Malathion 5 EC, 2 pt (7 days).

DISEASES

Alternaria leafspot, downy mildew, anthracnose, Botrytis blight, bottom rot. Apply at first sign of disease and repeat every 7 to 10 days.

Terranil 6 L, 1 1/2 to 2 pt (10 days)

Bravo 720, 1 1/2 to 2 pt (10 days).

or

or

Bravo 90 DG, 1 1/8 to 1 3/4 lb (10 days).



Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SEED TREATMENT

Treatments applied to seed prior to planting. Insecticide and fungicide treatments can be combined according to directions. Handle seed carefully to prevent cracking.

NSECTS

Seed corn maggot.

Diazinon (RUP). USE COMMERCIAL FORMULATION.

or

Lindane (*Isotox Seed Treater F*), 4 oz/100 lb seed. Use as planter box treatment only.

or

Lorsban 50 SL, 2 oz/100 lb seed. Use as a slurry.

or

Lindane/Diazinon/Captan (*Triple Seed Protectant*) 3 oz/bushel as a planter box treatment.

DISEASES

Damping off (*Pythium* spp., *Rhizoctonia solani*), early season *Phytophthora*).

Use slurry or dust method:

Thiram 50 WP Dyed, 3 oz/100 lb seed.

or

Apron-Terraclor, 4 oz/bu seed.

Apron 25 W, 2 oz/100 lb seed (Pythium and early season Phytophthora control only).

or

Apron 25 W, 5 oz/100 lb seed (Pythium

damping off and systemic downy mildew).

Captan 300, 2 oz/100 lb seed.

Captan 30-DD, 2 oz/100 lb seed.

Captan 400, 2 1/2 oz/100 lb seed.

Captan 400-D, 2 1/2 oz/100 lb seed.

Captan 75%, 1 oz/bu. seed.

Anchor, 1.5 to 2.25 oz/100 lb seed (*Pythium* spp. only).

or

or

or

or

or

or

or

or

Apron FL, 0.75 to 1.5 oz/100 lb seed (*Pythium* spp. only).

Apron FL, 3.4 oz/100 lb seed (*Pythium* damping off and systemic downy mildew).

Note: If possible, buy fungicide treated seed instead of treating seed on the farm.

PLANTING TREATMENT

DISEASES

Damping off (*Pythium*, *Phytophthora* and *Rhizoctonia* spp.).

Apron, 4 oz/100 lb seed.

or

Apron + Captan, 4 oz/100 lb seed.

SOIL TREATMENT

Apply in a band (not in contact with seed) at planting time, or as a sidedress after emergence.

INSECTS

Leafhoppers and aphids.

Di-Syston 15 G, 6.7 to 16.7 1b or 8 E, 1 to 2 1/2 pt (RUP) (50 days).

FOLIAR TREATMENT

INSECTS

Armyworm, loopers and climbing cutworms, apply as needed. Pay special attention to grassy areas in the field.

* Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Carbaryl (*Sevin*) 80 S, 17/8 lb or XLR Plus 1 1/2 to 2 1/2 qt (0 days).

Peas to Peppers

or

- *Lannate* 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day; 5 days if forage is fed to livestock; 14 days if fed as hay) (RUP).
- or
 - *Dibrom* 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

Leafhoppers, apply as necessary.

Carbaryl (Sevin) 80 S, 1 1/4 lb (0 days).

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

Aphids, apply as needed, usually beginning in early- or mid-June.

Methyl parathion 4 EC, 1 to 2 pt (15 days) (RUP).

or

or

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day; 5 days if forage is fed to livestock; 14 days if fed as hay) (RUP).

or

Penncap-M 2 F, 2 pt (10 days; 15 days if vines are fed to livestock) (RUP). Do not apply during bloom.

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

or

or

Mites, apply if necessary. Usually most serious in dry weather.

Dibrom 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

or

Methyl parathion 7.5 EC, 3/4 to 1 1/2 pt (15 days).

Pea weevil, apply when they appear at blossom time, usually at 10 to 50% bloom and 7 days later.

Carbaryl (*Sevin*) 80 S, 1 7/8 lb or XLR Plus, 1 1/2 qt (7 days).

or

Malathion 5 EC, 2 pt (3 days; 7 days if vines

are fed to livestock).

Methoxychlor 50 WP, 2 to 4 lb (7 days).

Penncap-M 2 F, 2 pt (10 days; 15 days) if vines are fed to livestock) (RUP). Do not apply during bloom.

DISEASES

Powdery mildew (*Erysiphe polygoni*). Apply every 7-10 days after disease appears.

Kocide DF, 1 1/2 to 3 lb (0 days).

or

or

Champ F, 2 to 4 pt (0 days).

PEPPERS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particula recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Northern root-knot nematodes can reduce pepper yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant parasitic nematodes are present in population densities above the economic threshold for peppers, crop rotation or application of a nematicide is recommended. The following nematicide is suitable for control of root-knot nematodes in pepper production.

Soil Injection

Metham (*Busan* 1020 or *Vapam*), 75 to 100 gal injected with injector, shanks spaced 5 inches apart at a depth of 4 to 10 inches. Roll and irrigate treated surfaces to prevent escape of gas. (RUP)

Chemigation Treatment

Vapam, (75 to 100 gal) applied with an irrigation system. Soil should be moist prior to treatment See Bulletin E-2099 (RUP).

Do not plant for 14 to 30 days after treatment

Dibrom 8 EC, 1 pt (1 day). Do not feed treated vines to livestock.

Malathion 5 EC, 2 pt (3 days; 7 days if vines are fed to livestock).

Dimethoate (*Cygon*), 4 EC, 1/3 pt (0 days; 21 days if vines are fed to livestock).

Diazinon 4 EC, 1 pt (0 days; 4 days if vines are fed to livestock) (RUP).

be wetter the soil, the longer the waiting iod).

FALL SOIL TREATMENT (Broadcast)

NEMATODES

- 1,**3**-D
- --*Telone II*, 36 gal (muck soil), 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at 6inch depth are above 50° F. Inject the fumigant to soil depth of 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

SEED TREATMENT

DISEASES

Pre-emergence damping off (*Rhizoctonia solani, Pythium spp., Phytophthora spp.*).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

- *Ridomil* 2 E, 4 to 8 pt before planting in 20 to 50 gal water (*Pythium* and *Phytophthora* only). Must be mechanically incorporated in the root zone or watered in with 1/2 to 1 inch sprinkler irrigation water.
- or

Captan 400, 2 to 3 oz/100 lb seed.

or

- *Captan* 400-D, 2 to 3 oz/100 lb seed. or
- Captan 75%, 2 oz/100 lb seed.
- or
- 42-S Thiram, 8 oz/100 lb seed.
- or

Anchor, 1.5 oz/100 lb seed (*Pythium* spp. only).

SEEDBED TREATMENT

DISEASES

Bacterial spot (*Xanthomonas vesicatoria*), (*Pseudomonas* spp.), apply when first true leaves appear and repeat at 5 day intervals.

Agri-Strep 21 1/4 W, 1 lb in 100 gal of water (200 ppm).

Note: For additional controls see foliar treatments.

SOIL FUMIGATION (SPRING)

DISEASES

Fusarium and verticillium wilt, apply to production fields before planting. **Note**: Most fumigants applied to the soil for control of disease organisms will also control soil insects, nematodes and weed seeds.

Soil Injection

Metham (*Busan* 1020 or *Vapam*), 75 to 100 gal injected with injector, shanks spaced 5 inches apart at a depth of 4 to 10 inches. Roll and irrigate treated surfaces to prevent escape of gas. (RUP)

Chemigation Treatment

Vapam, (75 to 100 gal) applied with an irrigation system. Soil should be moist prior to treatment. See Bulletin E-2099 (RUP).

Do not plant for 14 to 30 days after treatment (the wetter the soil, the longer the waiting period).

TRANSPLANT WATER TREATMENT

NEMATODES

Apply as needed.

Vydate L, 2 pt in at least 200 gal of water (bell peppers only). Do not apply during periods of slow plant growth, such as below 45°F.

AT PLANTING OR TRANSPLANTING

INSECTS

Aphids, for early season control.

Di-Syston 15 G, 6.7 to 13.3 oz/1,000 row ft banded beside the row.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply as needed.

- Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (4 days). Consult label for rotation restrictions.
- Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Peppers

or

Permethrin (bell peppers only)

- --Ambush 2 EC, 6.4 to 12.8 oz (3 days), (RUP).
- --Pounce 3.2 EC, 4 to 8 oz (3 days) (RUP).

or

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (21 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

or

Methyl parathion 7.5 EC, 3/4 to 1 pt (15 days).

Cutworms, **armyworm**, **and cabbage loopers**, apply as needed.

* Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

or

- *Permethrin (bell peppers only)
- --Ambush 2 EC, or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (3 days) (RUP).

or

Lannate, 1.8 L, 2 pt or 90 SP, 1/2 lb (10 days) (RUP).

or

or

Orthene 75 S, 1 1/3 lb (7 days). Bell peppers only.

Aphids, apply when first seen and continue as needed. Early control is essential to prevent transmission of mosaic viruses.

Orthene 75 S, 2/3 to 1 2/3 lb for bell peppers, 2/3 lb for non-bell peppers (7 days). Consult label for further restrictions regarding use on non-bell peppers.

or

Metasystox-R 2 SC, 2 pt (3 days). Maximum 2 applications.

or

Dimethoate (Cygon) 4 EC, 2/3 pt (0 days).

or

Diazinon 4 EC, 1/2 pt or 50 WP, 1/2 lb (5 days) (RUP).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (10 days) (RUP).

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (4 days, 1 day at 2/3 qt or 1 lb rate). Consult label for rotation restrictions.

or

Methyl parathion 7.5 EC, 3/4 to 1 pt (15 days). or

Vydate L, 2 to 4 pt (7 days).

European corn borer, apply treatments coincide with fruit formation and second-brood egg-laying period (usually around July 20 to August 15) and continue as needed. Direct spray to underside of leaves and cap area of fruit.

*Orthene 75 S, 1 1/3 lb (7 days). Bell peppers only.

or

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

or

Permethrin (bell peppers only)

--Ambush 2 EC, 6.4 to 12.8 oz (3 days) (RUP).

--Pounce 3.2 EC, 4 to 8 oz (3 days) (RUP).

or

Carbaryl (Sevin) 80 S, 1 1/2 to 2 1/2 lb or XLR Plus, 1 to 2 qt (0 days).

or

Guthion Solupak 50 WP, 1 lb or 2 L (RUP), 2 pt (21 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

Mites, apply if needed.

Kelthane MF, 3/4 to 1 1/2 pt (2 days). Limited to 2 applications per season.

or

Metasystox-R 2 SC, 2 pt (3 days). Maximum 2) applications.

DISEASES

Gray mold, (Botrytis spp.,) **Cladosporium leaf mold** (Cladosporium capsici), **Sclerotinia white mold** (Sclerotinia sclerotiorum).

No fungicides are presently labeled for this use.

Cercospora leaf blight, apply as needed at 7- to 10-day intervals.

*Maneb 80 W, 1 1/2 to 3 lb (7 days).

or

*Maneb + zinc F4, $1 \frac{1}{5}$ to $2 \frac{2}{5}$ qt (7 days).

or Copper sulfate 53 W, 3 to 4 lb (0 days).

or *Kocide* DF, 2 to 3 lb (0 days).

Anthracnose (Colletotrichum spp.) and Alternaria (ripe) rot (Alternaria tenvis), apply when disease threatens and every 7 to 10 days.

Maneb 80 W, 1 1/2 to 3 lb (7 days).

or

Maneb + zinc F4, 1 1/5 to 2 2/5 qt (7 days).



Carbaryl (Sevin) 80 S, 1 1/2 to 2 1/2 lb or XLR Plus, 1 to 2 qt (0 days).
ytophthora crown, stem and fruit rot iytophthora capsici and Pythuim spp.). rudomil 2 E must be applied to the soil before the plants are infected with Phytophthora to obtain satisfactory disease control).

Ridomil 2 E, 4 (1 lb a.i.) to 8 (2 lb a.i.) pt at time of planting in 20 to 50 gal water or liquid fertilizer. Incorporate mechanically before planting or move into root zone after planting with 1/2 to 1 inch sprinkler water. For banded applications, use 12- to 16-inch band.

After initial application:

Two supplemental post-directed applications at 4 pt (1 lb a.i.) should be made at 30-day intervals. Spray should be directed at the base of the plants and cover 6 to 8 inches of soil on either side of the plants. *Ridomil* must be moved into the root zone mechanically or by sprinkler irrigation. Spray may be applied with liquid fertilizer shanked in as a band treatment to either side of the plant. The foliar blight phase of *Phytophthora* cannot be controlled with foliar applications of *Ridomil* 2E.



