

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

Mix only what is required for the area to be sprayed according to label directions. Avoid mixing excessive amounts. To do otherwise will create a hazardous waste which is difficult and expensive to dispose of. Keep unauthorized persons out of the area 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 non-corrodible 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 low-pressure 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 should be adjusted and used. For example, if pests are on the underside of the leaves, adjust the implement so that the chemical is 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

nematode-crop action thresholds. These thresholds are published in the MSU Vegetable PM 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 presented in Appendix B.

For More Information

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.

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| AM-95 | <i>Rinsing & Recycling Pesticide Containers</i> | E-2174 | <i>SARA Title III: The Agricultural Businesses' Responsibilities under the Emergency Planning and Community Right-to-Know Law.</i> |
| E-584 | <i>European Corn Borer: Corn, Peppers, Potatoes, Snap Beans</i> | E-2195 | <i>Commercial and Private Applicator Core Manual: Initial Certification</i> |
| E-890 | <i>Detection and Control of Carrot Weevil</i> | E-2195-SP | <i>Manual Basico Para Aplicadores de pesticidas Comerciales y Privados</i> |
| E-959 | <i>Know Your Asparagus Pests</i> | E-2199 | <i>Detection and Control of Nematodes</i> |
| E-965 | <i>Potato Insect Pests</i> | E-2200 | <i>Soybean Cyst Nematode</i> |
| E-966 | <i>Snap Bean Insect Pests</i> | E-2215 | <i>Using Pesticides Safely: A Guide for the Applicator</i> |
| E-967 | <i>Sweet Corn Insect Pests</i> | E-2278 | <i>Managing Sweet Corn Pests in Massachusetts (with Michigan insert)</i> |
| E-968 | <i>Cole Crop Insect Pests</i> | E-2334 | <i>Sara Title III Farm Response Planning: Information Needed to Prepare Offsite Response Plans for Farms in Michigan</i> |
| E-969 | <i>Cucumber, Melon, Squash and Pumpkin Insect Pests</i> | E-2335 | <i>On-Farm Agrichemical Storage & Handling</i> |
| E-970 | <i>Celery and Carrot Insect Pests</i> | E-2340 | <i>Recordkeeping System for Crop Production</i> |
| E-971 | <i>Tomato, Eggplant and Pepper Insect Pests</i> | E-2341 | <i>Recordkeeping System for Crop Production, Annual Record Book (pocket size)</i> |
| E-972 | <i>Lettuce and Onion Insect Pests</i> | E-2342 | <i>Recordkeeping System for Crop Production, Annual Record Book (full size)</i> |
| E-1427 | <i>Disease and Insect Pests of Celery</i> | E-2343 | <i>Field File</i> |
| E-1546 | <i>Take Cover: Protect Yourself from Exposure</i> | E-2413 | <i>Read Before Washing Pesticide-Soiled Clothing - Magnet in English</i> |
| E-1668 | <i>Disorders of Cole Crops</i> | E-2413-SP | <i>Lea Esto Antes de Lavar la Ropa Manchada o Sucia con Pesticides - Magnet in Spanish</i> |
| E-1679 | <i>Disorders of Tomatoes</i> | E-2434 | <i>Silver Scurf of Potato</i> |
| E-1720 | <i>Diseases of Carrots</i> | E-2448 | <i>Diseases of Potato: Fusarium Dry Rot</i> |
| E-1721 | <i>Diseases of Onions</i> | E-2453 | <i>Biological Control of Insects</i> |
| E-1823 | <i>Fusarium Yellows of Celery in Michigan</i> | MWPS-37 | <i>Designing Facilities for Pesticide and Fertilizer Containment</i> |
| E-1858 | <i>Using Spray Additives with Herbicides</i> | NB-07 | <i>Michigan Onion Growers' Manual</i> |
| E-1943 | <i>Bacterial Canker of Tomatoes</i> | NCR-126 | <i>Diseases of Radishes in the U.S.</i> |
| E-2067 | <i>Vegetable Pest Scouting</i> | NCR-261 | <i>Wilt Disorders of Cucurbits</i> |
| E-2099 | <i>Using Chemigation Safely and Effectively</i> | VT-023 | <i>Vegetable Pest Scouting (video)</i> |
| E-2149 | <i>Ten Tips for Laundering Pesticide Soiled Clothing</i> | VT-036 | <i>Integrated Pest Management for Michigan Celery (video)</i> |
| E-2150 | <i>Choosing Clothing for Pesticide Safety</i> | xxx-xxx | <i>Vegetable Crop Advisory Team(CAT) Alerts Newsletter (see p. 103 of this bulletin)</i> |
| E-2160 | <i>Commercial Pesticide Applicator: Vegetable Crop Pest Management - Category 1B</i> | | |
| E-2173 | <i>SARA Title III: The Farmers Responsibility under the Emergency Planning and Community Right-to-Know Law.</i> | | |

Lettuce

Methyl parathion 7.5 EC, 1 to 2 pt (21 days).
or
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
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
Pyrenone, 2 to 12 oz (0 days).
or
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
*Larvin (thiodicarb) 3.2 EC, 16 to 30 oz (14 days).
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
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*).

Rovral 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.

or

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 (7 days).

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 plant-parasitic 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)

or

Bravo 720, 1 1/2 to 2 pt (10 days).

or

Bravo 90 DG, 1 1/8 to 1 3/4 lb (10 days).

PEAS

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.

INSECTS

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.

or

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).

or

Captan 300, 2 oz/100 lb seed.

or

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

or

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

or

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

or

Captan 75%, 1 oz/bu. seed.

or

Anchor, 1.5 to 2.25 oz/100 lb seed (*Pythium* spp. only).

or

Apron FL, 0.75 to 1.5 oz/100 lb seed (*Pythium* spp. only).

or

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 lb 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, 1 7/8 lb or XLR Plus 1 1/2 to 2 1/2 qt (0 days).