One supplemental application of *Ridomil* 2 E at 4 pt (1 lb a.i.) should be made 30 days later followed by foliar applications of *Ridomil/Copper* 70 W, 2 1/2 lb (1/4 lb a.i.) (7 days). Make 3 to 4 applications of *Ridomil/Copper* 70 W at 10-to 14-day intervals.

Note: Do not apply more than a total of 3 lb a.i./crop.

Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), apply as needed every 5 to 7 days.

Copper sulfate 53 W, 3 to 4 lb (0 days).

or *Kocide DF*, 2 to 3 lb (0 days).

or

TopCop with sulfur, 3 gal (0 days).

or

Champ F, 2 2/3 to 4 pt (0 days).

or *Kocide* LF, 2 2/3 to 4 pt (0 days).

or

Champ Formula 2 Copper 37.5% F, 1 1/3 to 2 pt (0 days).

puthern Blight (Sclerotium rolfsii).

Terraclor 75 W, 3 to 5 lb/100 gal water, use 1/2 pt solution/plant, apply at transplanting.

Terraclor 75 W, 10 lbs/100 gal water, apply as an in-furrow spray to the open "V" trench just prior to planting. When cultivating set plows as flat as possible to avoid getting untreated soil against stems of plant.

POTATOES

Amount of chemical formulation to apply per acre (unless otherwise directed), Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Root-lesion, root-knot and potato rot nematodes can reduce potato yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If these plantparasitic nematodes are present in population densities above the economic threshold for potatoes, crop rotation or application of a nematicide is recommended. Potato growers should not rely on a single strategy or tactic for their total nematode control program. The following nematicides are suitable for control of root-lesion, root-knot or potato rot nematodes in potato production.

FALL SOIL TREATMENT (Broadcast)

NEMATODES

1,3-D

--*Telone II*, 36 gal for muck soil, 15 gal for mineral soil.

or

1,3-D and chloropicrin

--*Telone C-17*, 40 gal for muck soil, 15 gal for mineral soil.

or

Metham (*Busan* 1020 or *Vapan*), 40-100 gal injected with injector, shanks spaced 5 in. apart at a depth of 4 to 10 in. Material should be applied with at least equal parts water or in a 2 to 1, water to fumigant, ratio. Seal surface after application.

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 8 inches and lightly seal the soil immediately after application. Use soil

or

Potatoes

fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations, soil fumigants can be applied in the spring in Michigan.

Chemigation Treatment

Metham (Sodium methyl dithiocarbamate) --Busan 1020, Vapam, Soilprep or Nemasol, 50 gal for mineral soil situations. Rates of 25 to 75 gal have been recommended following both nematode and Verticillium analysis of the soil. In some years, spring application is possible.

Fall application in center pivot irrigation water. Have local product distributor provide additional application methodology and safety details from manufacturer. All recommended safety equipment must be installed to prevent groundwater contamination. See Extension Bulletin E-2099, Chemigation Safety Manual.

Preplant Soil Treatment

Vydate 2 L, 2 to 4 gal in at least 20 gal of water, applied within 1 week of planting as a band or broadcast treatment and incorporated to a depth of 4 to 6 inches. May aid in early season insect control.

or

Mocap 10 G, broadcast 60 up to 120 lb and incorporate to a depth of 2 to 4 inches (RUP).

or

Mocap 6 EC, broadcast 1 to 2 gal/A within 2 weeks of planting.

Soil Treatment at Planting

Vydate 2 L, 1 to 2 gal in at least 20 gal of water in furrow at planting. May aid in early season insect control.

or

Mocap 10 G, band 30 lb/acre (36 in. row spacing) in a 12-inch band over the row at planting (RUP).

INSECTS

Wireworms, broadcast evenly on soil surface and incorporate 4 to 6 inches deep prior tr planting.

Dyfonate II 10 G, 40 lb or 15 G, 27 lb or Dyfonate 4 EC, 4 gt (RUP). Do not rotate to carrots.

or

Diazinon 14 G, 21 to 28 lb or 4 EC, 3 to 4 qt (RUP). Use higher rate for heavier soil.

or

Mocap 10 G, 40 to 60 lb or 15 G, 26.7 to 40 lb or 20 G, 20 to 30 lb (RUP).

White grubs.

Effective chemical control is not presently available.

SEED TREATMENT

DISEASES

Fusarium tuber rot (Fusarium spp.) (Fall treatment). Treat seed going into storage or at the time of shipping. This must be done at least 6 weeks before planting.

Mertect 340, 0.42 fl oz/ton of potatoes applied in enough water for complete coverage. Apply as a spray to potato tubers (seed and table stock) at time of storage and again at removal. See manufacturer's recommendations for equipment and methods to use. Treatment may be applied to washed or unwashed potatoes.

SEED TREATMENT AND HANDLING

Disinfection of cutting knives -- Spray, mist dip surface of knives:

Chlorine dioxide (Penetraat ClO₂ or Oxine) solution 2,500 to 2,900 ppm (1 1/4 to 1 1/2 parts commercial 2% formulation in 10 parts of water).

or

Formaldehyde, 1 pt to 15 gal of water. Rinse implements after use. Avoid contact with food.

DISEASES

Fusarium tuber rot (Fusarium spp.), dip or dust cut or whole seed just before planting.

Tops 2.5 D, 1 lb per 100 lb seed.

- or
 - Captan 10 Potato Seed Protectant, 12 oz per 100 lb cut seed pieces.
- or

Manzate 200 80 W, 2 1/2 lb per 100 gal water. Dip, drain and plant as soon as possible.

or

Manex II 4 F, 1 gal per 50 gal water. Dip whole or cut tubers. Place in a clean container and plant as soon as possible after treatment. or

Manex 4 F, 0.8 qt per 10 gal water. Treat as above.

or

74

Maneb 80 W, 1 lb per 10 gal water. Treat as above.

or

Penncozeb 80 W, 1 1/4 lb per 50 gal water. Treat as above.

- or
 - Dithane M-45 80 W, 1 1/4 lb per 50 gal water. Treat as above.
- or
 - *Dithane* F-45 4 F, 1 qt per 50 gal water. Treat as above.

Use only as directed. DO NOT feed treated seed to livestock.

Rhizoctonia disease (*Rhizoctonia solani*), dust cut or whole seed just before planting.

TOPS 2.5 D, 1 lb/100 lb seed.

FURROW TREATMENT

INSECTS

Colorado potato beetle, potato leafhopper and aphids.

*Admire 2 F, 0.9 to 1.3 oz per 1,000 row ft. Apply directly on seed in furrow. (Use high rate for muck soil. Consult label for rotation restrictions. Contact local MSU Extension office for guidelines to reduce resistance build-up in Colorado potato beetle).

Aphids, flea beetles, leafhoppers. Apply in seed furrow or with fertilizer band at planting. Check the package label for further directions and limitations.

Di-Syston 15 G, 23 oz (or 8 EC, 3.5 fl oz)/1,000 row ft (75 days) (RUP). An additional application may be made as a sidedress treatment. Not recommended for control of Colorado potato beetles.

or

Thimet 20 G, 11.3 oz (for light, sandy soils) 17.3 oz (for heavy, clay soils)/1,000 row ft (90 days). May also help control Colorado potato beetles.

FOLIAR TREATMENT

INSECTS

lea beetles, apply as needed when pest populations are present in damaging numbers. May occur soon after plants emerge and again in late July and August. Endosulfan (*Thiodan*) 3 EC, 2 pt or 50 WP, 1 1/2 lb (0 days) --- Consult label for rotation restrictions.

Permethrin

--*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (7 days) (RUP).

--*Ambush* 2 EC, 6.4 oz or 25 WP, 6.4 oz (7 days) (RUP).

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or
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or

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Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).
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or
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Methyl parathion 7.5 EC, $1 \ 1/2 \text{ pt}$ (5 days).

Diazinon 4 EC, 3/4 pt (35 days) (RUP).

Monitor 4 EC, 1 1/2 pt (14 days) (RUP).

or

or

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (6 days) (RUP).

or

Guthion Solupak 50 WP, 3/4 to 1 1/2 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

or *Penncap-M* 2 F, 2 to 4 pt (5 days) (RUP).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (7 days).

or Furadan 4 F, 1 pt (14 days) (RUP). Consult label for further restrictions.

or

Asana XL, 5.8 oz (7 days) (RUP).

Colorado potato beetle, apply as needed. Contact your MSU Extension office for resistance test kits and management of insecticide resistant beetles. PBO (*Butacide, Prentox PBO-8, Incite*) at 1/2 to 1 pt per acre may be effective as a synergist to block MFO resistance to organophosphate (*Guthion, Imidan*, etc.) and pyrethroid (*Asana*, etc.) insecticides.

Guthion Solupak 50 WP, 3/4 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications. (Higher rates, labeled for leafhopper control, may be

^{*}Provado 1.6F, 3.75 fl oz (7 days). Maximum of 4 applications. Do not use if Admire was used at planting. Do not use in Allegan, Lake, Monroe, Muskegon, Newaygo, and Oceana Counties because of risk to endangered species. Consult label for rotation restrictions. Contact local MSU Extension office for guildelines to reduce resistance build-up in Colorado potato beetle.

or

Potatoes

or Furadan 4 F, 2 pt (14 days) (RUP). Consult label for further restrictions. Do not use more than once per season or serious resistance problems may develop.

necessary in some situations.)

or

Bacillus thuringiensis tenebrionis Novodor, M-Trak, or Foil (0 days). Small larvae only. Do not mix Foil with Bravo. or

Asana XL, 9.6 oz (7 days) (RUP).

or

Permethrin

- --Ambush 2 EC, 12.8 oz or 25 WP, 8 oz (7 days) (RUP).
- --Pounce 3.2 EC, or 25 WP, 4 to 8 oz (7 days) (RUP).

or

Endosulfan (Phaser, Thiodan) 3 EC, 1 1/3 qt or 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Penncap-M 2 F, 2 to 6 pt (5 days) (RUP).

or

Vydate 2 L, 2 to 4 pt (7 days).

Leafhoppers, apply as needed.

*Dimethoate (Cygon) 4 EC, 1/2 to 1 pt (0 days). or

*Provado 1.6F, 3.75 fl oz (7 days). Maximum of 4 applications. Do not use if Admire was used at planting. Do not use in Allegan, Lake, Monroe, Muskegon, Newaygo, and Oceana Counties because of risk to endangered species. Consult label for rotation restrictions. Contact local MSU Extension office for guildelines to reduce resistance build-up in Colorado potato beetle.

or

Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, $1 \frac{1}{2}$ lb (0 days).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Methyl parathion 7.5 EC, $1 \frac{1}{2} \text{ pt}$ (5 days). or

Malathion 5 EC, 1 pt (0 days).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (6 days) (RUP).

or Diazinon 4 EC, 3/4 pt (35 days) (RUP).

or

Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

or Imidan 70 WP, 1 1/3 lb (7 days).

or

Monitor 4 EC, 1 1/2 pt (14 days) (RUP). or

Metasystox-R 2 SC, 2 pt (7 days).

or

Furadan 4 F, 1 pt (14 days) (RUP). Consult label for further restrictions.

or Permethrin

- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (7 davs) (RUP).
- --Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (7 days) (RUP).

or

Penncap-M 2 F, 2 to 4 pt (5 days) (RUP).

or Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

Aphids, treat as needed. Control is especially important to reduce virus disease in seed potato production.

*Monitor 4 EC, 1 1/2 pt (14 days) (RUP).

or

- *Provado 1.6F, 3.75 fl oz (7 days). Maximum of 4 applications. Do not use if Admire wa used at planting. Do not use in Allegan, Lake, Monroe, Muskegon, Newaygo, and Oceana Counties because of risk to endangered species. Consult label for rotation restrictions. Contact local MSU Extension office for guildelines to reduce resistance build-up in Colorado potato beetle.
- or

Metasystox-R 2 SC, 2 pt (7 days).

or

Dimethoate (Cygon) 4 EC, 1 pt (0 days).

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (6 days) (RUP).

or

or

Di-Syston 8 EC, 1 pt (30 days) (RUP). Consult label for further restrictions.

or

Methyl parathion 7.5 EC, $1 \frac{1}{2}$ pt (5 days). or

Diazinon 4 EC, 3/4 pt (35 days) (RUP).

or

Endosulfan (Phaser, Thiodan) 3 EC, 2 pt or 50 WP, 1 1/2 lb (1 day).

Tarnished plant bug.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

Penncap-M 2 F, 2 to 4 pt (5 days) (RUP).

Cutworms, armyworm and loopers, apply as necessary.

- *Monitor 4 EC, 1 1/2 pt (14 days) (RUP).
- or
 - *Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (6 days) (RUP).
- or
 - **Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (7 days) (RUP).
- or
 - *Asana XL, 5.8 to 9.6 oz (7 days) (RUP).
- or
 - Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 1/3 qt (1 day).
- or
- Carbaryl (*Sevin*) 80 S, 1 1/2 to 2 1/2 lb; or XLR Plus, 1 to 2 qt; or 5 B, 40 lb or 20 B (10 lb) (0 days).

Penncap-M 4 F, 2 to 4 pt (5 days) (RUP).

European corn borer, plan treatment to coincide with egg laying period.

*Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

- or
 - *Permethrin
 - --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (7 days).
 - --*Ambush* 2 EC, or 25 WP, 6.4 to 12.8 oz (7 days) (RUP).
- or
- Furadan 4 F, 1 1/2 to 2 pt (14 days) (RUP). or
 - *Guthion* Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.
- or
 - Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

Endosulfan (*Thiodan*) 3 EC, 2 2/3 pt or 50 WP, 20 lb (0 days). Consult label for rotation restrictions.

or

Penncap-M 4 F, 2 to 4 pt (5 days) (RUP).

or Monitor 4 EC, 1 1/2 pt (14 days) (RUP).

DISEASES

Early blight (*Alternaria solani*), apply every 7 to 10 days after emergence.

Manzate 200 80 W, 1 to 2 lb (3 days). May be

used through irrigation equipment.

Dithane M-45 80 W, 1 to 2 lb (3 days). May be used through irrigation equipment.

Penncozeb 80 W, 1 to 2 lbs (3 days).

- $M_{apov} = 1 \frac{1}{4} \frac{1}{4} \frac{1}{2} \frac{1}{2}$
- Manex 4 F, 1 1/4 to 1 1/2 qt (3 days).

Manex II 4 F, 4/5 to 1 3/5 qt (3 days).

Polyram 80 DF, 2 lb (3 days).

- Maneb 80 W, 1 1/2 to 2 lb (3 days).
- *Bravo* Zn 40.4 FL, 1 to 2 1/8 pt (0 days). May be used through irrigation equipment.
- or

or

or

or

or

or

or

- Bravo 720, 3/4 to 1 1/2 pt (0 days). May be used through irrigation equipment. or
 - *Rovral* 50 W, 2 lb (14 days). See label for rotational crop restrictions.
- or *Rovral* 4 F, 1 to 2 pt (14 days). See label for rotational crop and other restrictions.
- or Terranil 6 L, 3/4 to 1 1/2 pt (0 days). May be used through irrigation equipment.

Late blight (*Phytophthora infestans*), apply after plants are 6 inches tall and every 14 days thereafter.

**Ridomil/Bravo* 81 W, 1 1/2 to 2 lb (7 days), apply at flowering and once more 14 days later. Use registered protectant fungicides (below) for late season applications. Only crops listed on the *Ridomil/Bravo* label can be planted for 12 months following the last application.

or

**Ridomil* MZ 58, 1 1/2 to 2 lb (3days), apply at flowering and once more after 14 days. Use registered protectant fungicides (below) for late season disease control. Wheat, barley and oats can be planted 40 days after the last application.

or

Ridomil/Copper 70 W, $1 \frac{1}{2}$ to $2 \frac{1}{2}$ lb (7 days). Begin applications when conditions are favorable for disease and continue at 14 day intervals. Wheat, barley, and oats can be planted 14 days following the last application.

Note: Apply additional fungicide using one of the fungicides recommended above on alternate weeks for early blight control. Better results have been obtained using ground sprays than with aerial applications due to improved leaf

or

Potatoes

coverage. Apply when plants are 4 to 6 inches high and repeat every 7 to 10 days. *Manzate* 200 75 DF, 1 to 2 lb (3 days). May be used through irrigation equipment.
Or *Dithane* F-45 4 FL, 1.6 to 3.2 pt (3 days). May

be used through irrigation equipment.

Dithane M-45 80 W, 1 to 2 lb (3 days). May be used through irrigation equipment.

or

or

Penncozeb 80 W, 1 to 2 lbs (3 days).

Maneb 80 W, 1 1/2 to 2 lb (3 days).

or

Bravo 720, 3/4 to 1 1/2 pt (0 days). May be used through irrigation equipment.

or

Terranil 6 L, 3/4 to 1 1/2 pt (0 days). May be applied through irrigation equipment.

Polyram 80 DF, 2 lb (3 days).

or

or

Manex 4 F, 4 to 5 pt (3 days).

or

Champ Formula 2 Copper 37.5% F, 2 to 5 pt (0 days).

or

Kocide 2.4 LF, 2 lb (0 days).

or

Copper Count-N, 1 to 2 pt (0 days).

or Top C

Top Cop with sulfur 54.4% FL, 4 to 6 pt (0 days).

Late blight tuber rot (Phytophthora infestans) leak (Pythium spp.), and pink rot (Phytophthora erythroseptica), apply at flowering and again 14 days later.

Ridomil MZ-58, 1 1/2 to 2 lbs (7 days).

Botrytis blight (*Botrytis cinerea*), apply after mid-season when disease symptoms are likely to appear.

Bravo 720, 1 to 1 1/2 pt (0 days).

White mold (*Sclerotinia sclerotiorum*), apply at first sign of disease or immediately prior to row closing, and again 28 days later if needed.

Rovral 4 F, 2 pt in at least 10 gal water per acre (14 days). See label for rotational crop restrictions.

PRE-HARVEST SPRAYS

DISEASES

Late blight, when vines are seriously infected at harvest time, apply as necessary.

These may be applied separately or in combination with vine killers (0 days).

Champ Formula 2 Copper 37.5% F, 2 to 5 pt. or

Kocide 2.4 LF, 2 lb.

or Copper Count-N, 1 to 2 pt.

PRE-STORAGE TREATMENTS

STORAGE DISEASES

Bacterial soft rot (*Erwinia carotovora*), wash potatoes in chlorinated water to (1) disinfect tuber surfaces; (2) cauterize wounds; and (3) promote rapid formation of protective tissue over injured surfaces.

Add a concentrated stock solution of chlorine (sodium hypochlorite) to wash water to give a concentration of 200 ppm million (= 1 quart household bleach (5.25% sodium hypochlorite) per 60 gal of water or 1 gal of bleach per 240 go f water).

Mix stock solutions or chlorine in earthenware crocks or plastic containers. DO NOT USE metal containers. Dry washed potatoes before bagging or bulk storing by passing hot air over the end of the sorting table. Usually, the sponge drying technique is inadequate without the addition of heat.

Fusarium dry rot (Fusarium spp.).

Mertect 340, 42 oz flowable formulation in 100 gal of water. Apply as a spray to potato tubers (seed and table stock) at time of storage and again at removal; 1 gal of solution per 2,000 lb of tubers. See manufacturer's recommendations for equipment and methods to use. Treatment may be applied to washed or unwashed potatoes. Addition of chlorine (200 ppm) to solution will help control bacterial soft rot. It is advisable to add a wetting agent when treating before storage to ensure good coverage.

Mix stock solutions or chlorine in earthenware crocks or plastic containers. DO NOT USE metal containers. Dry washed potatoes before baggir or bulk storing by passing hot air over the end of he sorting table. Usually, the sponge drying hnique is inadequate without the addition of ...cat.

STORAGE DISINFECTION

To disinfect storages, boxes, truck beds, bags and equipment (tools, farm machinery), spray or drench surfaces with one of the following compounds.

8-copper quinolinolate (*Penetraat* or *Cunilate*) at manufacturer's recommended rate.
8-copper quinolinolate is not recommended for tools and farm machinery.

or

Chlorine solution (*sodium hypochlorite*), 1,000 to 2,000 ppm concentration. Commercial formulations vary in concentration; therefore, follow manufacturer's recommendations when mixing solutions. Example: Perchlorin is a granule containing 70% calcium hypo-chlorite. It takes 5 teaspoons in 3 gal of water to make a solution of 1,000 ppm. Rinse food containers and implements that come in contact with food after treatment.

Chlorine dioxide (*Oxine*), 2,500-2,900 ppm (1.25 to 1.5 parts commercial 2% formulation to 10 parts water). Rinse food containers and implements that come in contact with food after treatment.

or

Quaternary ammonium compounds. Hyamine 2389 (Rohn & Haas), Odorless Disinfectant (Haviland) or Aquahyme (E-Z Flo). Use according to manufacturer's recommendations. The addition of a wetting agent with quaternary ammonium sprays or drenches is suggested to obtain more uniform coverage of surfaces. Use only those wetting agents recommended by the manufacturer because some are not compatible. Rinse food containers and implements that come in contact with food after treatment.

or

Soluble copper sulfate (blue vitriol, bluestone, etc.) 10 to 15 lb in 100 gal of water.

or

Formaldehyde, 1 pt in 15 gal of water. Since this material is highly volatile, it has a fumigating action. Therefore, close-treat storages and cover treated equipment for 24 hours before airing until there is no longer an odor. **NOTE**: Do not inhale formaldehyde fumes.

Note: It is important to remove all dirt and trash from surfaces to be treated.

PUMPKINS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SEED TREATMENT

INSECTS

Seed corn maggot.

Lindane (*Isotox Seed Treater F*), 4 oz/100 lb seed as planter box treatment.

DISEASES

Damping off (*Pythium* spp., *Phytophthora* spp., *Rhizoctonia solani*).

Thiram 50 WP Dyed, 4.5 oz/100 lb seed. Use only as directed; over-treatment may cause injury.

Ridomil 2 E, 4 to 8 pt. or

or

Captan 300, 1 2/3 oz/100 lb seed.

Captan 30-DD, 1 2/3 oz/100 lb seed.

or Captan 400, 1 1/2 to 2 oz/100 lb seed.

or

Captan 400-D, 1 1/2 to 2 oz/100 lb seed.

or *Captan* 75%, 8 oz/100 lb seed.

or

or

42-S Thiram, 4 1/2 oz/100 lb seed.

Anchor 1.5 oz/100 lb seed (*Pythium* spp. only).

PREPLANT INCORPORATED

INSECTS

Cucumber beetles.

**Furadan* 4 F, 2.4 oz/1000 ft of row (RUP). Apply at planting or transplanting in a 7inch band, incorporate into the top 3 inches of soil, or apply into the furrow and mix

or

Pumpkins

with the covering soil. (Special Michigan SLN label.)

FOLIAR TREATMENT

Pumpkin plants may be sensitive to insecticide formulations under certain conditions. Be sure a problem exists before treatment. Read and observe restrictions or the label. To avoid killing bees, do not treat pumpkins during bloom. See pages 18-20 for relative safety of insecticides to bees.

INSECTS

Cutworms, apply when damage is first seen and repeat as needed.

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Dylox 80 SP, 1 1/4 lb (3 days). Maximum of 3 applications.

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Striped and spotted cucumber beetles, apply as soon as beetles are seen and repeat as needed to prevent bacterial wilt disease.

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Endosulfan (*Phaser, Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

Flea beetles, apply as needed.

Methoxychlor 50 WP, 2 lb (1 day).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

Leafhoppers, apply when damage is seen.

Carbaryl (Sevin) 80 S, 1 1/4 lb (0 days).

or

Dibrom 8 EC, 1 pt (1 day).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Squash bugs, apply as needed.

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days)

or

Dylox 80 SP, 1 1/4 lb (3 days). Maximum of 3 applications.

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Squash vine borer, apply to base of plants when moths are active, usually starting when plants start to vine. Repeat every 3 to 5 days for 3 weeks.

Permethrin

- --*Ambush* 2 EC, 6.4 to 12.8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --Pounce 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

Malathion 5 EC, 3 pt (3 days)

Aphids, apply as needed to prevent disease transmission to plants. Repeat as needed.

Metasystox-R 2 SC, 1 1/2 to 2 pt (14 days).

or

Malathion 5 EC, 1 1/2 pt (3 days).

or Endosulfan (*Phaser, Thiodan*) 3 EC, 1 qt or 50 WP 1 1/2 lb (2 days).

Mites, apply when needed. Usually a problem only in hot dry weather.

Dibrom 8 EC, 1 pt (1 day).

or

Malathion 5 EC, $1 \frac{1}{2}$ pt (3 days).

Slugs.

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

PISEASES

Alternaria leaf spot (Alternaria cucumerina), anthracnose (Colletotrichum lagenarium), apply every 7 to 10 days after disease appears.

Terranil 6 L, 1 1/2 to 2 pt, 7-day intervals (0 days).

or

Bravo 90 DG, 1 1/4 to 1/12 lb.

or

Bravo 720 6 F, 1 1/2 to 2 pt.

or

Benlate 50 WP, 1/4 to 1/2 lb (0 days).

or

Benlate 50 DF, 1/4 to 1/2 lb (0 days).

or

Topsin M, 8 oz (0 days).

Scab (*Cladosporium cucumerinum*), apply every 7 to 10 days after plants are 2 to 3 inches tall.

Terranil 6 L, 2 to 3 pt, 7-day intervals (0 days). or

Bravo 720 6 F, 2 to 3 pt (0 days).

or

Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days).

pwdery mildew (Sphaerotheca fuliginea, rysiphe cichoracearum).

*Bayleton 50 WP or 50 DF, 2 to 4 oz (0 days). Treat at disease appearance and at 14-day intervals. A maximum of 16 oz may be applied per season. Will not give commercially acceptable control of Sphaerotheca fuliginea.

or

Terranil 6 L, 2 to 3 pt (0 days). Treat when conditions favor disease and at 7-day intervals.

or

Bravo 720 6 F, 2 to 3 pt (0 days). Treat when conditions favor disease and at 7-day intervals.

or

Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days). Treat when conditions favor disease and at 7-day intervals.

or

Copper sulfate 53 W, 2 lb (0 days). Treat at disease appearance and at 7-day intervals. or

Kocide DF, 1 1/2 to 3 lb (0 days). Treat at disease appearance and at 7-day intervals. or

Champ F, 2 to 4 pt (0 days). Treat at disease appearance and at 7-day intervals.

Gummy stem blight or black rot (*Didymella bryoniae*--also called *Mycosphaerella melonis*), begin at the 2-leaf stage and apply every 7 to 10 days.

Terranil 6 L, 2 to 3 pt, 7-day intervals (0 days).

Bravo 720 6 F, 2 to 3 pt (0 days).

Benlate 50 WP, 1/4 to 1/2 lb (0 days).

Benlate 50 DF, 1/4 to 1/2 lb (0 days).

Bravo W-75, 2 to 3 lb (0 days).

Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days).

Downy mildew (*Pseudoperonospora cubensis*). Begin applications when conditions are favorable for disease, but before infection and continue at 14-day intervals until the threat of disease is over.

*Ridomil/Bravo 81 W, 1 1/2 to 2 lb.

or

or

or

or

or

or

or

or

*Ridomil/Copper 70 W, 1 1/2 to 2 lb.

Note: Do not make more than a total of four foliar applications.

Spray at 7- to 10-day intervals.

Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

Maneb 80 W, 1 1/2 to 2 lb (5 days).

Manex 4 F, 1 1/5 to 1 3/5 gt (5 days).

Terranil 6 L, 1 1/2 to 2 pt, 7-day intervals (0 days).

Phytophthora damping off (Phytophthora spp.).

Ridomil 2 E, 4 to 8 pt at planting using a 7-in band. If natural rainfall is not expected before the seeds start germinating, Ridomil 2E should be incorporated mechanically before planting or be moved into the seed zone after planting with 1/2 to 1 in sprinkler irrigation.

Currently there are no fungicides registered to control the crown and fruit rot phase of *Phytophthora* rot. Fungicides applied to control downy mildew may have limited efficacy against *Phytophthora*.

82

Radishes

RADISHES

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SOIL TREATMENT

NEMATODES

Root-knot nematodes can reduce radish yields. Fields with soil or root problems of undetermined cause should be tested for nematodes (see Appendix B). If the above plant-parasitic nematodes are present in population densities above the economical threshold for radishes, crop rotation or application of a nematicide is recommended. The following nematicides are suitable for control of root-knot nematodes in radish production. Application is only needed before first crop. The radish life cycle is shorter than that of the northern root-knot nematode and radishes serve as a good trap crop for this nematode.

FALL SOIL TREATMENT (Broadcast)

NEMATODES

1,3-D

-- Telone II, 36 gal (muck soil) (RUP).

Fumigate in the fall when soil temperatures at a 6 inch depth are above 50° F. Inject the fumigant to soil depth of 6 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

SEED TREATMENT

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

or Captan 300, 1 1/4 oz/100 lb seed.

or Captan 30-DD, 1 1/4 oz/100 lb seed.

or

- *Captan* 400, 1 to 2 oz/100 lb seed. or
- Captan 400-D, 1 to 2 oz/100 lb seed. or
- Captan 75%, 1 oz/100 lb seed.
- or
- 42-S Thiram, 8 oz/100 lb seed. or

Anchor, 1.5 oz/100 lb seed (Pythium spp. only).

SOIL TREATMENT

DISEASES

Damping off (*Pythium* spp.), apply as a single preplant application.

Ridomil 2E, 4 - 8 pt in a 7 inch band.

INSECTS

Cabbage maggot.

Lorsban 15 G, 3.3 oz or 4 EC, 1 fl oz/1,000 of row, in row with seed at time of planting.

or

Dyfonate II 10 G, 20 lb or 15 G, 13.4 lb broadcast and incorporated prior to seedi (RUP).

FOLIAR TREATMENT

INSECTS

Armyworm or cutworms, apply as needed.

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

Flea beetle, apply when damage is first seen. Repeat if needed.

Carbaryl (Sevin) 80 S, 2/3 to 1 1/4 lb or XLR Plus, 1/2 to 1 qt (3 days)

or

Methoxychlor 50 WP, 2 lb (14 days).

or

Diazinon 4 EC, 1 pt (10 days) (RUP).

Asana XL, 5.8 to 9.6 oz (7 days) (RUP).

Cabbage worms, apply as needed.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

or

or

Methoxychlor 50 WP, 2 lb (14 days).

Densilling 4

*Bacillus thuringiensis Agree, Biobit, Cutlass, Dipel, Javelin, MVP or Thuricide (0 days).

phids, apply as necessary.

Malathion 5 EC, 2 pt (7 days).

Diazinon 4 EC, 1 pt (10 days) (RUP).

Slugs.

or

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Alternaria leaf spot, (*Alternaria raphani*), apply after plants are fully emerged and repeat at 7- to 10-day intervals.

Top-Cop Tribasic, 1 to 2 qt (0 days).

Downy mildew, (*Peronospora parasitica*), apply as a single preplant application.

Ridomil 2 E, 4 to 8 pt in a 7 inch band.

White rust (*Albugo candida*). Apply preplant or at planting.

Ridomil 2 E, 4 to 8 pt.

Apply foliar spray 40 to 50 days following *Ridomil* 2 E at-planting application and make 2 to 4 applications on a 14-day schedule depending on disease development.

Ridomil/Copper 70 W, 2 lb (7 days).

RHUBARB

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SANITATION AND DISINFECTION OF FORCING HOUSES

DISEASES

Leaf rot or gray mold (*Botrytis cinerea*), treat walls, ceiling and soil with a disinfectant when the house is empty.

Formaldehyde, 1 pt to 15 gal of water. Use formaldehyde only as directed. (See

appendix).

Chlorine dioxide (*Penetraat Cl0*₂) 2,500 to 2,900 ppm (1 to 1 part of commercial 2% formulation to 10 parts of water).

INSECTS

or

Fruit flies.

Chemical control is not presently available for this use. Sanitary measures must be emphasized to reduce these flies.

SEED TREATMENT

DISEASES

Damping off (*Pythium* spp.).

Anchor, 1.5 oz/100 lb seed.

FOLIAR TREATMENT

INSECTS

Cutworms and loopers.

Permethrin

- --Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Larvin (thiodicarb) 3.2 EC, 16 to 30 oz (14 days).

Rhubarb curculio.

No materials are currently registered for this use.

DISEASES

Leaf rot and Botrytis gray mold (Botrytis cinerea).

No fungicides are currently labeled for this disease.

RUTABAGAS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SEED TREATMENT

DISEASES

Damping off (*Pythium* spp.), apply as a pre-plant incorporated application or as a surface pre-plant application.

Ridomil 2 E, 4 to 8 pt. See label for application instructions.

or

Anchor, 1.5 oz/100 lb seed.

SOIL TREATMENT

INSECTS

Cabbage maggot, apply in a 4- to 6-inch band around seed at time of planting so plants grow in treated soil.

Lorsban 15 G, 4.6 to 9.2 oz or 4 E, 1.6 to 3.3 fl oz per 1,000 ft of row.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply if necessary.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

or

Methoxychlor 50 WP, 2 lb (7 days).

or

Methyl parathion 7.5 EC, 1 to 2 pt (21 days). (7 days for 1 pt rate.)

Cabbage worms, apply if damage is severe.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days).

or Methoxychlor 50 WP, 2 lb (7 days).

or

*Bacillus thuringiensis Agree, Biobit, Cutlass, Dipel, Javelin, MVP or Thuricide (0 days).

Aphids, apply as needed to prevent population build up.

Malathion 5 EC, $1 \frac{1}{2}$ pt (7 days).

or

Methyl parathion 7.5 EC, 1 to 2 pt (21 days) (7 days for 1 pt rate).

SPINACH

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SEED TREATMENT

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 8 oz/100 lb seed.

Ridomil 2 E, (*Pythium* only), apply 4 to 8 pt at planting as a 7-inch band.

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or
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or

Anchor, 1.5 oz/100 lb seed (Pythium only).

White Rust (Albugo occidentalis).

Ridomil 2 E, apply 4 to 8 pt at planting. Two additional applications (1 pt) can be made 40 days following the pre-plant application (see label).

FOLIAR TREATMENT

INSECTS

Flea beetles, may be a problem on young seedlings. Apply as needed.

Permethrin

- --*Pounce* 3.2 EC, 4 to 8 or 25 WP, 6.4 to 12.8 oz (7 days) RUP).
- --Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (7 days) (RUP).
- or

Carbaryl (*Sevin*) 80 S, 2/3 to 1 1/4 lb or XLR Plus, 1/2 to 1 qt (14 days).

or or

Methoxychlor 50 WP, 2 lb (14 days).

Methyl parathion 7.5 EC, 1/2 to 1 pt (21 days).

Crown maggots (several species are involved).

Chemical control is not presently available fc. this use.

afhoppers, apply as necessary.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (14 days).

or

- Permethrin
- --Ambush 2 EC or 25 WP, 6.4 oz (7 days) (RUP).
- --*Pounce* 3.2 EC, 4 oz or 25 WP, 6.4 oz (7 days) (RUP).

or

Methoxychlor 50 WP, 2 lb (14 days).

or

Dimethoate (Cygon) 4 EC, 1/2 pt (14 days).

or

Methyl parathion 7.5 EC, 1/2 to 1 pt (21 days).

Loopers and armyworm, apply when insects are small.

- * Permethrin
- --Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).
- --*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

**Lannate* 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (7 days) (RUP). Do not apply to seedlings less than 3 inches in diameter.

Larvin (thiodicarb) 3.2 EC, 16 to 30 oz (14 days).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (14 days).

or

Methoxychlor 50 WP, 2 lb (14 days).

or

Dibrom 8 EC, 1 pt (1 day). Ground application only.

or

*Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply as needed to avoid contamination at harvest.

Dimethoate (*Cygon*) 4 EC, 1/2 pt (14 days). or

Endosulfan (*Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (21 days). Maximum of one application.

or

or

Methyl parathion 7.5 EC, 1/2 to 1 pt (21 days). or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days) (RUP).

Dibrom 8 EC, 1 pt (1 day). Ground application only.

Malathion 5 EC, 2 pt (7 days).

Leaf miners, apply when eggs are first seen on undersides of leaves to prevent miners from entering leaves. Treatment after larvae are in the leaf is generally unsuccessful. Early-planted spinach usually is less susceptible to damage than when planted late.

Dimethoate (Cygon) 4 EC, 1/2 pt (14 days).

or Permethrin

--Ambush 2 EC or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

--*Pounce* 3.2 EC, 4 to 8 oz or 25 WP, 6.4 to 12.8 oz (1 day) (RUP).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (10 days) (RUP).

or

Dibrom 8 EC, 1 pt (1 day).

Slugs.

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Downy mildew (*Peronospora effusa*), apply as needed.

Copper sulfate 53 W, 2 to 4 lb (0 days).

Top Cop with sulfur, 2 to 4 qt (0 days).

Anthracnose (Colletotrichum spinaciae).

No materials are currently registered for this use.

Cercospora leaf spot (Cercospora beticola).

Top Cop with sulfur, 2 to 4 pt (0 days).

SQUASH

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SEED TREATMENT

Squash

INSECTS

Seed corn maggot.

Lindane (*Isotox Seed Treater F*), 4 oz as planter box treatment.

DISEASES

Damping off (Pythium spp., Rhizoctonia solani).

Thiram 50 WP Dyed, 4.5 oz/100 lb seed. Use only as directed. Over-treatment may cause injury.

or

Ridomil 2 E, 4 to 8 pt.

or

Captan 300, 1 2/3 oz/100 lb seed.

or Captan 30-DD, 1 2/5 oz/100 lb seed.

- or Captan 400, 1 1/2 to 2 oz/100 lb seed.
- or

Captan 400-D, 1 1/2 to 2 oz/100 lb seed.

Captan 75%, 1 1/3 oz/100 lb seed.

or

42-S Thiram, 4 1/2 oz/100 lb seed.

or

Anchor, 1.5 oz/100 lb seed (*Pythium* spp. only).

SEEDBED PREPARATION

DISEASES

Damping off, root rots (*Pythium* spp., *Rhizoctonia solani*), grow transplants in disease-free soil (sterilized) and fumigate fields before planting. To sterilize soil, use steam or fumigate with chemicals suggested for seedbed sterilization on page 95.

Follow manufacturer's recommendations for use with particular crops. Avoid planting until soil is free of fumigant.

PREPLANT INCORPORATED

INSECTS

Cucumber beetles.

**Furadan* 4 F, 2.4 oz/1000 ft of row (RUP). Apply at planting or transplanting in a 12to 15-inch band, incorporate into the top 3 inches of soil or apply into the furrow and mix with the covering soil. (Special Michigan SLN label.)

FOLIAR TREATMENT

INSECTS

Summer and winter squash plants may be sensitive to certain insecticide formulations. Make certain a problem exists before treatment. Read and observe restrictions on the label. To avoid killing bees, do not treat plants during bloom.

Cutworms, apply as needed.

*Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Striped and spotted cucumber beetles, apply when first seen and repeat as needed to prevent bacterial wilt disease.

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

or

- Methoxychlor 50 WP, 2 lb (1 day).
- Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 gt (0 days).

or Malathion 5 EC, 3 pt (1 day).

or

Dibrom 8 EC, 1 pt (0 days). Use on summer squash only.

or

Lannate 1.8 L, 2 pt or 90 SP 1/2 lb (1 day) (RUP). Use on summer squash only.

Flea beetles, apply if needed.

Carbaryl (*Sevin*) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

Methoxychlor 50 WP, 2 lb (1 day).

or

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP). Use on summer squash only.

Leafhoppers, apply if necessary.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Diazinon 4 EC, 1 pt or 50 WP, 1 lb (7 days for summer squash; 3 days for winter squash) (RUP).

or

Dibrom 8 EC, 1 pt (1 day). Use on winter squash only.

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Squash bug, apply as needed.

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

Squash vine borer, apply to base of plants when moths are active, usually starting when plants start to vine. Repeat as needed.

Endosulfan (*Phaser, Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

Asana XL, 5.8 to 9.6 oz (3 days) (RUP).

or

Methoxychlor 50 WP, 2 lb (1 day).

or

Malathion 5 EC, 3 pt (1 day).

Aphids, apply when first seen to avoid disease ismission to plants. Repeat as needed.

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 1 qt or 50 WP, 1 1/2 lb (2 days).

or

Malathion 5 EC, 1 1/2 pt (1 day).

or

Diazinon 4 EC, 1 pt, 50 WP, 1 lb (7 days-summer squash; 3 days--winter squash) (RUP).

or

Metasystox-R 2 SC, 1 1/2 to 2 pt (3 days-summer squash; 14 days--winter squash).

or

Dibrom 8 EC, 1 pt (0 days). Use on summer squash only.

Mites, apply when needed. Usually a problem only in hot, dry weather.

Diazinon 4 EC, 1 pt; 50 WP, 1 lb (7 days-summer squash; 3 days--winter squash) (RUP).

or

Dibrom 8 EC, 1 pt (0 days--summer squash; 1 day--winter squash).

or

Malathion 5 EC, 1 1/2 pt (1 day).

Marips, apply when damage is seen. Repeat as needed.

Diazinon 4 EC, 1 pt, 50 WP, 1 lb (7 days for summer squash; 3 days for winter squash)

(RUP). or

Slugs.

Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product.

DISEASES

Powdery mildew (Sphaerothera fuliginea or *Erysiphe cichoracearum*), treat at disease appearance.

**Bayleton* 50 WP or 50 DF, 2 to 4 oz (0 days) at 14-day intervals. A maximum of 16 oz may be applied per season. Will not give commercial control of *Sphaerothera fuliginea*.

*Benlate 50 W, 1/4 to 1/2 lb (0 days).

*Topsin-M 70 WP, 1/4 to 1/2 lb.

or Kocide LF, 2 to 4 pt (0 days).

or

or

Champ Formula 2 Copper, 1 to 2 pt (0 days).

or

or

or

Bravo 720 6F, 2 to 3 pt (0 days), at 7-day intervals.

Kocide DF, 1 1/2 to 3 lb (0 days), at 7-day intervals.

Terranil 6 L, 2 to 3 pt (0 days), at 7-day intervals.

Scab (*Cladosporium cucumerinum*), treat every 7 to 10 days after plants are 2 to 3 inches tall.

Bravo 720 6 F, 2 to 3 pt (0 days). or

Terranil 6 L, 2 to 3 pt (0 days), at 7-day intervals.

Alternaria leaf spot (*Alternaria cucumerina*), treat every 7 to 10 days when conditions favor disease.

Bravo 720 6 F, 2 to 3 pt (0 days).

or Terranil 6 L, 2 to 3 pt (0 days), at 7-day intervals.

Anthracnose (*Colletotrichum lagenarium*), treat every 7 to 10 days after disease appears.

Bravo 720 6 F, 1 1/2 to 2 pt (0 days).

Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days).

or

Dibrom 8 EC, 1 pt (0 days). Summer squash only.

Squash to Sweet Potatoes

or

Benlate 50 W, 1/4 to 1/2 lb (0 days).

or Topsin M, 8 oz (0 days).

or N or

Maneb + zinc F4, 1 1/5 to 1 3/5 qt (5 days).

Maneb 80 W, 1 1/2 to 2 lb (5 days).

or

Manex 4 F, 1 1/5 to 1 3/5 qt (5 days).

or

Penncozeb 80 W, 2 to 3 lb (5 days).

or

Penncozeb 75 DF, 2 to 3 lb (5 days).

Angular leaf spot (*Pseudomonas lachrymans*). Spray every 7 days, starting before the first fruit form and continue to protect fruit at all stages of development.

Copper sulfate 53 W, 2 to 4 lb (0 days).

Gummy stem blight (*Didymella bryoniae---*also called *Mycosphaerella melonis*), begin at the 2-leaf stage and apply every 5 to 7 days.

Terranil 6 L, 2 to 3 pt (0 days).

or Bravo 7206 F, 2-3 pt (0 days).

or

Bravo 90 DG, 1 1/2 to 2 1/2 lb (0 days).

Topsin-M 70 WP, 1/4 to 1/2 lb, at 7 to 14 day intervals.

Downy mildew (*Pseudoperonospora cubensis*), treat plants at first sign of disease and continue at 14-day intervals.

*Ridomil/Bravo 81 W, 1 1/2 to 2 lb (5 days).

Apply at 7- to 10-day intervals.

Dithane 75 DF, 2 to 3 lb (5 days).

or

Dithane M-45 80 W, 2 to 3 lb (5 days). or

Dithane F-45, 1 3/5 to 2 2/5 qt (5 days).

Manex II 4 F, 1 3/5 to 2 2/5 qt (5 days).

or *Aliette WDG, 2 to 5 lb (0 days).

or

Aliette 80 W, 2 to 5 lb (0 days).

Note: Most fungicides that protect against *Alternaria*, anthracnose and gummy stem blight also provide limited downy mildew protection.

Phytophthora damping off (Phytophthora spp.)

Ridomil 2 E, 4 to 8 pt at planting using a 7-in band. If natural rainfall is not expected before the seeds start germinating, Ridomil 2 E should be incorporated mechanically before planting or be moved into the seed zone after planting with 1/2 to 1 in sprinkler irrigation.

Currently, there are no fungicides registered to control the crown and fruit rot phase of *Phytophthora*. Fungicides applied to control downy mildew may have limited efficacy against *Phytophthora*.

SWEET POTATOES

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parenthases. (RUP) = Restricted Use Pesticide.

SEED (ROOT) TREATMENT

DISEASES

Black rot, scurf (*Ceratostomella simbriata, Monilochaetes infuscans*), dip roots and sprouts in one of the following suspensions for 5 minutes. Plant immediately.

Mertect 340 F, 53 1/2 oz per 50 gal of water (8 oz/7 1/2 gal). Do not use treated roots for food or feed.

or

Botran 75 W, 1 lb/7.5 gal water, dip for 10 to 15 seconds, drain and plant immediately.

SOIL TREATMENT

NEMATODES

Root-lesion, root-knot and other nematodes are associated with sweet potato. If you believe you have a nematode problem associated with sweet potato production, a sample should be tested (see Appendix B). If plant-parasitic nematodes are present in population densities above estimated damage thresholds for sweet potatoes, management recommendations will be provided at that time.

SECTS

Wireworms, apply treatments evenly to soil surface before planting and incorporate 4 to 6 inches deep.

Dyfonate 10 G, 40 lb (RUP).

Diazinon 14 G, 28 lb or 4 EC, 4 qt (RUP).

FOLIAR TREATMENT

INSECTS

Flea beetles, apply when damage is first seen.

Methoxychlor 50 WP, 2 lb (0 days).

or

or

Sevin XLR Plus, 1 to 2 qt (0 days).

Armyworm, apply when feeding damage is first seen.

Methoxychlor 50 WP, 2 lb (0 days).

or Carbaryl (Sevin) XLR Plus, 1 to 2 qt (0 days).

afhopper, treat as necessary.

Malathion 5 EC, 2 pt (3 days).

Aphids.

Malathion 5 EC, 2 pt (3 days).

TOMATOES

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

*Materials marked with an asterisk are particularly recommended for problem infestations.

SOIL TREATMENT

NEMATODES

Root-knot and root-lesion nematodes can reduce tomato yields. Fields with soil or root problems of undetermined cause should be tested for ematodes (see Appendix B). If the above plantparasitic nematodes are present in population densities above the economic threshold for tomatoes, crop rotation or application of a nematicide is recommended. The following nematicide is suitable for control of root-knot and root-lesion nematodes in tomato production.

1,3-D

--Telone II, 15 gal (mineral soil).

Fumigate in the fall when soil temperatures at a 6-inch depth are above 50° F. Inject the fumigant to a soil depth of 6 to 8 inches and lightly seal the soil immediately after application. Use soil fumigants only as directed on the label. See Extension Bulletin E-1025b for details about soil fumigation. In some limited situations soil fumigants can be applied in the spring in Michigan.

Metham (*Busan* 1020 or *Vapam*) 40 to 100 gal injected with shanks spaced 5 inches apart or to a depth of 4-10 inches in well prepared soil. Follow immediately with a roller to smooth and compact surface. Light watering to the treated surface helps to prevent escape of gas.

SEED TREATMENT

DISEASES

Damping off, pre-emergence (*Pythium* spp., *Rhizoctonia solani*, *Phytophthora*).

Thiram 50 WP Dyed, 6 oz/100 lb seed. Apply to seed before planting.

or

Dithane DF, 8.5 oz/100 lb seed.

or

Ridomil 2 E, 4 to 8 pt as a broadcast surface spray immediately before or after planting, in 20 to 50 gal of water, lightly incorporated (*Pythium* only).

or

Ridomil 5 G, 20 lbs at planting (*Pythium* only).

or

Anchor, 1.5 oz/100 lb seed (Pythium only).

SEEDBED TREATMENT

DISEASES

Bacterial spot (*Xanthamonas vesicatoria*) and **bacterial speck**, (*Pseudomonas spp.*) apply when first true leaves appear and repeat at 5 day intervals.

Streptomycin (*Agri-strep*) 21 1/4 W, 1 lb in 100 gal of water (200 ppm).

Tomatoes

Note: For additional controls see foliar treatments.

INSECTS

Aphids, flea beetles and leafhoppers, apply evenly over soil surface and incorporate 2 to 3 inches, or apply evenly over soil surface after plant emergence and water thoroughly.

Di-Syston 15 G, 20 lb or 8 E, 3 pt (RUP).

PREPLANT SOIL FUMIGATION

DISEASES

Fusarium wilt (*Fusarium oxysporum*) **and verticillium wilt** (*Verticillium albo-atrum*), apply to production fields in the spring before planting. **Note**: Most fumigants applied in the soil for control of disease organisms will also control soil insects, nematodes and weed seeds.

Soil Injection

Methyl bromide, 175 to 240 lb broadcast application. See manufacturer's recommendations for method of application and covering treated soil. Aerate 2 weeks before setting transplants.

or

Metham (Vapam, Busan 1020), 75 to 100 gal injected with injector, shanks spaced 5 inches apart at a depth of 4 to 10 inches. Roll and irrigate treated surface to prevent escape of gas.

Chemigation Treatment

Metham (Busan 1020, Vapam), 75 to 100 gal applied via chemigation. Soil should be moist prior to treatments and a watersealant applied after treatment. See Bulletin E-2099. Do not plant for 14 to 30 days after treatment (the wetter the soil, the longer the waiting period).

SOIL TREATMENT

INSECTS

Aphids, flea beetles and leafhoppers, apply as a band on each side of seed furrow or transplant row at planting or after plants become established.

Di-Syston 8 E, 1.2 to 3.4 fl oz/1,000 ft (30 days) (RUP). Consult label for maximum amount allowed and further details.

Wireworms and cutworms, apply treatme evenly to soil surface before planting incorporate to a 4- to 6-inch depth.

Diazinon 14 G, 28 lb or 4 EC, 4 qt (RUP). Preplant treatment only.

FOLIAR TREATMENT

INSECTS

Cutworms, apply in late evening when damage is first seen and repeat if needed.

*Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

or

Monitor 4 EC, 1 1/2 pt (7 days) (RUP). Maximum of 3 applications. Fresh market only.

or

Carbaryl (*Sevin*) 80 S, 2 lb or 5 B, 40 lb or 20 B, 10 lb (0 days).

Flea beetles, apply if necessary.

Endosulfan (*Thiodan*) 3 EC, 1 1/3 pt or 50 WP, 1 lb (1 day). Consult label for rotation restrictions.

or

- Carbaryl (Sevin) 80 S, 1 1/4 lb (0 days). or
 - Methoxychlor 50 WP, 2 lb (1 day).

or

- Guthion Solupak 50 WP, 3/4 to 1 1/2 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.
- or

or

- *Penncap-M* 2 F, 2 to 4 pt (15 days) (RUP).
- Dibrom 8 EC, 1 pt (1 day).
- or
 - Methyl parathion 7.5 EC, 1/2 to 1 1/2 pt (21 days).
- or
 - Di-Syston 8 E, 1 to 3 pt (30 days) (RUP).

Colorado potato beetles, apply as needed

**Guthion*¹ Solupak 50 WP, 3/4 lb or 2 L (RUP), 1 1/2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

or

Monitor 4 EC, 1 1/2 to 2 pt (7 days) (RUP). Maximum of 3 applications. Fresh market only. (Michigan SLN label.)

¹ Piperonyl butoxide (*Incite, PBO-8, Butacide*) may increase effectiveness on resistant beetles.

 $1.5ana^{1}$ XL, 5.8 to 9.6 oz (1 day) (RUP).

Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2/3 qt or 50 WP, 1 lb (2 days).

or

Penncap-M 2 F, 4 pt (15 days) (RUP).

or

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

or

Bacillus thuringiensis tenebrionis Novodor, M-Trak, Trident or Foil (0 days). Small larvae only. Do not mix Foil with Bravo.

Aphids, apply as needed. May be a problem on transplants.

Dimethoate (Cygon) 4 EC, 1 pt (7 days).

- or
- Endosulfan (*Phaser*, *Thiodan*) 3 EC, 2/3 qt or 50 WP, 1 lb (2 days).

or

Monitor 4 EC, 1 1/2 to 2 pt (7 days) (RUP). Maximum of 3 applications. Fresh market only. (Michigan SLN label.)

Diazinon 4 EC, 1/2 pt or 50 WP, 1/2 lb (1 day) (RUP).

or

Di-Syston 8 E, 1 to 3 pt (30 days) (RUP).

or

Lannate 1.8 L, 2 pt or 90 SP, 1/2 lb (1 day) (RUP).

or

Methyl parathion 7.5 EC, 1/2 to 1 1/2 pt (21 days).

Leafhoppers, occasionally a problem early in the season. Apply as needed.

Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (0 days).

or

Methoxychlor 50 WP, 2 lb (1 day).

Dimethoate (Cygon) 4 EC, 1 pt (7 days).

- or
 - Guthion Solupak 50 WP, 1 to 1 1/2 lb or 2 L (RUP), 2 to 3 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.

Di-Syston 8 E, 1 to 3 pt (30 days) (RUP).

¹ Piperonyl butoxide (*Incite, PBO-8, Butacide*) may increase effectiveness on resistant beetles.

Mites (usually two-spotted), may become a problem in hot, dry weather.

Kelthane MF, 3/4 to 1 1/2 pt (2 days). Limited to 2 applications per season.

Dibrom 8 EC, 1 pt (1 day).

Methyl parathion 7.5 EC, 1/2 to 1 pt (21 days).

Hornworms, apply if larval damage is evident and repeat as needed.

Endosulfan (*Phaser, Thiodan*) 3 EC, 2/3 qt or 50 WP, 1 lb (2 days).

Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

or

or

or

or

Monitor 4 EC 1 1/2 pt (7 days) (RUP). Maximum of 3 applications. Fresh market only. (Michigan SLN label.)

Dylox 80 SP, 1 1/4 lb (21 days).

or

or

or

or

or

or

or

- *Guthion* Solupak 50 WP, 1 1/2 to 3 lb 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications.
- Carbaryl (*Sevin*) 80 S, 1 1/2 to 2 1/2 lb or XLR Plus, 1 to 2 qt (0 days).
- *Penncap-M* 2 F, 4 pt (15 days) (RUP).
- or

Dibrom 8 EC, 1 pt (1 day).

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, or MVP (0 days).

Cabbage loopers, apply as needed.

*Asana XL, 5.8 to 9.6 oz (1 day) (RUP).

- or *Monitor 4 EC, 1 1/2 to 2 pt (7 days) (RUP). Maximum of 3 applications. (Michigan SLN label.)
 - *Lannate 1.8 L, 4 pt or 90 SP, 1 lb (2 days) (RUP).
 - Endosulfan (*Phaser, Thiodan*) 3 EC, 2/3 qt or 50 WP, 1 lb (2 days).
- or Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, or MVP (0 days).

Tomatoes

Tomato fruitworms, occasionally a problem after fruit begins to form. Apply as needed. * Asana XL, 5.8 to 9.6 oz (1 day) (RUP). or Monitor 4 EC, 1 1/2 pt (7 days) (RUP). Maximum of 3 applications. Fresh market only. (Michigan SLN label.) or Lannate 1.8 L, 2 to 4 pt or 90 SP, 1/2 to 1 lb (2 days) (RUP). or Carbaryl (Sevin) 80 S, 1 1/2 to 2 1/2 lb or XLR Plus, 1 to 2 qt (0 days). or Guthion Solupak 50 WP, 1 1/2 to 3 lb or 2 L (RUP), 3 to 6 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications. or Endosulfan (Phaser, Thiodan) 3 EC, 2/3 qt or 50 WP, 1 lb (2 days). or *Dibrom* 8 EC, 1 pt (1 day). or *Penncap-M* 2 F, 4 pt (15 days) (RUP). Fruit flies, may be a problem on certain cracks of ripening fruit. Apply as needed. Malathion 5 EC, $2 \frac{1}{2}$ pt (1 day). or Diazinon 4 EC, 1 pt or 50 WP, 1 lb (1 day) (RUP). or Dibrom 8 EC, 1 pt (1 day). or Guthion Solupak 50 WP, 3/4 lb or 2 L (RUP), 2 pt (7 days). Do not exceed more than 3 applications per season. Allow at least 7 days between applications. Slugs. Metaldehyde 7.5 G, 20 lb, apply between the rows. Avoid contact to edible product. DISEASES Cladosporium leaf mold (Cladosporium fulvum), Sclerotinia white mold (Sclerotinia sclerotiorum) and Botrytis gray mold (Botrytis cinerea), apply weekly as a foliar spray.

Durene 50 W, 2 to 5 lb (0 days). Note: Although the Dyrene label is being withdrawn by the manufacturer, product is still available.

or

Benlate 50 DF, 1/2 to 2 lb (0 days). or

Benlate 50 W, 1/2 to 1 lb (0 days).

Bravo 720, 13/8 to 2 pt (0 days).

Brave 90 DG, $1 \frac{1}{4}$ to $1 \frac{1}{2}$ lb (0 days). or

Manex 4 F, 1 1/5 to 2 2/5 qt (5 days).

Maneb 80 W, 1 1/2 to 3 lb (5 days).

varieties during harvest season. Eggs are laid in

or

or Dithane F-45, 1 1/5 to 2 2/5 gt (5 days). or Dithane 75 DF, 1 1/2 to 3 lb (5 days). or Dithane M-45, 1 1/2 to 3 lb (5 days). or Penncozeb 80 W, 1 1/2 to 3 lb (5 days). or

Maneb + F4, $1 \frac{1}{5}$ to $2 \frac{2}{5}$ gt (5 days). or

Penncozeb 75 DF, 1 1/2 to 3 lb (5 days).

Bacterial spot (Xanthomonas vesicatoria), apply every 5 to 7 days after disease appearance.

Copper sulfate 53 W, 2 to 4 lb (0 days). May be used through irrigation equipment.

Kocide DF, 2 to 4 lb (0 days).

Champ F, 2 2/3 to 5 1/3 pt (0 days).

or Champ Formula 2 Copper, 1 1/3 to 2 2/3 pt (0 days).

or

or

or

or

or

or

Kocide LF, 2 2/3 to 5 1/3 pt (0 days).

Bacterial speck (Pseudomonas tomato), apply every 5 to 7 days after disease appearance.

Copper sulfate 53 W, 2 to 4 lb (0 days). May be used through irrigation equipment.

Copper oxide 80 W, $1 \frac{1}{2}$ to 3 lb (0 days).

or Kocide 101 50 W, 2 lb (0 days).

or

or

Copper Count N 8 L, 1/3 to 3/4 gal (0 days). or

Oxy Cop 8 L, 1/3 to 3/4 gal (0 days).

or

Champ Formula 2 Copper, 1 1/3 pt (0 days). or

Kocide LF, 2 2/3 pt (0 days).

Early blight (Alternaria solani).

Dyrene 50 W, 2 to 5 lb (0 days). Note: Although the Dyrene label is being withdrawn by the manufacturer, product is still available.

Terranil 6 L, 1 3/8 to 2 pt (foliage) (0 days). or Bravo 720 6F, 1 3/8 to 2 pt (foliage) (0 days). or or Bravo 90 DG, 1 1/8 to 1 3/4 lb (foliage) (0 days). or or Terranil 6 L, 2 to 3 pt (fruit) (0 days). or or Bravo 720 6 F, 2 to 3 pt (fruit) (0 days). or or Bravo 90 DG, 1 3/4 to 2 1/4 lb (fruit) (0 days). or or Manzate 200 80 W, 1 1/2 to 3 lb (5 days). or or Penncozeb 80 W, 1 1/2 to 3 lb (5 days). or or Dithane M-45 80 W, 1 1/2 to 3 lb (5 days). or or Maneb 80 W, 1 to 3 lb (5 days). or or Manex 4 F, 1 1/4 to 1 1/2 qt (5 days). or or Manex 4 F, 1 1/5 to 2 2/5 qt (5 days). or or Dithane F-45, 1 1/5 to 2 2/5 gt (5 days). or Dithane 75 DF, 1 1/2 to 3 lb (5 days). Penncozeb 75 DF, $1 \frac{1}{2}$ to 3 lb (5 days). or *Maneb* + zinc F4, $1 \frac{1}{5}$ to $2 \frac{2}{5}$ qt (5 days). or Echo 720, 13/8 to 2 pt (foliage) (0 days). or Echo 720, 2 to 3 pt (fruit) (0 days). or Late blight (Phytophthora infestans). or Ridomil/Bravo 81 W, 1 1/2 to 2 lb (7 days). or or Ridomil MZ-58, 1 1/2 to 2 lb (5 days). or Ridomil 2 E, 4 pt as a soil surface application or under the vines (28 days). or or Ridomil/Copper 70 W, 1 1/2 to 2 1/2 lb (7 days). or Most fungicides that protect against early blight also provide limited late blight protection. or Septoria blight (Septoria lycopersici). or Dyrene 50 W, 2 to 5 lb (0 days). Note: Although or the Dyrene label is being withdrawn by the manufacturer, product is still available. or Terranil 6 L, 1 3/8 to 2 pt (0 days). or or

Bravo 7206 F, 13/8 to 2 pt (0 days). May be used through irrigation equipment.

Bravo 90 DG, 1 1/8 to 1 3/4 lb (0 days).

Manzate 200 80 W, 1 1/2 to 3 lb (5 days).

Dithane M-45 80 W, 1 1/2 to 3 lb (5 days). May be used through irrigation equipment.

Penncozeb 80 W, 1 1/2 to 3 lb (5 days).

Maneb 80 W, 1 1/2 to 3 lb (5 days).

Manex 4 F, 1 1/5 to 2 2/5 gt (5 days).

Dithane F-45, 1 1/5 to 2 2/5 gt (5 days).

Dithane 75 DF, $1 \frac{1}{2}$ to 3 lb (5 days).

Dithane M-45 80 W, 1 1/2 to 3 lb (5 days).

Penncozeb 75 DF, 1 1/2 to 3 lb (5 days).

Maneb + zinc F4, $1 \frac{1}{5}$ to $2 \frac{2}{5}$ qt (5 days).

Echo 720, 13/8 to 2 pt (foliage) (0 days).

Anthracnose (Colletotrichum phomoides).

Dyrene 50 W, 2 to 5 lb (0 days). Note: Although the Dyrene label is being withdrawn by the manufacturer, product is still available.

Bravo 720 6F, 2 to 3 pt (0 days) or Bravo 90 DG, 13/4 to 21/4 lb. May be used through irrigation equipment.

Terranil 6 L, 2 to 3 pt (fruit) (0 days).

Manzate 200 80 W, 1 1/2 to 3 lb (5 days).

Dithane M-45 80 W, 1 1/2 to 3 1b (5 days). May be used through irrigation equipment.

Penncozeb 80 W, 1 1/2 to 3 lb (5 days).

Maneb 80 W, 1 to 3 lb (5 days).

Dyrene 50 W, 2 to 5 lb (3 days). (Do not exceed 30 lb per season.)

Manex 4 F, 1 1/5 to 2 2/5 qt (5 days).

Dithane F-45 4 F, 1 1/5 to 2 2/5 qt (5 days).

Dithane 75 DF, 1 1/2 to 3 lb (5 days).

Penncozeb 75 DF, 1 1/2 to 3 lb (5 days).

Maneb + zinc F4, 1 1/5 to 2 2/5 qt (5 days).

or Echo 720, 2 to 3 pt (fruit) (0 days).

93

Buckeye rot (Phytophthora parasitica).

Ridomil/Bravo 81 W, 1 1/2 to 2 lb (0 days).

Ridomil 5 G, 10 to 20 lbs/acre (7 days). Maximum of 40 lbs/acre/season.

Make applications on a 5- to 7-day schedule depending on disease pressure.

Ridomil/Copper 70 W, 1 1/2 to 2 1/2 lb (7 days).

or

Ridomil 2 E, 4 to 8 pt, applied as a pre-plant incorporated or surface treatment. See label for application instructions.

TURNIPS

Amount of chemical formulation to apply per acre (unless otherwise directed). Apply no closer to harvest than number of days given in parentheses. (RUP) = Restricted Use Pesticide.

SEED TREATMENT

DISEASES

Damping off, apply treatment as dust or slurry.

Thiram 50 WP Dyed, 8 oz/100 lb seed.

Captan 300, 1 1/4 oz/100 lb seed.

Captan 30-DD, 1 1/4 oz/100 lb seed.

or

or

or

Captan 400, 1 to 2 oz/100 lb seed.

or

Captan 400-D, 1 to 2 oz/100 lb seed. or

Captan 75%, 2 oz/100 lb seed.

or

or

42-S Thiram, 8 oz/100 lb seed.

Anchor, 1.5 oz/100 lb seed (Pythium only).

SOIL TREATMENT

INSECTS

Cabbage maggot, apply in 4-inch band at planting.

Lorsban 15 G, 4.6 to 9.2 oz or 4 E, 1.6 to 2.75 fl oz/1,000 ft of row.

FOLIAR TREATMENT

INSECTS

Flea beetles, apply if foliar injury is observed to prevent larval injury to roots.

Carbaryl (Sevin) 80 S, 1 1/4 lb XLR Plus, 1 qt (3 days; 14 days if tops are eaten).

Methoxychlor 50 WP, 2 lb (14 days).

or

or

Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

Cabbage worms, apply when feeding damage is first seen. Repeat as needed.

Carbaryl (*Sevin*) 80 S, 1 1/4 to 2 1/2 lb or XLR Plus, 1 to 2 qt (3 days; 14 days if tops are eaten).

or

Methoxychlor 50 WP, 2 lb (14 days).

or Malathion 5 EC, 2 pt (7 days).

or

Dibrom 8 EC, 1 pt (1 day). or

Bacillus thuringiensis Agree, Biobit, Condor, Cutlass, Dipel, Javelin, MVP, Vault or Xentari (0 days).

Aphids, apply as needed to prevent population buildup.

Diazinon 4 EC, 1 pt (10 days) (RUP).

or

Malathion 5 EC, 2 pt (7 days).

or

Dimethoate (Cygon) 4 EC, 1/2 pt (14 days).

or

*Metasystox-*R 2 SC, 2 pt (7 days; 21 days if tops are eaten).

or

Dibrom 8 EC, 1 pt (1 day). Ground application only.

Methyl parathion 7.5 EC, 1 to 1 1/2 pt (21 days).

DISEASES

Alternaria leaf spot (Alternaria spp.), downy mildew (Peronospora parasitica) apply as needed at 7- to 10-day intervals.

Top-Cop Tri-Basic 4.2 FL, 1 to 2 qt.

or

Top-Cop with Sulfur 55% FL, 2 qt (do not apply at temperatures above 90°F).

APPENDIX A (Seedbed Preparation)

SEEDBED PREPARATION

Clean soil is necessary for good seedbed production. Organisms that cause damage to vegetable seedlings may be present in any soil or growing mixture. Soils may be sterilized by a number of chemical or physical techniques, such as steam or dry heat.

Warnings: All the listed fumigants may be used both in the seedbeds and to treat soils in which vegetables are grown to maturity, with the following exceptions: 1) METHYL BROMIDE and FORMALDEHYDE can be used only for seedbeds. 2) None of the materials can be used where living plants are growing. Carefully read the directions in the table below, and especially those of manufacturers, to avoid danger and to obtain successful results.

SEED TREATMENT

Dust method---place the seed and suggested wettable powders in a closed container and agitate vigorously for several minutes or until eed is coated with dust. For best results, use a container with twice the capacity of the seed treated.

Slurry method---to suggested wettable powders, add enough water to make a sloppy paste or slurry. Treat by stirring or swirling seed in the slurry until thoroughly coated. Dry the seed before planting. Slurries are preferred to dusts because they adhere to the seed better and are less irritating to use.

CHEMICALS SUGGESTED FOR SEEDBED STERILIZATION

METHYL BROMIDE

Brom-O-Gas

Note: Not suitable for celery. Warnings: Fumes are deadly poisonous to humans, animals and growing plants. Avoid use in greenhouses or confined areas unless well ventilated and free of growing plants. Must wear self contained breathing apparatus. Do not wear rubber gloves or boots.

Rate and Method of Application

Inject under sealed plastic cover, 1 to 2 lb per 100 sq ft to 6-in. depth when soil temperature is above 50° F. If soil, air temperature or both are

below 55°F, heat methyl bromide to change the liquid to gas by placing opened can with (1 lb) applicator end up in a bucket of hot water. When dispensing from large containers, direct liquid through a coil of copper tubing immersed in hot water. Remove cover after 24 to 48 hours and aerate soil a minimum of 3 days before seeding, or 5 to 14 days before setting transplants. Do not use methyl bromide on cabbage seed beds.

Chloropicrin

(e. g. Chlor-O-Pic, Picfume)

Warnings: Fumes are very irritating to eyes and are poisonous to growing plants. Wear full coverage protective clothing and a MSHA/ NIOSH-approved respirator with the proper carbon filter.

Rate and Method of Application

Inject 1.6 to 2.3 cc of material 6 in. deep and at 8inch intervals using a hand operated fumigation gun. Treat only when soil temperature 6 inches deep is above 65°F. Pack treated soil and apply water seal (wet to a depth of several inches) or cover with plastic for 48 hours. Cultivate to speed aeration and avoid planting for 2 weeks, or until odor of fumigant is no longer detectable.

FORMALDEHYDE

Note: Not effective for nematodes. Especially suited for cabbage and cauliflower.

Warnings: Fumes are irritating to eyes and nasal passages and poisonous to growing plants. Avoid prolonged contact with skin. Wash off with soap and water. Wear goggles, rubber footwear and rubber gloves when handling. Wear full coverage protective clothing and a MSHA/NIOSH-approved respirator with the proper carbon filter. Ventilate when treating a confined area.

Rate of Method of Application

Mix 1 pt (37% to 40% strength) with 5 gals of water and apply with a sprinkling can at the rate of 1/2 gal/sq ft of soil surface. Treat only if soil temperature 6 in. deep is above 60°F. Cover treated soil with a plastic cover. Leave undisturbed for 48 hours, then cultivate one or more times. Avoid planting for 2 weeks or until odor of fumigant is no longer detectable. Do not use near living plants. As a disinfectant for equipment and storage interiors or greenhouses, spray surfaces with a mixture of 1 pt (37% to 40% strength) in 5 gal of water. Cover equipment with plastic and keep storage or greenhouse closed for 24 to 48 hours after treatment, then air out well before planting.

<u>1,3-D</u>

(Dichloropropene; Telone II)

Warnings: Fumes are irritating to eyes and nasal passages. Prolonged inhalation is dangerous; poisonous to growing plants. Avoid contact with skin. Wash off with soap and water. Wear goggles, rubber footwear and rubber gloves when handling. Wear full coverage protective clothing and a MSHA/NIOSH-approved respirator with the proper carbon filter.

Rate and Method of Application

Apply as a preplant broadcast treatment at least 14 to 21 days prior to planting. Late summer or early autumn is usually best for applying fumigants in Michigan. Inject at 8 inches deep with chisels spaced 10 to 12 inches apart when soil temperature is between 50° and 80°F. Seal immediately after application. If soil is waterlogged or temperature is below 60°F, allow additional time before planting. Use only on crops listed on the respective label.

1,3-D AND CHLOROPICRIN

(e.g., Telone C-17)

Warnings: Fumes are irritating to eyes and nasal passages. Prolonged inhalation is dangerous; poisonous to growing plants. Avoid contact with skin. Wash off with soap and water. Wear goggles, rubber footwear and rubber gloves when handling. Wear full coverage protective clothing and a MSHA/NIOSH-approved respirator with the proper carbon filter.

Rate and Method of Application

Apply as a preplant broadcast treatment at least 14 to 21 days prior to planting. Late summer or early autumn is usually best for applying soil fumigants in Michigan. Inject 8 inches deep with chisels spaced 10 to 12 inches apart when soil temperature is between 50° and 80° F. Seal immediately after application. If soil is waterlogged or temperature is below 60° F, allow additional time before planting. Use only on crops listed on the respective label.

SODIUM METHYLDITHIOCARBAMATE

(Metham) (e.g., Busan 1020 orVapam)

Warnings: Avoid breathing vapor or spray mist. Do not get in eyes, on skin, or clothing. Causes skin irritation. May be fatal if absorbed through skin. Wash with soap and water. Wear full coverage protective clothing and a MSHA/NIOSH-approved respirator to reduce exposure.

Rate and Method of Application

With a sprinkling can, fill with 1 to $1 \frac{1}{2}$ pints metham and water and sprinkle uniformly over 50 sq. ft. of well-prepared soil. Sprinkle immediately with water until soil is sealed, or tarp for 48 hours. Seven days after treatment cultivate area to a depth of 2 in. to aerate soil. Do not seed earlier than 21 days after application if tarp is used. For soil injection, space injectors 5 in. apart and inject metham 4 in. into well-prepared soil. Follow immediately with a roller to smooth and compact the soil surface. Light watering or a tarp after rolling helps to prevent gas escape. For seedbeds, 75 to 100 gal/A (1 1/2 pt. to 2 pt. per 100 sq. ft.) is recommended.



Appendix B Detecting and Avoiding Nematode Problems

Plant parasitic nematodes are microscopic roundworms that live in soil and feed on roots or foliage of economically important plants. Nematode feeding can result in diseased plants with symptoms such as stunting, yellowing, wilting, yield reduction, root galling and the formation of root lesions. Although damage from plant parasitic nematodes costs Michigan vegetable growers millions of dollars annually, many of these losses are never correctly diagnosed. Appendix B provides instructions for the nematode detection methods necessary to avoid or diagnose nematode problems.

A laboratory analysis of soil and root or shoot system tissue is usually necessary for diagnosis or long-term avoidance of plantparasitic nematode problems. In Michigan, this service is provided by the Michigan State University Nematode Diagnostic Service Laboratory, operated under the direction of MSU Extension. There are also a number of private sector laboratories that provide ematode detection services. A \$10 fee is harged by MSU for analyzing each combined soil and root or individual sample. Nine dollars per sample is charged for lots of 20 to 49 samples, and \$8 per sample for 50 or more samples. Pre-payment is desired. A fee of \$8 is charged for all billings. However, growers, pest management organizations, corporations, and researchers can contract with the MSU Nematode Advisory Service Laboratory for billings on a monthly or quarterly basis.

Samples for nematode analysis should be forwarded to:

Nematode Advisory Service Laboratory Department of Entomology Michigan State University East Lansing, MI 48824-1115

Samples taken directly to MSU should be delivered to Room 35 in the basement of the Natural Science Building. All samples must be submitted with a completed nematode sample information form (Fig. 1). These forms are available at county MSU Extension offices.

Sample objective

The results from the samples are used to decide how to deal with nematode problems and how to avoid problems.

Diagnosing problems

When plants exhibit symptoms such as stunting, yellowing, wilting, early-die, yield reduction, root-galling, root-lesions or plant mortality that cannot be attributed to other causes, take samples of appropriate soil, root system, or shoot systems, and submit them for nematode analysis.

Avoiding nematode problems

Generally soil from Michigan agricultural sites should be analyzed for nematodes every 3-5 years. The test results are used to make decisions for avoiding nematode problems.

When to sample

Generally, soil and root samples can be taken, submitted and reliably processed whenever the soil is not frozen. For the best possible results, however, do not take samples until 45 days after annual root growth, and not after the soil is frozen in late fall or winter. When considering fall soil fumigation or spring nematicide application, take and submit samples between the end of July and early September.

How to sample

Sampling instrument: Take samples with a soil sampling tube, trowel, or narrow-bladed shovel at a 2- to 12-inch depth. Include as many feeder roots as possible.

Feeder roots or shoot tissue must always be included for samples submitted for re cov er ing endoparasitic nematodes.

Sample size: Each sample should consist of a pint to a quart of soil taken from a larger sample composed of 10 or more subsamples. The number of samples needed depends on the size, history, and uniform soil texture of the area being investigated (Fig. 2-6).

- Small area (less than 5,000 sq. ft.), take at least 10 subsamples (soil cores or borings). Recommended sampling schemes are illustrated in Figures 2-6.
- Medium area (5,000 sq. ft. to 1 acre), take at least 25 subsamples.
- Large area (1 to 80 acres), take at least 50 subsamples. In Michigan, no one sample should represent more than 80 acres, and each sample should be from an area of uniform soil texture.

Appendix B (continued)

The sampling pattern depends on the commodity and field history. Mix subsamples in a clean pail or a plastic bag and submit one pint to a quart for nematode analysis. This is basically a common-sense approach to sampling, as indicated in Figures 2-6.

Subsamples from problem area: Plantparasitic nematodes feed only on living tissues and are rarely found in dead root samples. Therefore, take samples from the margin of the problem areas where the plants are still living.

Sampling container: A plastic bag can be used for nematode samples. Place samples in plastic bags as soon as possible. Nematodes will be killed if the sample is allowed to dry, and it is important that nematodes are living when the sample arrives at the laboratory.

Sample storage: Soil and root samples should be regarded as perishable. Handle accordingly, and process as quickly as possible. Ideally, they should be stored at 10-15C (50-58F). Do not expose them to direct sunlight or store them in hot areas, such as the trunk of your car. Temperatures greater than 40C (100F) will kill nematodes.

How to submit samples

Samples are usually submitted to the MSU Nematode Laboratory through the local extension office, accompanied by a completed form (Fig. 1). The information required on the form is essential for diagnosing nematode problems and proper recommendations for nematode population management.

It generally takes two weeks from the time a sample is taken until the results are returned to the grower. The results may be returned through the local extension agent, a private consultant, or directly. The rapid root and soil assays used for mineral soils, however, are not always satisfactory for analysis of organic soils. In a few cases, a bioassay that requires a 45day incubation period is used to analyze organic soils. When this procedure is recommended, the grower will be immediately notified of the delay and will receive the results within two months after the sample was received.

Results and recommendations

Sample results and recommendations are usually returned through the local extension agent. The types and numbers of nematodes will be recorded on the assay form along with an indication of whether or not nematodes are a problem (Fig. 7). If nematodes appear to by problem, you will be referred to an appropriate extension bulletin for a recommendation. The recommendation should be discussed in detail with the local extension agent or private consultant. Fig. 1. Completed nematode sample form for vegetable production site.

MICHIGAN COOPERATIVE EXTENSION SERVICE MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN 48824 AND U.S. DEPARTMENT OF AGRICULTURE COOPERATING									
		NEN		DVISO	RY SERVIC	E SAMPLE	SUBN	ISSION FOF	RM
Name	Mike Jones				Present Cro	op/Plant	Swee	et Corn	
Address R	RR2County Ro	ad 3			Variety		M-42	2	
Altun	la	Zip	43072		Planting Da	ite	15 M	lay 93	
County B	urke To	wnship	Monroe		Future Crop	o 1994 <u>:</u>	94	Snap Bea	ins
Section 16	Sample	Date	25 Aug 9	93	Past Crops	1993:	93	Sweet Co	rn
Sample/Fiel	d I.D. Dad's 8	30				1992:	92	Soybeans	
Soil Type	McBay	Sandy L	oam		Nematicide	Use	Nor	ne	
			oribod in MS			Other	(describ		
TYPE OF ANALYSIS REQUESTED Soil and root analysis for root-feeding nematodes (\$10, \$9 or \$8/sample). Foliar nematode analysis (\$10, \$9, or \$8/sample). Verticillium dahliae analysis for potato soil (\$7/sample). Soybean cyst nematode race determination (\$15/field).									
			DIS	EASE	SYMPTOMS	S			
Yell Nec Stur	Above Ground Symptoms lowing crosis nting	% of Plant with Syn 40	ts in Field nptoms		Distributi	n round	k):	Entire Plan Localized Scattered Galls	ting
Oth Retu	er low yields rn Results to <u>Sar</u>	n Smith. RR2	, Consulta	ants	Sympton	ns (check):	Excessive Rot Reduced G	branching Growth
Fruitville, MI County Burke Previous plum orchard had a root-lesion, dagger and ring nematode problem. Objective of this sample is to determine what additional action is needed before planting a peach orchard in 1991.									
49 samples, \$8.00/sample for >50 samples. ² A billing charge of \$8will be added for all sample lots of quarterly contracts not paid at the time of sample submission.									
DO NOT WRITE BELOW THIS LINE Revised 1988									
Number of s	amples received	1				Date receive	d _2	25 Aug 93	
Samples nur	mber(s):	3067				Amount rece	ived \$	0.00	
MSU is an A	ffirmative Action/Ec	qual Opport	unity Institutic	on			M	lichigan State Un	niversity Printing



Fig. 7. Nematode sample results form for a snap bean field with a soybean cyst nematode problem.

MICH A		MICHIGAN COOPERATIVE EXTENSION SERVICE CHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN 48824 AND U.S. DEPARTMENT OF AGRICULTURE COOPERATING							
			I	NEMA	TODE ADVISORY SERVICE REPORT				
Name Mike Jones					Date Processed				
Sample Number					Nematode Analysis Method X C X S BA				
Date Received26 Aug 93					Sample Condition Good				
PLANT PARASITIC NEMATODES, POPULATION OCCURRENCE OF BENEFICIAL NEMATODES AND THRESHOLD									
	Nematode		ulation Root ²	Risk ³ Index	Saprophagous Nematodes CM Predaceous Nematodes FW				
	Root-lesion X Penetrans	_ 5	12	1	Endomycorrnizal Fungi CM Nematode Trapping Fungi NN NN = none AB = abundant				
	False root-lesion				CM = common				
	Cyst Soybean Oat	72 r cysts	312 J2s	5	DIAGNOSIS: Nematode problem site Disease complex problem site Possible problem site				
	Pinewood Stubby-root				Future problem site Possible future problem site				
	Dagger Needle Stunt Lance Sheath Ring Pin								
					Action advisable [X] Employ tactic on a trial basis Refer to MSU Ext. Bulletin No.				
Statistics of the local division of the loca			1	1	E-312 pages 25 E-2200 pages 1-6				
					No action strategy available				
				0	Submit root sample Submit additional soil sample Submit additional soil sample before next snap				
	Spiral								
	Foliar				Soybean cyst nematode problem site				
	Other				• Recommend a non-host in 1994.				
	Other				• Anything other then open beens dry beens				
¹ Nematodes/100 cm ³ soil ² Nematodes/1.0 g root ³ Risk Index 0 = None detected 1 = Low 2-3 = Moderate Sample Fermionic Sample Fermionic Sa			\$ 10. \$ 8. \$ 18.	<u>00</u> 00 ←	 Anything other than shap beans, dry beans, soybeans, peas or alfalfa (Note: total cost would have been \$10 if payment received with the sample.) 				
5 = Severe MSU Lis an Affirmative Action/Equal Opportunity Institution									
1	and an Annihianve Action/Equa	opport	unity Ins	manon	Revised 1989 0-18069				

Michigan State University Printing

Pesticide Use Information Record Keeping Fc



Date mo/day/yr	Crop	Chemical Applied (Trade Name, Formulation & EPA Registration Number)	Rate/Act Total Applied	e Location Size of Area	Target Pest*	Name & Cert. No. of Applicator	Notes**
nio/ duy/ y1	Crop					TI	
			-				
-							
			+				

* i.e., kind of weed, insect, nematode or disease
** "Notes" could include information such as weather, wind conditions, crop stage, pest stage, etc.



Subscribe to Vegetable CAT Alerts to get expert pest management advice when you need it

During the busy growing season, the *Vegetable Crop Advisory Team (CAT) Alert* newsletter delivers timely advice for managing pests. You'll receive the latest recommendations on:

- managing insects, diseases, and weeds of vegetables;
- soil fertility and potato production;
- updates on pesticide registrations and new regulations;
- regional reports from across the state on vegetable growth stages and pest status.
- agricultural weather;

The Alert is published weekly beginning in May until pest activity declines, and then is issued biweekly until fall.

The CAT Alert newsletter is your connection to MSU's expertise

The CAT Alert program uses weekly conference calls to link the MSU Extension faculty with field staff to discuss pest and crop status. At this time, field agents report on crop status and problems in their regions and request specific management advise. The information exchanged is compiled for the fort newsletter that same day and is printed and mailed to subscribers the following day. You re-

How to subscribe

New subscribers can use this form to subscribe. (Regular subscribers are sent a renewal mailing in February.) You may send your subscription in any time during the year, but please note that **the first issue will not arrive until May**. You will receive back issues from the current publishing year, if you subscribe after the start of the season.

Editions available on other crops

In addition to vegetable, Alerts are available in the following areas: field crops, fruit, and landscape/ Christmas trees.

1995 CAT Alert Subscription Form						
Name	I am subscribing to the following editions of the CAT for the 1995 growing season:					
Address	Vegetable CAT Alert	(\$30 each)	\$			
	Field Crop CAT Alert	(\$30 each)	\$			
City, State	Fruit CAT Alert	(\$30 each)	\$			
	Landscape CAT Alert	(\$30 each)	\$			
Phone ()	Total amo	unt enclosed	\$			

Make check payable to Michigan State University. Send your check and this form to: CAT Alerts, Room 11 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039 (Phone 517-355-0117).

PESTICIDE EMERGENCY INFORMATION

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

Current as of November 1994

Human Pesticide Poisoning

Π.

S

MICHIGAN POISON CONTROL SYSTEM

From anywhere in Michigan, call

P

Special Pesticide Emergencies

Animal Poisoning	Pesticide Fire	Traffic Accident	Environmental Pollution	Pesticide disposal information Michigan Department of Natural Resources. Waste Management Division. Monday– Friday: 8 a.m.–5 p.m. (517) 373-2730	
Your veterinarian:	Local fire department:	Local police department or sheriff's department:	Pollution Emergency Alert- ing System (PEAS), Michi- gan Department of Natural Resources:		
Phone No.	Phone No.	Phone No.	Phone No.		
or	and	and	and		
Animal Health Diagnostic Laboratory (Toxicology) Michigan State University: (517) 355-0281	Fire Marshal Division, Michigan State Police: M – F: 8–12, 1–5 (517) 322-5847	Operations Division, Michi- gan State Police: *(517) 336-6605	For environmental emer- gencies: *1-800-292-4706	National Pesticide Telecommunications Network	
	Provides advice on recognizing and				

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Texas Tech University Health Services Center. Monday – Friday: 8:00 a.m. – 6:00 p.m. Central Time Zone **1-800-858-7378**

Revised by Larry G. Olsen, Pesticide Education Coordinator, Michigan State University



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